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A Performance Quality Index to Assess Professional Conduct of Contractors at Sustainable Construction Projects in Saudi Arabia

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Abstract: The quality performance of contractors in sustainable construction projects is a major concern for the industry. Over the past decade, studies on measurements, factors, and indicators for assessment of the professional conduct of construction companies are to be found in the sustainable construction management literature. There is adequate evidence over the last decade that an increasing number of construction professionals have adopted the measurement of the professional conduct of contractors as a tool to support their future decisions. The method of the Analytical Hierarchy (AHP) process has been deployed to identify the major factors and sub-factors involved in sustainable construction in Saudi Arabia. Using several governing factors, including quality of document submittals (QDS), quality system implementation (QSI), and quality of construction works (QCW), a working framework was developed by using the pair-wise comparison method. The results show that proper accountability and keen consideration of factors that could hinder sustainable construction by contractors contribute to the development of a better perspective on quality issues. After a critical analysis, a Performance Quality Index was developed, and a benchmark value was obtained. The benchmark value of PQI will assist project managers and owners in the sustainable construction sector as a reference for future improvement in the quality performance of contractors.

Keywords: quality performance index; construction management; contractor's performance; sustainable construction

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1. Introduction

In the construction sector, quality is of essential importance to final users. The problems of quality in the construction sector began to be analyzed in the times of the Code of Hammurabi (1750 BC), where the consequence of the death of a construction object user caused by improper construction was the death of the builder [1]. In executing construction projects, achieving quality is a major objective for all stakeholders. Quality can be described as meeting specifications and approved standards agreed upon by stakeholders and is a key factor in achieving organizational success and business growth [2]. Expenditures related to quality constitute almost 1–5% of the total cost of construction projects [3]. Major projects worldwide suffer from poor quality, which is a crucial issue and results in considerable waste of resources. Many researchers around the globe have made several efforts to explore the factors affecting quality performance in all phases of sustainable construction projects. One study stated that the attributes of the local construction industry that impact the quality of construction projects are the competence of the project manager, top management support, and project participant feedback [4–6]. Another study conducted in Hong Kong showed that factors impacting quality are related to project owner requirements, project environment, project manager, project methods, and project management [7]. Thus, having a framework to better address these factors would go a long way in the building industry to increase the quality of deliverables and thus quality of construction.

Sustainable construction projects entail a lot of management in their various phases. When managing construction projects, managers struggle to balance project achievements in terms of time, cost, and quality which is referred to as the iron triangle [8]. Attaining the time and cost objectives are usually the main aspects on which project management focuses. As a result, project quality is sometimes overlooked in the trade-off of other elements of the iron triangle. Despite the importance of quality, a further study stated that quality aspects are sacrificed for the sake of attaining temporary goals such as handing over a critical part of the project [9]. Withal, various professionals emphasize that quality in construction projects should be managed similarly to the time and cost aspects.

Most researchers refer only to the manufacturing industry when discussing quality performance in construction projects. In manufacturing, processes are designed so that products are produced according to specific standards to achieve customer satisfaction and value on investment. Similarly, sustainable construction projects need to be finished according to quality levels as in any other industry. The main aspect of a successful construction project is to be finished within the contracted cost and time, per specifications, and end-user satisfaction [10]. Most of the literature cited in this article discusses sustainable construction practices. The presented article also discusses sustainability in terms of construction processes and not in terms of construction materials. Only quality work can be considered to be sustainable when it helps save finances, time, and various direct and indirect resources of a construction project.

Commonly, the understanding of quality in construction projects satisfies the client's requirements. In construction projects, a quality management system may be asserted to be functioning effectively if the project is completed according to owner requirements [11]. The quality system includes the execution of all processes conforming to the ISO 9000 standard series. ISO standards help to make the construction industry more effective and efficient by establishing internationally agreed design and manufacturing specifications and processes. They cover virtually every part and process of the construction project, from the soil it stands on to the building roof [2]. The ISO 9000 series is specifically a quality management standard that presents guidelines intended to increase business efficiency and customer satisfaction. The goal of the ISO 9000 standard series is to embed a quality management system within an organization, increasing productivity, reducing unnecessary costs, and ensuring the quality of processes and products [2]. Nevertheless, there are claims by several researchers that it is difficult to precisely define quality in construction projects [12], with the reason being the complexity of construction processes, and that the theories of quality in manufacturing and other industries cannot be applied to construction projects [13]. Quality management in construction is to fulfill end-user or client requirements rather than controlling the construction processes. Because of the lack of a precise definition of quality in construction, the industry has limited empirical data to study quality performance, although many attempts have been made to figure out how quality is perceived in construction projects. There are five definitions of quality in construction, as reported [12] which are: as follows: 1. fulfilling client expectations; 2. decreasing the number of defects and reworks; 3. repeat customers; 4. compliance with quality standards; 5. finishing the project within schedule and budget.

