Enhancing Subcontractor Selection in Construction Projects Using the Analytic Hierarchy Process (AHP)

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Abstract

The increasing complexity of construction projects and the growing demand for specialized contractors have made subcontractors essential stakeholders in the successful delivery of construction activities. However, selecting a professional, highly qualified, and efficient subcontractor remains one of the most critical challenges in the construction industry. Traditionally, subcontractor selection has relied primarily on the lowest bid price, a subjective approach that often fails to ensure the best choice. In reality, subcontractor selection is a complex, multi-criteria decision-making (MCDM) problem. This research aims to develop a systematic and structured model to enhance the subcontractor selection process. The model is based on the Analytic Hierarchy Process (AHP), a widely recognized MCDM technique. The proposed model was validated through a case study, demonstrating its simplicity, practicality, and effectiveness in supporting informed decision-making and identifying the most suitable subcontractor.

1. Introduction

The construction industry is a cornerstone of economic development and a vital driver of growth across various sectors, including tourism, healthcare, education, agriculture, and commerce. In Palestine, the significance of this sector is particularly pronounced. According to the Palestinian Central Bureau of Statistics (PCBS), the construction sector contributes over 11% to the national Gross Domestic Product (GDP), making it one of the key pillars of the economy. In addition to its economic impact, the industry provides employment opportunities to a large segment of the population and stimulates activity in supporting industries. Despite its importance, the construction sector is becoming increasingly complex and faces numerous challenges. These challenges include escalating project sizes, tighter timelines, stricter quality requirements, and higher safety expectations. Managing construction projects effectively requires not only sound planning and coordination but also strategic decisions regarding project participants, particularly subcontractors, who are responsible for delivering many of the specialized components of construction work.

Subcontracting has become a common and necessary practice in the modern construction industry. A significant portion of construction work is executed by subcontractors, making their role indispensable to project success. Subcontractors typically perform specific tasks or provide critical resources such as labor, materials, equipment, and sometimes design input. Therefore, the ability of main contractors to select qualified and reliable subcontractors directly affects project outcomes (Polat et al., 2016; Basu et al., 2017; Hartmann et al., 2009; Alva et al. 2021).

However, one of the most persistent and overlooked issues in the industry is the inappropriate and often subjective selection of subcontractors. In many cases, especially in Palestine and other developing countries, subcontractor selection is based almost entirely on financial considerations, with contracts frequently awarded to the lowest bidder. While this approach may appear cost-effective initially, it often leads to substandard outcomes. Relying solely on the lowest bid price as the main selection criterion introduces significant risks to construction projects. Numerous studies have highlighted the negative consequences of this practice:

- Quality Compromise: Subcontractors who win bids by underpricing may cut corners during execution, resulting in poor workmanship and increased claims (Lavelle et al., 2007; Daoor et al., 2020).
- Financial Instability: Operating with minimal profit margins may discourage subcontractors from investing in quality resources or skilled labor, which can jeopardize the entire project (Dolama & Sadeghpour, 2015, Daoor et al., 2020).
- Safety Lapses: A focus on cost reduction often leads to neglect of safety standards and regulatory compliance, increasing the likelihood of accidents and legal issues (Manoharan, 2005, Daoor et al., 2020).

Moreover, scholars such as Abunemeh et al. (2022) have emphasized that project success is closely tied to the selection of the right contractors. Banaitiene and Banaitis (2006) argued that the use of inappropriate criteria and unreliable evaluation methods often results in contracts being awarded to underqualified subcontractors. The implications are far-reaching, including project delays, cost overruns, structural failures, client dissatisfaction, and in some cases, subcontractor bankruptcy (El Wardani et al., 2006).

