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Contractor Selection Criteria Impact on Construction Project Delays using AHP and TOPSIS: A Case Study

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***Abstract*:** Delays are a prevalent challenge in construction projects, affecting their performance across various phases. These delays often stem from the interplay of key project constraints: scope, cost, time, and quality. Changes in one constraint typically trigger alterations in others, leading to time overruns. Such delays impose significant financial and economic burdens, underscoring the importance of understanding their root causes. This study identifies and prioritizes contractor selection criteria that impact project delays, focusing on Mashhad's 12th district. The analysis evaluated contractor capabilities, management skills, quality assurance, reliability, resource availability, commitment, and financial stability. A sample of 384 individuals, selected from a statistical population of 10,000 using Morgan's table, was surveyed. Respondents included 289 workshop employees and 95 technical and management office staff. The AHP and TOPSIS ranking revealed that contractor ability, with a weight of 0.166, is the most critical factor for achieving project success in the region. Conversely, financial factors, though significant, ranked lowest with a weight of 0.073. These findings suggest that while financial challenges are common in construction, the primary cause of delays is the contractors' lack of technical ability and inefficient resource utilization. The study highlights the need for prioritizing contractor selection criteria to mitigate delays and enhance project outcomes. By focusing on competency and effective management, projects in Mashhad's 12th district—and similar regions—can achieve greater success despite financial constraints.

Keywords: Project management, Contractor selection, Delays, Construction project, Hierarchical analysis, TOPSIS.

I. INTRODUCTION

The evaluation and selection of contractors play a pivotal role in the construction process, as contractors serve as key contributors in transforming resources into final outputs. With the majority of a construction project's budget allocated to execution, selecting a capable contractor is essential to ensure timely completion within the prescribed quality and resource constraints. A competent contractor must demonstrate the ability to complete projects efficiently and effectively, aligning with the allocated time and resources (Perera & Sutrisna, 2010). Annually, billions of dollars are invested in national infrastructure through public and private initiatives. However, significant delays in execution, often caused by mismatches between project scope and contractor capacity, impose economic and social costs (Razi et al., 2019). Effective contractor evaluation requires a focus on execution quality and adherence to timelines. A contractor must navigate various challenges, including resource procurement, legal compliance, and financial constraints, while shouldering the responsibility for project success (Sodangi & Salman, 2022).

Contractor selection is a cornerstone of successful project execution, directly influencing the timeliness, quality, and overall success of construction projects (Olaniran, 2015). Contractors play a critical role in transforming project resources into tangible outcomes, making their abilities and management skills pivotal for achieving project objectives (Semaan & Salem, 2017). An inadequate or ill-suited contractor can lead to inefficiencies, mismanagement of resources, and project delays, which in turn escalate costs and compromise stakeholder satisfaction. Recognizing the significance of contractor selection is essential for avoiding such setbacks and ensuring the seamless delivery of construction projects (Mahdi et al., 2002). Delays are one of the most common challenges in construction, often stemming from poor contractor performance, inadequate planning, or resource mismanagement (Braimah & Ndekugri, 2008). These delays not only extend the project timeline but also inflate budgets, disrupt schedules, and undermine the confidence of stakeholders. In large-scale infrastructure projects, where financial and social implications are substantial, delays can have far-reaching consequences, impacting regional development and public perception (Amireh, 2022). Effective contractor selection serves as a preventive measure, minimizing the risks of delays by ensuring that the chosen contractor is capable of meeting the project's demands (Mahdi et al., 2002).

The economic and social implications of project delays are profound. Delayed infrastructure projects, such as roads, bridges, and water facilities, hinder societal progress, affecting communities reliant on these developments (Lee et al., 2020). From an economic perspective, delays increase costs through extended labor, equipment usage, and inflation. This financial burden often strains public budgets, particularly in government-funded projects (Ayettey & Danso, 2018). By selecting contractors with a proven track record of efficiency and reliability, project managers can mitigate these risks and ensure that resources are utilized effectively (Jaskowski et al., 2010).

Controlling delays requires a multi-faceted approach, beginning with the contractor selection process (Hossen et al., 2015). Evaluating contractors based on their technical capabilities, financial stability, management skills, and past performance can significantly reduce the likelihood of delays (Mahdi et al., 2002). Advanced decision-making frameworks like the Analytical Hierarchy Process (AHP) and TOPSIS provide structured methods for assessing and prioritizing contractor attributes (Zohremotadel et al., 2021). These tools enable stakeholders to make informed decisions by considering multiple criteria, ensuring that selected contractors align with the project's requirements and goals (Leśniak et al., 2018). Beyond selection, proactive delay management strategies are crucial. Clear communication, robust project scheduling, and monitoring of progress help identify potential delays early, allowing for timely interventions (Martin et al., 2018). Contractors must also demonstrate adaptability in responding to unforeseen challenges, such as weather conditions, supply chain disruptions, or regulatory changes (Perera & Sutrisna, 2010). Effective collaboration between project stakeholders and contractors fosters a cooperative environment where potential obstacles can be addressed collaboratively (Amireh, 2022).