Quality is one of the main measures of construction project performance (QPP). Construction phases follow a standard mutually agreed upon by project participants. Withal, the parties involved in the construction project share distinctive perspectives about quality. Thus, construction quality varies based on the place of the study.

There are factors impacting quality that are related to project owner requirements, project environment, project manager, project methods, and project management [7]. Various studies have shown different factors that influence quality and mention various performance indicators as discussed below.

In Taiwan, eight factors were identified that influence the quality of sustainable construction projects, which are: labor skills, compliance with codes and specifications, compliance with client's requirements, satisfying design requirements, schedule compliance, cost compliance, and constructability [14]. In India, a study investigated the attributes of the Indian construction industry that impacts the quality of construction projects with 55 attributes indicating that; competence of project management, top management support, and project participant feedback are among the most impacting success factors [6]. On the other hand, conflict of interests, aggressive working environment, bad climate conditions, and project management ignorance are the most critical failure factors. The affirmation of the role of project manager qualification and top management involvement to achieve the quality performance goals in construction projects is similar to that which the construction industry has with the manufacturing industry. In Switzerland, the impact of various factors affecting the quality of construction projects was examined [15]. The findings showed that the major issues impacting quality performance were related to contractor skills and site supervision. Moreover, adequate scheduling and planning, and labor skills are also important issues affecting quality.

In a broader view of issues affecting construction projects, 26 factors having the most impact on time, cost, and quality of completing construction projects were analyzed to determine whether the time, cost, and quality were affected by the same factors or if they were different [16]. The findings showed that the most influential factor for the time was lack of funding; for the cost, errors in construction material; and for quality, errors in construction work. The main finding of this study was that time, cost, and quality are affected significantly in different ways. Therefore, the project management team could not assume that schedule, budget, and quality were equally affected especially when dealing with critical issues. In Pakistan, the effect of poor quality on owner satisfaction in Pakistani public projects using partial least squares structural equation modeling (PLS-SEM) was investigated [17]. The results showed that variations in the desired quality have a significant effect on owner satisfaction. The main factors that impact the quality of building construction projects in the Gaza Strip were identified [18,19] The results showed that the most important factors were site layout, the experience of site staff, consistency of design documents, the financial power of the contractor, availability of construction materials, subcontractors, political environment, and the control systems used. In Jordan, the most significant factors impacting quality in construction projects were examined based on the perceptions of architects and contractors [20]. The most influencing factors were human resource management, customer satisfaction with uses of technology and supplier management. However, differences have been reported between contractors and architects regarding the use of the technology factor. In various studies related to Saudi Arabia, researchers explored the challenges in the sustainable construction industry using various analytical techniques [21–26]. Another study was conducted to determine the key attributes of effective quality management systems in construction [27]. Findings indicated that substantial improvement can be achieved by utilizing Total Quality Management (TQM) in construction organizations to meet quality requirements.

Despite the availability of a literature review regarding construction project quality, there is a lack of an integrated framework to monitor and assign scores to various contractors, consultants, and other parties involved in the construction phases to be able to achieve quality products at the end of sustainable construction projects. Contractors and owners need to utilize a unified system to determine the quality level achieved during the execution of the project. The key performance indicators for quality and their impacts are not well defined for these projects and therefore have many inputs based on an unstructured expert judgment which creates much disagreement between owners and contractors. A structured and well-defined method is required to determine the impact of quality factors on project performance. Such a method would aid decision-makers during the planning stage to minimize their effect. Owners need clear performance historical data of all previous projects to support them in decision-making during the bidding stage. A performance quality index

(PQI) framework needs to be developed which will help decision-makers to assess the performance of contractors in the sustainable construction area during the construction phase of the projects.

To address the study's primary goal, the following research questions were formulated:

RQ-1: What are the major factors and indicators that reflect the performance of contractors on a construction project?
RQ-2: What could be the priority order of the factors which affect the performance of contractors and how they can be weighed in terms of percentage?
RQ-3: How can a benchmark or an index be created to help assess the professional conduct and performance of contractors on sustainable construction projects?

2. Research Methodology

The methodology and steps followed to complete the research are shown in Figure 1.