Given the shortcomings of current subcontractor selection practices, particularly the over-reliance on lowest-price bidding, there is an urgent need to adopt a more balanced and objective approach. The selection process should consider multiple criteria beyond cost, such as technical expertise, financial capacity, safety record, experience, and overall performance history. This research aims to address this gap by identifying the most significant criteria that should be used to evaluate subcontractors and developing a structured, multi-criteria decision-making (MCDM) model using the Analytic Hierarchy Process (AHP). The proposed model is designed to support contractors in making more informed, transparent, and balanced decisions when selecting subcontractors for specialized tasks. By doing so, it aims to enhance project outcomes, mitigate risks, and improve the overall performance of the construction industry in Palestine and similar contexts.

2. Methodology

The methodology employed to achieve the research objectives is illustrated in Figure 1. The process begins with a comprehensive review of existing literature to identify the key criteria commonly used for subcontractor evaluation and to assess the feasibility of applying a multi-criteria decision support system within the context of this study. Following the literature review, a structured questionnaire was designed and distributed to experienced professionals in the construction industry to determine the most critical criteria for evaluating subcontractors. The data collected from the survey informed the development of an Analytic Hierarchy Process (AHP) model, which was subsequently constructed to support systematic subcontractor evaluation.

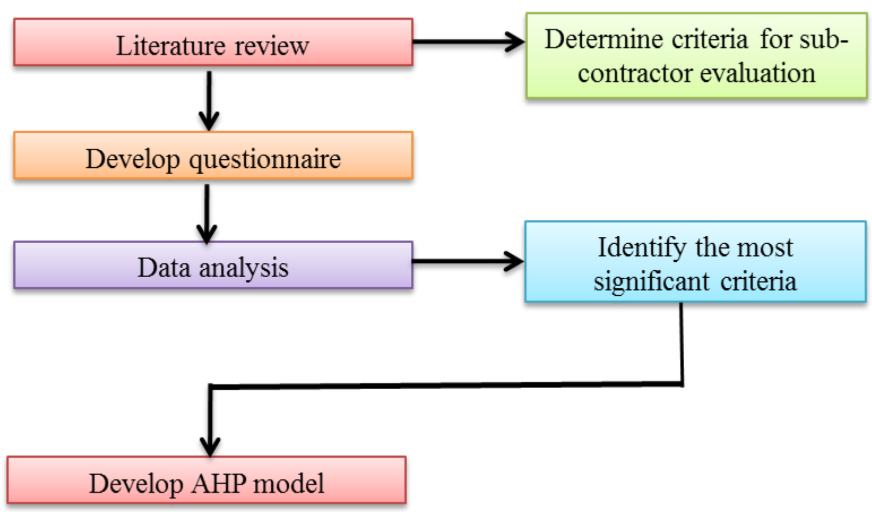

Figure 1. Methodology flowchart

2.1.Questionnaire Design and Implementation

The questionnaire was developed based on criteria identified from an extensive literature review and refined with input from industry experts to ensure clarity, simplicity, and accuracy. Its objectives were: (1) to identify the most significant criteria adopted for subcontractor evaluation and selection to be then used for developing the AHP model.

The questionnaire was distributed to 30 professional contractors in the West Bank with direct experience in subcontractor evaluation and selection. Nineteen completed responses were received, yielding a response rate of approximately 60%.

3. Results, model development, and implementation

From the initial set of seventeen evaluated criteria, only the ten most significant were selected for the development of the Analytic Hierarchy Process (AHP) model for subcontractor evaluation and selection. These criteria include: quality of work, technical capability, construction capacity, reputation, financial stability, bid price, relevant experience, staff and equipment availability, official classification, and prior collaboration.

3.1. Development AHP Model for subcontractor selection

The Analytic Hierarchy Process (AHP) was applied to develop a structured decision-making model for selecting the most suitable subcontractor. The process comprised four steps: defining the problem in a hierarchical structure, performing pairwise comparisons, calculating eigenvalues to determine criteria weights, and synthesizing these weights to produce the final ranking. Figure 2 presents the Analytic Hierarchy Process (AHP) model developed for subcontractor evaluation and selection. The model is organized into three hierarchical levels. Level 1 defines the main goal, namely, the selection of the most appropriate subcontractor. Level 2 specifies the evaluation criteria against which each subcontractor will be assessed. Level 3 comprises the set of potential subcontractor candidates from which the final selection will be made. The model was implemented in Expert Choice software.