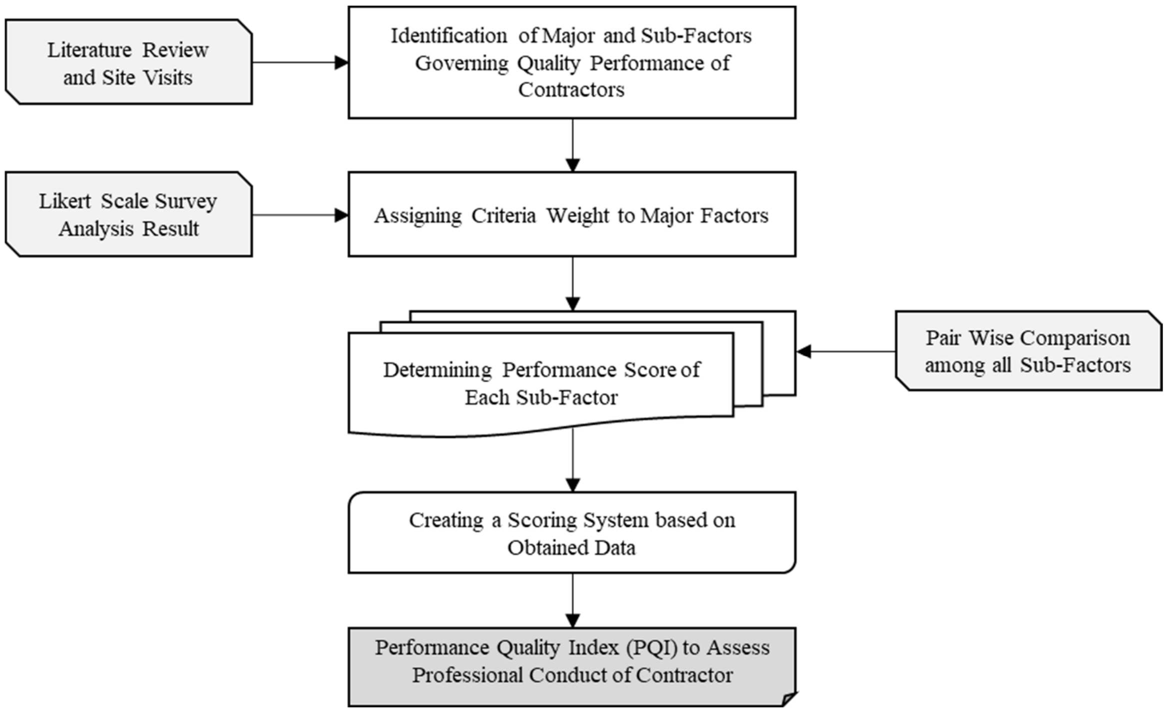

Figure 1. The methodology followed for the research.

To achieve the main goal of this paper, related literature on construction projects was reviewed. Factors affecting quality were identified with the help of a questionnaire survey. The questionnaire was designed in English and Arabic as English is the common international language in Saudi Arabia and respondents could read and understand the questions. The questions were required to be responded to using a Likert scale structured to five scales, that are, 1 = No Effect; 2 = Low Effect; 3 = Moderate Effect; 4 = Strong Effect; and 5 = Very Strong Effect. The factors impacting the construction performance were ranked following similar studies and via a pilot study from experts, according to their severity index. After ranking each of the factors, the statistical results from the questionnaire survey were used to calculate the corresponding weight for each indicator. The pairwise technique is a commonly used systematic procedure to capture experts' opinions on a specific subject. This method is used when there is a lack of empirical evidence or to ensure the validity of results by preserving the heterogeneity of the participants [28,29]. It has been commonly applied in the field of construction management research. Thus, adopting this technique in this study was considered appropriate as it can address the problem of subjectivity in selecting the most important factors for developing the PQI framework. The extraction of the weighting framework included various estimations and examination of the information.

It is likewise critical in decision-making processes to know how dependable and substantial those choices are.

2.1. Analytical Hierarchy Process

Analytical Hierarchy Process (AHP) was deployed to evaluate the scenario. AHP is a method for organizing and analyzing complex decisions, using mathematics and psychology. It was developed by Thomas L. Saaty in the 1970s and has been refined since then [28]. This process contains three major parts: the ultimate goal or problem which is required to be solved, all of the possible solutions called the alternatives and the criteria on which the alternatives are analyzed. AHP provides a rational framework for a needed decision by quantifying its criteria and alternative options and relating those elements to the overall goal. The AHP is most useful when finding decisions for complex problems with high stakes. It stands out from other decision-making techniques as it quantifies criteria and options that traditionally are difficult to measure with hard numbers. Rather than prescribing a correct decision, AHP helps decision-makers find one that best suits their values and their understanding of the problem. The basic workflow of an AHP is shown in Figure 2 below.

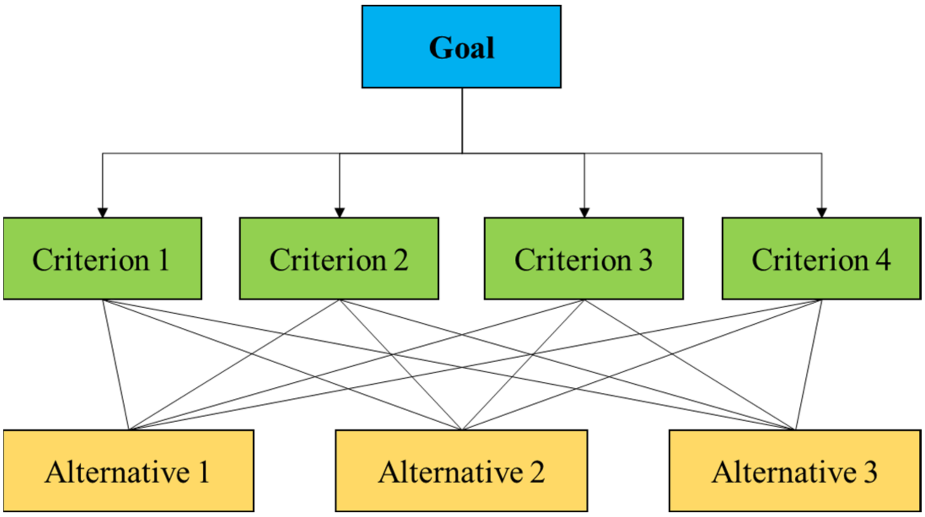

Figure 2. Analytical Hierarchy Process workflow.