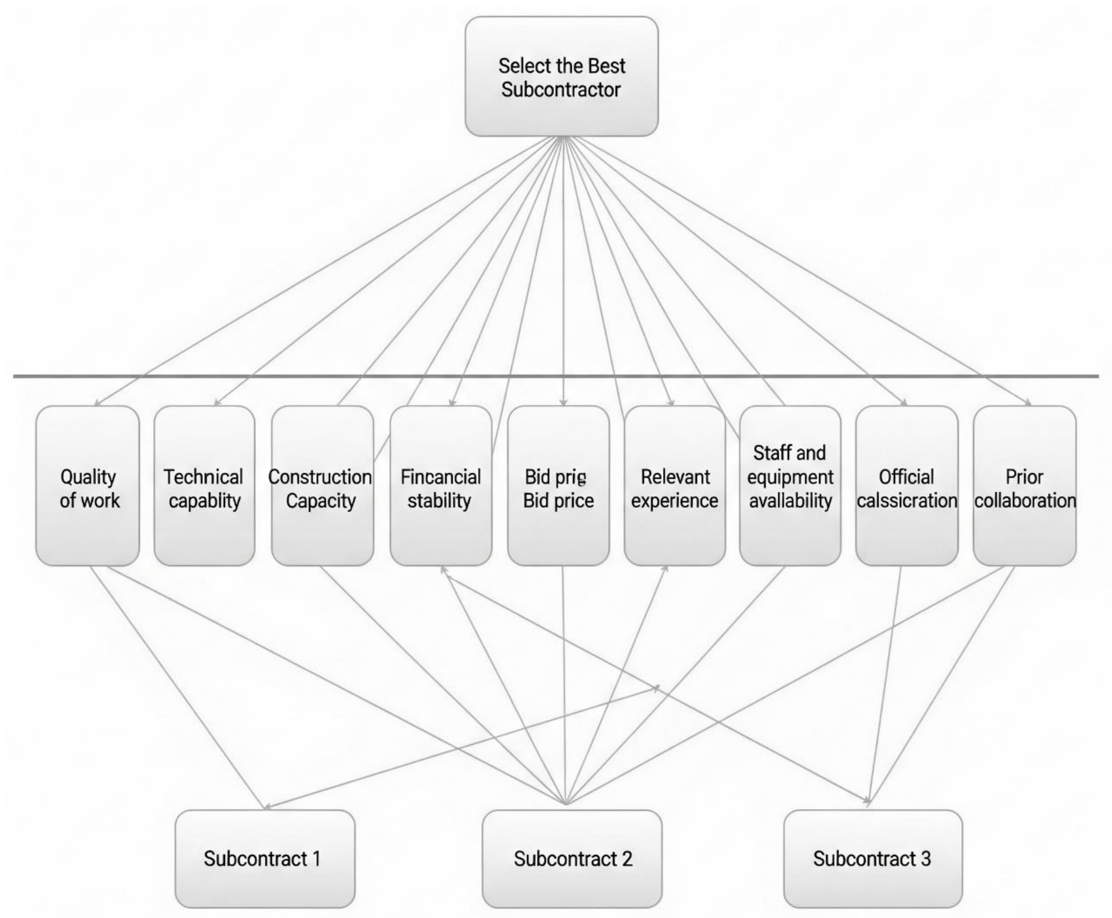

Figure 2. AHP Model for Subcontractor Selection

3.2.Pair-wise Comparison among criteria

To prioritize the top ten subcontractor evaluation criteria, a pairwise comparison questionnaire was conducted using the Analytic Hierarchy Process (AHP) 1–9 scale, where 1 denotes equal importance and 9 denotes extreme importance, with even numbers representing intermediate judgments. Each criterion was compared against all others, resulting in 45 comparisons n(n–1)/2. This method captures the relative influence of each criterion on the overall decision, forming the basis for calculating precise weightings in the AHP model.