While using AHP, first the scenario is decomposed into a hierarchy of more easily comprehended sub-problems, each of which can be analyzed independently. The elements of the hierarchy can relate to any aspect of the decision problem, carefully measured or roughly estimated, well or poorly understood, and anything at all that applies to the decision at hand considering all the possibilities.

Once the hierarchy is built, the decision makers evaluate its various elements by comparing them to each other two at a time, concerning their impact on an element above them in the hierarchy. In making the comparisons, the decision makers can use concrete data about the elements, and they can also use their judgments about the elements' relative meaning and importance; this is generally done through expert opinions and survey questionnaires. It is the specialty of the AHP that not only the available information is used but human judgment is also given significant weighting in performing the evaluations which increases the reliability of the technique and makes it stand out among other decision-making tools. The AHP then converts the evaluations to numerical values that can be processed and compared over the entire range of the problem. A numerical weight or priority is derived for each element of the hierarchy, allowing various and often incommensurable elements to be compared to one another rationally and consistently. In the final step of the process, numerical priorities are calculated for each of the decision alternatives. These numbers represent the alternatives' relative ability to achieve the decision goal, so they allow a straightforward consideration of the various courses of action. The criteria are pairwise compared against the goal for importance. The alternatives are also pair-wise compared against each of the criteria for preference. Saaty's 9-point scale was used for the process of pair-wise comparison of all the factors for ranking them [28]. The comparisons are processed mathematically, and priorities are derived for each node.

The whole AHP analysis can be summarized in the following major steps.

1. Decide an objective or goal.
2. Identify the criteria and all the alternatives.
3. Assign the appropriate weights to each criterion and alternative based on the expert's opinions.
4. Compare each alternative with each criterion by pair-wise comparison.
5. Determine the numerical value of each alternative in order of preference.

2.2. Mathematical Validation of AHP

For any logical analysis, it is also important to validate its reliability through a mathematical procedure. In AHP, the general consistency of judgment is estimated through the Consistency Ratio (CR) which is the ratio of the Consistency Index (CI) and Random Consistency Index (RCI) whose value is fixed for a particular set of criteria. For a set of five criteria involved in an AHP solution, RCI is taken as 1.12 [28]. The consistency ratio is derived to determine the level of logical inconsistencies in the decision-makers' decisions. As Saaty states, a CR value under 0.1 is adequate [28,29].

The value of CR can be calculated by the following equation [28].

$$CR = \frac{CI}{RCI} \quad (1)$$

where CI can be calculated by the following equation [28].

$$CI = \frac{\lambda_{max} - 1}{n - 1} \quad (2)$$

where λ_{max} is the average of the ratios of Weighted Sum and Criterion Weight for all criteria and n is the number of criteria involved in the pairwise comparison process.

3. Results and Discussions

3.1. Identification of Major Factors and Sub-Factors

The survey responses from 60 experts were analyzed. All experts were in senior and management positions in their respective construction companies having an experience of at least 10 years in the industry. As per the developer of the AHP analysis, Thomas L. Saaty, the number of required experts cannot be fixed. He says that even one expert could be sufficient for a specific scenario given that he has practical experience and knowledge about the subject [30]. Hence, the opinion of 60 experts is considered sufficiently reliable. The responses of the experts through the questionnaire survey and literature review were made through the identification of the major factors and the criteria involved in the performance quality of a project. Three major factors identified were the quality of the document submittals (QDS), the quality system implementation (QSI), and the quality of the construction work (QCW).

Various sub-factors, the alternatives, were also listed under each major factor. The factors from the pilot study affecting the quality and performance of the construction project were categorized into three segments, each bearing sub-attributes, as shown in Figure 3 below.