For example, as shown in Table 2, when comparing financial stability and technical capability, if financial stability is considered strongly more important, it is assigned a score of 5. Similarly, when comparing financial stability with Construction capacity, if Construction capacity is judged moderately important, it is assigned a score of 3. These individual judgments populate the pairwise comparison matrix, enabling the computation of relative weights for all criteria.

Table 1. Pair-wise comparison example

Decision criteria	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Decision criteria
Financial stability					✓													Technical capability
Financial stability											✓							Construction capacity

The Expert Choice software was employed to analyze data collected from the participating contractors. Using pairwise comparisons, each evaluation criterion was assessed relative to the others, as illustrated in Figure 3. The analysis indicates that the five most influential criteria in subcontractor selection, ranked in descending order of importance, are: quality of work, construction capacity, technical capability, staff and equipment availability, and relevant experience. This ranking suggests that contractors place the highest priority on a subcontractor's proven ability to deliver superior workmanship and manage substantial project demands, while also valuing technical expertise, resource readiness, and prior experience in similar projects.

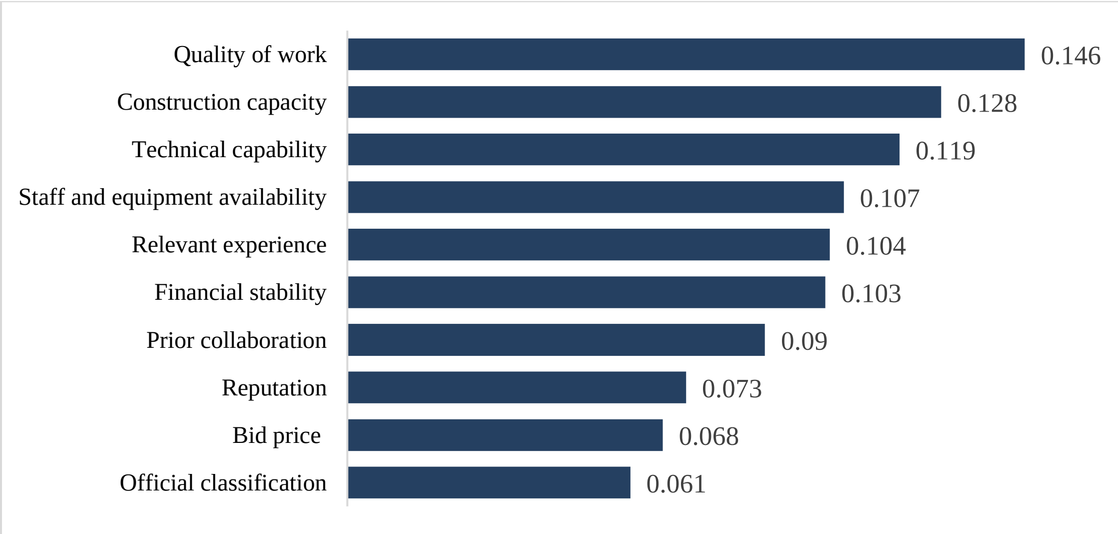

Figure 3. Priority ranking of criteria for the goal of selecting the most suitable subcontractor

3.3.Pairwise comparison among alternatives concerning each criterion

To prioritize the alternatives and determine the most suitable subcontractor, a nine-point scale commonly used in the Analytic Hierarchy Process (AHP) to express the intensity of preference was applied to perform pairwise comparisons among the alternatives concerning each criterion at the second level of the hierarchy. The *Expert Choice* software then automatically generates a comparison matrix for each alternative relative to every criterion, facilitating the calculation of priority weights. An example illustrating the hierarchical levels and corresponding factors is presented in Figure 4.

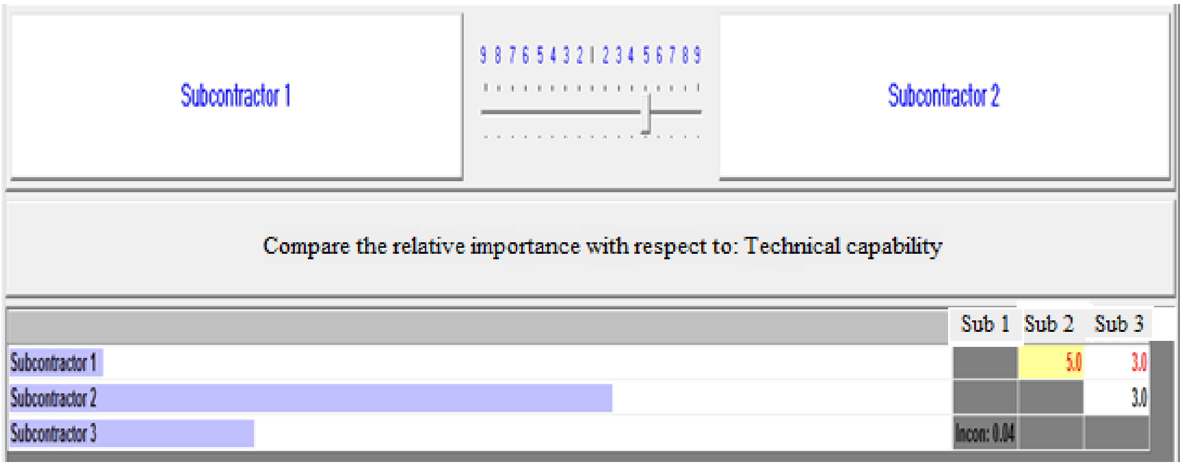

Figure 4. Pairwise comparison among the proposed subcontractor alternatives in relation to the technical capability evaluation criterion

The corresponding weights of the subcontractor alternatives for each evaluation criterion are presented in Figures 5–14.

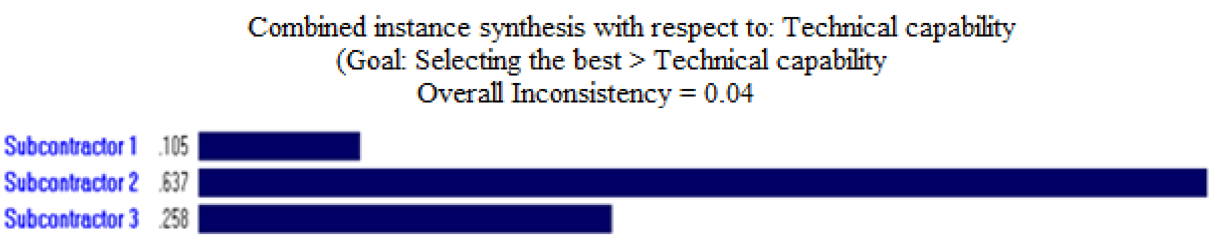

Figure 5. Relative weights of subcontractor alternatives in relation to the technical capability criterion

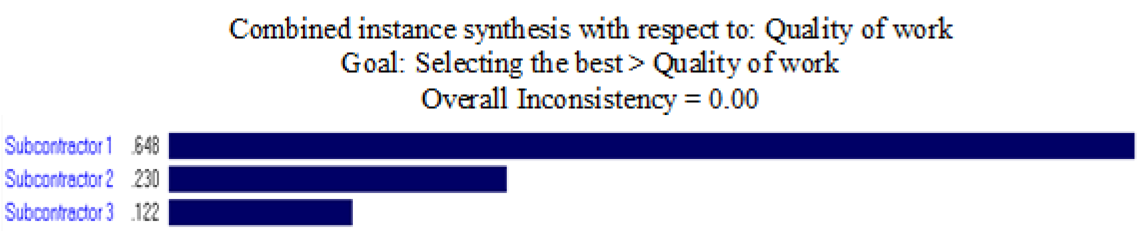

Figure 6. Relative weights of subcontractor alternatives in relation to the quality of work criterion