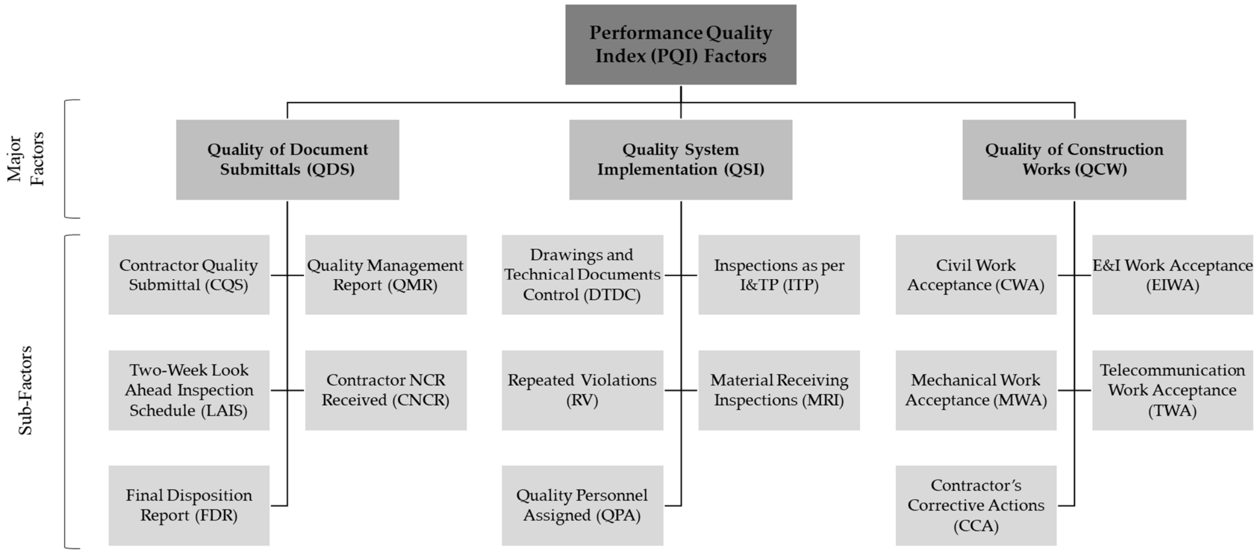

Figure 3. Shortlisted major factors and sub-factors.

3.2. Pair Wise Comparison

From the experts' survey for a typical construction project in Saudi Arabia, a comparison of one criterion with others was done to determine the level of preferences of each pair as shown in Table 1 below. The first pair comprised main factors followed by sub-factors. The number of required comparisons can be determined by using Equation (3) [28] as follows:

$$C_p = \frac{n(n-1)}{2} \quad (3)$$

Table 1. Pair-wise comparison of alternatives in all three criteria.

1	**Quality of Document Submittals—QDS**					**Weight**
	A	B	C	D	E	
A = CQS	A					5
B = QMR	A/1	B				3
C = LAIS	A/1	B/1	C			3
D = CNCR	A/1	D/1	C/1	D		3
E = FDR	A/1	E/B	C/E	D/E	E	4
2	**Quality System Implementation—QSI**					
A = DTDC	A					5
B = ITP	A/1	B				3
C = RV	A/1	C/B	C			4
D = MRI	A/1	B/1	C/1	D		2
E = QPA	A/1	E/B	C/1	D/E	E	4
3	**Quality of Construction Works—QCW**					
A = CWA	A					5
B = EIWA	A/B	B				5
C = MWA	A/C	C/B	C			5
D = TWA	A/D	B/1	C/1	D		5
E = CCA	A/E	E/B	C/E	D/E	E	3

Where C_p is the number of comparisons required and n shows the number of criteria. In this study three major factors and criteria were identified, hence, by using Equation (3) it can be found that there is a minimum of three comparisons required in this step.

3.3. Validation of Analysis

For the validation of the pairwise comparison process, a consistency check was performed. After assigning the weights to all the criteria, the value of λ_{max} turned out to be 3.19. Using Equation (2), the Consistency Index (CI) value was obtained to be 0.095 which resulted in a Consistency Ratio of 0.085 obtained by using Equation (1). This CR value is well within the limits of 0.1 which shows that the weights provided to the factors and sub-factors are consistent enough to be reliable and can be carried forward for further processing. With CR above 0.1 or 10%, it indicates that the pair-wise comparisons should be revisited or reversed [31,32].

3.4. Development of PQI Framework

Through the questionnaire response, the percentage weight of each major factor was calculated which was further used to score the sub-factors of QDS, QSI, and QCW respectively using weighted averages. Analytically it can be shown as follows:

$$PQI = 100\% \Rightarrow QDS + QSI + QCW = 100\%$$
$$But\ QDS \neq QSI \neq QCW$$

Based on the pair-wise comparison of all three major factors, the factor involving the quality of the construction works obtains the highest weighting standing at 43%, followed by the quality of construction works and quality of document submittals, respectively, as shown in Figure 4.

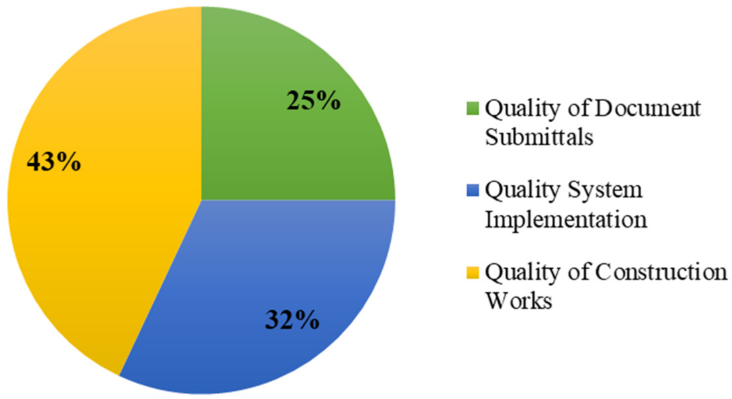

Figure 4. Weighting of major factors.