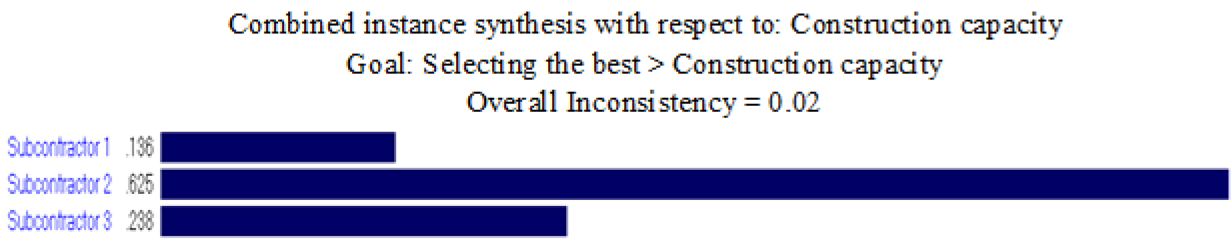

Figure 7. Relative weights of subcontractor alternatives in relation to the construction capacity criterion

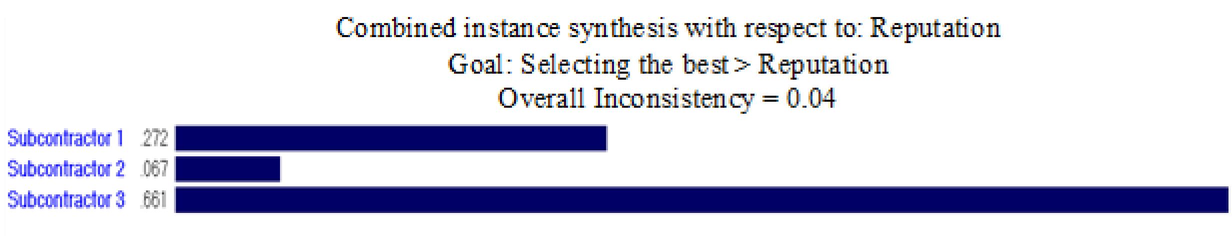

Figure 8. Relative weights of subcontractor alternatives in relation to the reputation criterion

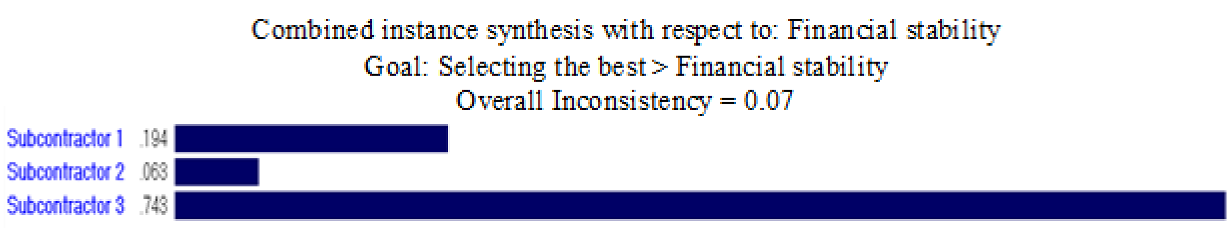

Figure 9. Relative weights of subcontractor alternatives in relation to the financial stability criterion