This implies that while assessing the performance quality of a contractor, his quality of construction work would play a major role and it would be given the highest priority. The second important factor comes out to be the quality system implementation with 32% weighting which is based on document control, inspections, and designated staff to control the quality at the site. The quality document submittals scored 25% of the weighting.

The framework developed for the building projects in Saudi Arabia is shown in Figure 5. The preference scores and rated scores are provided to each sub-factor based on the responses of the experts on the questionnaire survey on a scale of 1 to 5. For each major factor, the Criteria Weight (CW) can be determined by the sum of the products of the preference score and the rated score of each sub-factor. It can be shown mathematically as Equation (4):

$$CW = \sum_{i=1}^{n} (S_{Pi}\, S_{Ri}) \quad (4)$$

where S_{Pi} and S_{Ri} are the preference scores and rated scores of all the sub-factors i involved in a major factor respectively.

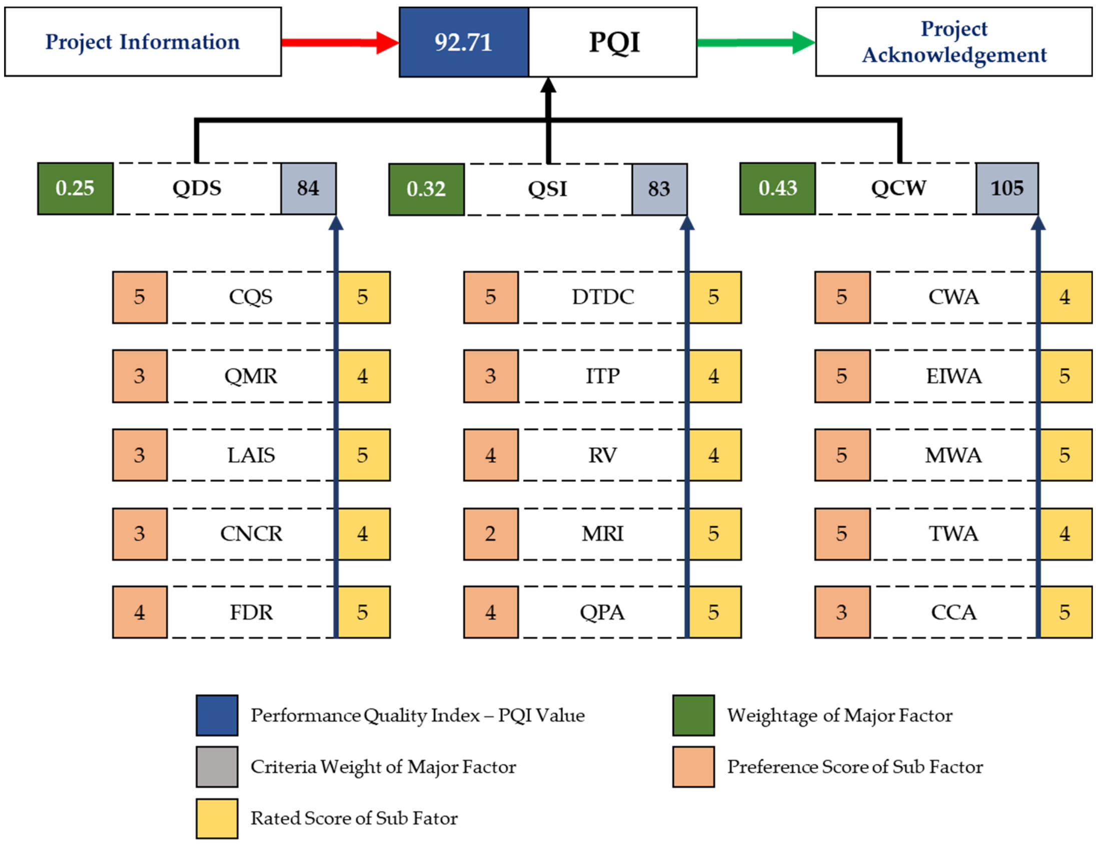

Figure 5. Developed PQI framework for assessing contractor's professional conduct.

Finally, the Performance Quality Index (PQI) can be obtained by the sum of the products of Criteria Weight and the Weighting of each major factor. It can be shown mathematically as Equation (5):

$$PQI = \sum_{j=1}^{n} (CW_j \, W_j) \tag{5}$$

where CW_j and W_j are the criteria weight obtained through Equation (4) and weighting mentioned in Figure 4 of major factors j.