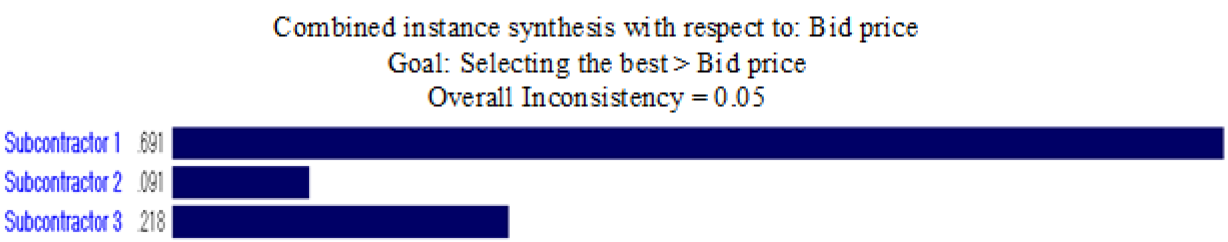

Figure 10. Relative weights of subcontractor alternatives in relation to the bid price criterion

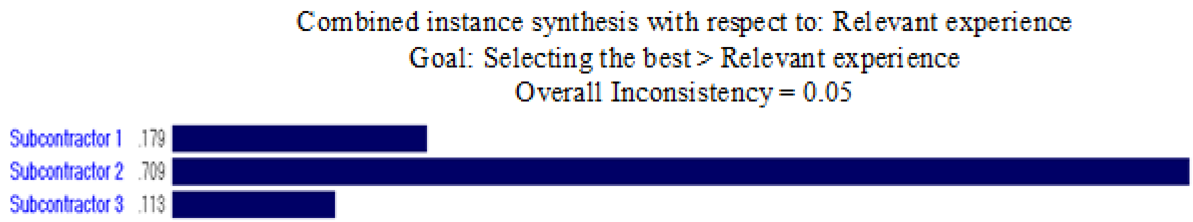

Figure 11. Relative weights of subcontractor alternatives in relation to the relevant experience criterion

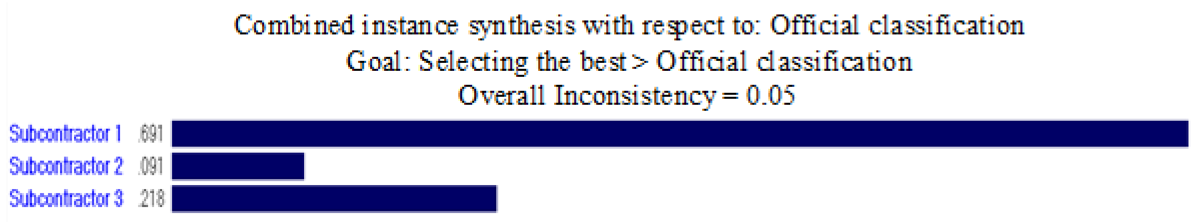

Figure 12. Relative weights of subcontractor alternatives in relation to the official classification criterion

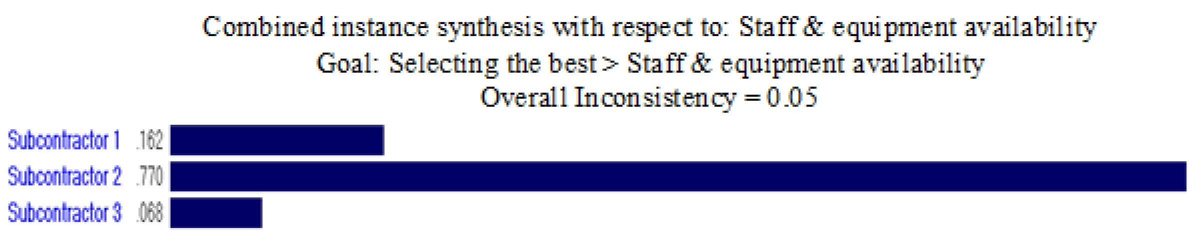

Figure 13. Relative weights of subcontractor alternatives in relation to the staff and equipment availability criterion

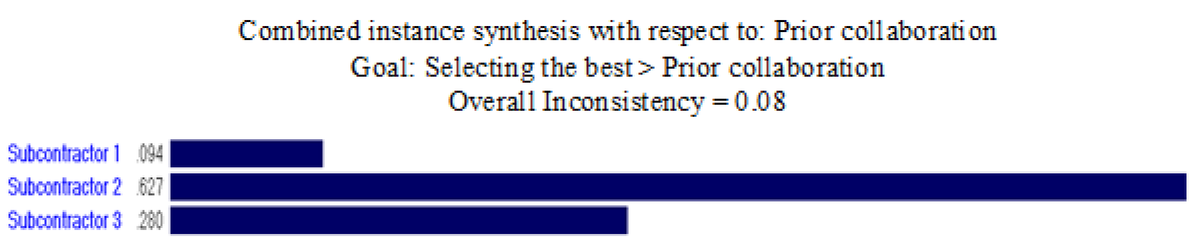

Figure 14. Relative weights of subcontractor alternatives in relation to the prior collaboration criterion

After determining the relative importance of each selection criterion and the corresponding weights of the subcontractor alternatives, the *Expert Choice* software synthesizes the results using the Analytical Hierarchy Process (AHP). This process yields the final ranking of alternatives, identifying the most suitable subcontractor, as presented in Figure 15.

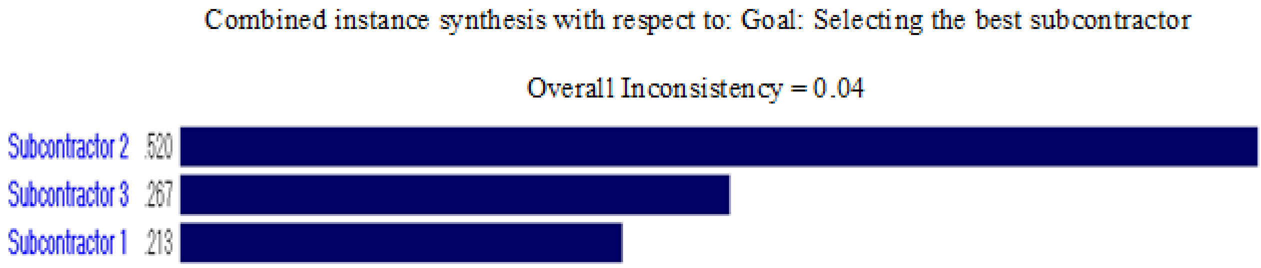

Figure 15. Priority ranking of subcontractors with respect to the overall selection goal

Figure 15 indicates that Subcontractor 2 is the most preferred option, having achieved the highest weight of 0.52.

4. Conclusion

This study aimed to develop a systematic and transparent framework for evaluating and selecting subcontractors in the construction industry using the Analytic Hierarchy Process (AHP). Ten key criteria were identified and structured hierarchically, with data collected through pairwise comparisons from industry experts. These criteria formed the second level of the AHP hierarchy. The methodology involved pairwise comparisons of criteria and alternatives, conducted using the nine-point AHP scale, with data collected from experienced contractors. The *Expert Choice* software was employed to generate comparison matrices, calculate criteria weights, and determine the relative priorities of subcontractor alternatives. The results indicated that the five most influential criteria, in descending order, were quality of work, construction capacity, technical capability, staff and equipment availability, and relevant experience.

While the proposed model provides a structured and evidence-based decision-making tool, certain limitations should be acknowledged. The analysis was based on expert judgments from a specific set of contractors, which may limit the generalizability of the results to other regions or project types. In addition, the criteria weights and rankings may vary depending on market conditions, project complexity, or contractor-specific requirements. Future research could expand the study by incorporating a larger and more diverse pool of industry experts, testing the model across different types of construction projects, and integrating other multi-criteria decision-making methods, such as fuzzy AHP or TOPSIS, to account for uncertainty in expert judgments. Such enhancements would further strengthen the robustness and applicability of subcontractor selection models in the construction sector.

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