By using the above procedure, the value of PQI comes out to be 92.71. This value shows the minimum score of PQI calculated for any building construction project based on the opinion of the experts and it can serve as a benchmark. Any contractor of a building construction project to be declared as having quality work must score at least 92.71 of PQI.

Evaluating the performance and quality of a contractor in its sustainable construction project is important. This framework will facilitate quality control of sustainable construction projects by taking into consideration the direct and indirect factors that define quality. The outcome of this framework can be used to indicate the quality level of the contractor's performance which can be used to facilitate communication and future improvements. The owners can use this number to evaluate contractors for future projects at the bidding stage. In addition, contractors can use the indicators identified in this model to plan for improvements regarding their quality performance.

4. Conclusions and Recommendations

In the construction sector, many firms and consulting companies are attempting to adopt quality as a tool for continuous improvement. Under the current levels of competition, projects are being implemented in complex, dynamic, and uncertain environments. As project management is becoming more integrated, performance measurement of projects is expanding to include more aspects of performance. In this study, a framework for PQI was developed to rank the various factors affecting construction quality with the help of a questionnaire study and by using the Analytical Hierarchy Process including the pair-wise comparison method; thus, helping to formalize ways by which contractors evaluate projects and assist project managers in controlling projects concerning quality. QCW occupies 43% in terms of the quality of the project. Many companies emphasize the QCW to rate the quality and pay less attention to the QSI and QDS which respectively weights 32% and 25% to the current study. The mathematical validation of AHP analysis was proven by calculating the Consistency Ratio for the scenario which came out to be 8.5% which is well within the range of the suggested 10% value. Based on the weights obtained through the AHP, all the alternatives and criteria were worked out to eventually obtain a PQI value of 92.71. This PQI value can serve as a benchmark. It is recommended that any contractor must obtain this minimum score to be acknowledged as having maintained acceptable quality at his construction project.

This index can be used to indicate the quality level and professional conduct of the contractor's performance to facilitate communication and future improvements. With the use of this index, managers can see a significant decrease in corrective and preventive actions which will also gain them more time. It is important to mention here that the PQI developed in the study is not dependent on the size of the project. It is equally applicable for a small building to a very large building considering that the factors listed in this study are all involved in construction activity. The method of calculating PQI in this research can also be modified and enhanced based on the available parameters for any project where the scenario is different or for any future research and extension of the study. The owners can also utilize this method of evaluating contractors for sustainable projects at the bidding stage.

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Informed Consent Statement: It is stated that the personal information of the respondents was not recorded during the questionnaire survey and only their opinion on the subject matter was taken. The respondents were allowed to keep their identities confidential.

Data Availability Statement: The datasets generated and analysed in the research are available from the corresponding author and can be furnished upon request.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Czajkowska, A.; Kadłubek, M. Management of factors affecting quality of processes in construction enterprises. *Pol. J. Manag. Stud.* **2015**, *11*, 28–38.
2. ISO. *ISO and Construction, International Organisation for Standardisation*; Vernier: Geneva, Switzerland, 2017; ISBN 978-92-67-10779-0.
3. Hays, R. Quality assurance in the building community. In Proceedings of the National Conference Quality Assurance in the Building Community, Anaheim, CA, USA, 16–19 May 1983.
4. Dahanayake, B.; Ramachandra, T. Assessment on Defects Occurrence and Rework Costs in Housing Construction Sector in Sri Lanka. In Proceedings of the 6th Int. Conf. Struct. Eng. Constr. Manag., no. December, Kandy, Sri Lanka, 11–13 December 2015; pp. 33–39.
5. Arditi, D.; Gunaydin, H.M. Total quality management in the construction process. *Int. J. Proj. Manag.* **1997**, *15*, 235–243. [CrossRef]
6. Jha, K.N.; Iyer, K.C. Critical Factors Affecting Quality Performance in Construction Projects. *Total. Qual. Manag. Bus. Excel.* **2006**, *17*, 1155–1170. [CrossRef]

7. Chan, A.P.; Tam, C. Factors affecting the quality of building projects in Hong Kong. *Int. J. Qual. Reliab. Manag.* **2000**, *17*, 423–442. [CrossRef]
8. Pollack, J.; Helm, J.; Adler, D. What is the Iron Triangle, and how has it changed? *Int. J. Manag. Proj. Bus.* **2018**, *11*, 527–547. [CrossRef]
9. Barnes, M. In Proceedings of the Construction Project Management, Seminar on Construction Project Management, London, UK, 21–22 October 1987.
10. Long, N.D.; Ogunlana, S.; Quang, T.; Lam, K.C. Large construction projects in developing countries: A case study from Vietnam. *Int. J. Proj. Manag.* **2004**, *22*, 553–561. [CrossRef]
11. Liu, A.M.M. The quest for quality in public housing projects: A behaviour-to-outcome paradigm. *Constr. Manag. Econ.* **2003**, *21*, 147–158. [CrossRef]
12. Loushine, T.W.; Hoonakker, P.L.; Carayon, P.; Smith, M.J. Quality and Safety Management in Construction. *Total. Qual. Manag. Bus. Excel.* **2006**, *17*, 1171–1212. [CrossRef]
13. Al-Momani, A.H. Examining service quality within construction processes. *Technovation* **2000**, *20*, 643–651. [CrossRef]
14. Tan, R.R.; Lu, Y. On the quality of construction engineering design projects. *Int. J. Qual. Reliab. Manag.* **1995**, *12*, 18–37. [CrossRef]
15. Oke, A.; Aigbavboa, C.; Dlamini, E. Factors Affecting Quality of Construction Projects in Swaziland. In Proceedings of the 9th International Conference on Construction in the 21st Century, Dubai, United Arab Emirates, 5–7 March 2017.
16. Larsen, J.K.; Shen, G.Q.; Lindhard, S.M.; Brunoe, T.D. Factors Affecting Schedule Delay, Cost Overrun, and Quality Level in Public Construction Projects. *J. Manag. Eng.* **2016**, *32*, 04015032. [CrossRef]
17. Hussain, S.; FangWei, Z.; Ali, Z. Examining Influence of Construction Projects' Quality Factors on Client Satisfaction Using Partial Least Squares Structural Equation Modeling. *J. Constr. Eng. Manag.* **2019**, *145*, 05019006. [CrossRef]
18. Rustom, R.N.; Amer, M.I. Modeling the factors affecting quality in building construction projects in gaza strip. *J. Constr. Res.* **2006**, *7*, 33–47. [CrossRef]
19. Amer, I. Modelling The Factors Affecting Quality of Building Construction Projects During The Construction Phase in Gaza Strip. Ph.D. Thesis, The Islamic University of Gaza, Al Zahra, Gaza, Palestine, 2002; p. 130.
20. Sweis, R.J.; Shanak, R.O.; Abu El Samen, A.; Suifan, T. Factors affecting quality in the Jordanian housing sector. *Int. J. Hous. Mark. Anal.* **2014**, *7*, 175–188. [CrossRef]
21. Shaawat, M.E.; Jamil, R. A Guide to Environmental Building Rating System for Construction of New Buildings in Saudi Arabia. *Emir. J. Eng. Res.* **2014**, *19*, 47–56.
22. Abazid, M.; Gokcekus, H.; Celik, T. Study of the Quality Concepts Implementation in the Construction of Projects in Saudi Arabia by using Building Information Modelling (BIM). *Int. J. Innov. Technol. Explor. Eng.* **2019**, *8*, 84–87.
23. Shaawat, M.E.; Jamil, R.; Al-Enezi, M.M. Analysis of Challenges in Sustainable Construction Industry by Using Analytic Hierarchy Process: A Case Study of Jubail Industrial City, Saudi Arabia. *Int. J. Sustain. Real Estate Constr. Econ.* **2018**, *1*, 109–122.
24. Alyami, S.H.; Abd El Aal, A.K.; Alqahtany, A.; Aldossary, N.A.; Jamil, R.; Almohassen, A.; Alzenifeer, B.M.; Kamh, H.M.; Fenais, A.S.; Alsalem, A.H. Developing a Holistic Resilience Framework for Critical Infrastructure Networks of Buildings and Communities in Saudi Arabia. *Buildings* **2023**, *13*, 179. [CrossRef]
25. Mahamid, I. Factors contributing to poor performance in construction projects: Studies of Saudi Arabia. *Aust. J. Multi-Discip. Eng.* **2016**, *12*, 27–38. [CrossRef]
26. Ali, H.A.E.M.; Al-Sulaihi, I.A.; Al-Gahtani, K.S. Indicators for measuring performance of building construction companies in Kingdom of Saudi Arabia. *J. King Saud Univ. Eng. Sci.* **2013**, *25*, 125–134. [CrossRef]
27. Burati, J.L., Jr.; Matthews, M.F.; Kalidindi, S.N. Quality management in construction industry. *J. Constr. Eng. Manag.* **1991**, *117*, 341–359. [CrossRef]
28. Saaty, T.L. *The Analytical Hierarchy Process, Planning, Priority*; Resource allocation; RWS Publications: Pittsburgh, PA, USA, 1980.
29. Saaty, T.L. The Modern Science of Multicriteria Decision Making and Its Practical Applications: The AHP/ANP Approach. *Oper. Res.* **2013**, *61*, 1101–1118. [CrossRef]
30. Saaty, T.L.; Özdemir, M.S. How Many Judges Should There Be in a Group? *Ann. Data Sci.* **2014**, *1*, 359–368. [CrossRef]
31. Sourani, A.; Sohail, M. The Delphi method: Review and use in construction management research. *Int. J. Constr. Educ. Res.* **2015**, *11*, 54–76. [CrossRef]
32. Setiawan, A.; Sediyono, E.; Moekoe, D.A. Application of AHP method in determining priorities of conversion of unused land to food land in Minahasa Tenggara. *Int. J. Comput. Appl.* **2014**, *89*, 2014.