The importance of contractor selection in controlling delays is further underscored by its impact on project quality and long-term outcomes (Wang et al., 2013). Delays often lead to rushed work, which can compromise the quality of construction. Substandard infrastructure not only poses safety risks but also requires costly repairs and maintenance in the future (Naji et al., 2022). By ensuring that contractors are well-equipped to handle the complexities of the project, stakeholders can safeguard both the immediate success and the enduring value of the infrastructure. Modern project management techniques, particularly decision-driven models, have revolutionized contractor selection (Amireh, 2022). Approaches such as the AHP and TOPSIS enable stakeholders to evaluate multiple criteria simultaneously. AHP ranks contractor attributes using pairwise comparisons, ensuring a structured assessment of qualitative and quantitative factors (Zohremotadel et al., 2021). Similarly, TOPSIS evaluates options based on their proximity to an ideal solution, integrating diverse criteria into the decision-making process (Gurmani et al., 2022).

This study employs both AHP and TOPSIS to identify and prioritize factors influencing contractor selection in construction projects. By focusing on criteria such as quality, management, and resource availability, the research aims to provide a comprehensive framework for optimizing contractor choice, minimizing resource wastage, and achieving project success. The findings underline the importance of adopting advanced decision-making approaches to enhance efficiency and accountability in the construction sector.

II. Project Management and Delay

Project management is the backbone of successful project execution, encompassing planning, organizing, and controlling resources to achieve specific objectives within defined constraints (El-Sayegh et al., 2021). One of the most critical aspects of project management is managing time effectively to avoid delays, which can derail the entire initiative. Delays disrupt schedules, escalate costs, and often lead to subpar results, emphasizing the need for efficient project management practices tailored to mitigate time overruns (Hasnain & Thaheem, 2016). The necessity of addressing delays stems from their profound impact on project outcomes. Delays often lead to cost overruns, strained relationships among stakeholders, and a diminished reputation for project teams (El-Sayegh et al., 2021). For public infrastructure or community-based projects, delays can disrupt societal progress and economic development, depriving communities of essential services. Effective project management ensures that schedules are realistic, resource allocations are optimized, and all team members are aligned with the project’s objectives, thus reducing the likelihood of time overruns (Tepe & Kaya, 2019).

Delays in projects also present opportunities for introspection and improvement. They highlight gaps in planning, resource allocation, and communication, prompting organizations to adopt better strategies and tools (Torfi & Rashidi, 2011). Advanced project management software, agile methodologies, and real-time tracking systems have emerged as powerful solutions to anticipate potential bottlenecks. Learning from delays enables teams to refine their processes, foster collaboration, and ensure more robust execution in future endeavors (Sarkar & Biswas, 2021). However, managing delays is fraught with challenges. Unexpected circumstances such as adverse weather, supply chain disruptions, regulatory hurdles, or unforeseen technical issues can derail even the best-planned projects (Gurmani et al., 2022). Internal challenges like poor communication, unclear roles, and inadequate stakeholder engagement exacerbate these problems. Effective project management requires a dynamic and proactive approach to address these uncertainties and minimize their impact (Rehman & Ishak, 2022). One of the most significant challenges in project management is aligning diverse teams toward a common goal. Each stakeholder (e.i., be it clients, contractors, or project managers); has unique expectations and priorities (Amireh, 2022). This misalignment often leads to conflicts, miscommunication, and ultimately, delays. Strong leadership and clear communication are essential to bridge these gaps, foster teamwork, and maintain focus on the project timeline and deliverables (Sodangi & Salman, 2022).

Effective project management also involves flexibility and adaptability (Wang et al., 2013). While a robust plan provides a strong foundation, unforeseen events may require teams to pivot and reallocate resources. The ability to adapt to changes without losing sight of the overarching objectives is a hallmark of successful project management. This requires a mindset of resilience and a willingness to embrace change as a natural aspect of the project lifecycle (Ndekugri et al., 2008). Another essential aspect is stakeholder management. Keeping all stakeholders informed and engaged reduces misunderstandings and ensures collective ownership of the project (Ansah & Sorooshian, 2018). Clear communication channels, regular updates, and transparent decision-making foster trust and collaboration, which are critical for navigating challenges and preventing delays (Amireh, 2022). The right contractor plays a pivotal role in ensuring projects are completed on time, within budget, and to the required standards (Rehman & Ishak, 2022). Conversely, selecting an unsuitable contractor can lead to significant delays, escalating costs, and compromised quality (El-Sayegh et al., 2021). Therefore, contractor selection directly impacts the timely delivery of a project and its overall success (Mahdi et al., 2002).

One of the primary ways contractor selection affects delays is through the contractor's competency and experience (Perera et al., 2016) as presented in Figure 1. A skilled and experienced contractor possesses the expertise to foresee potential challenges and devise strategies to overcome those (Rashvand et al., 2015). In contrast, an inexperienced contractor may struggle with project complexities, mismanage resources, or fail to adhere to the schedule, leading to delays (Ndekugri et al., 2008). Thorough evaluation of a contractor’s track record and their ability to handle similar projects is essential to mitigate such risks (Zohremotadel et al., 2021). Resource management capabilities are another critical factor. Contractors must have access to adequate labor, equipment, and materials to execute the project as planned (Lee et al., 2020). Poorly equipped contractors or those with limited access to resources can face bottlenecks, such as material shortages or equipment breakdowns, which contribute to time overruns (Torfi & Rashidi, 2011). Ensuring that contractors demonstrate sufficient capacity and resource management skills is vital during the selection process (Hasnain & Thaheem, 2016).

III. Contractor Delays in Construction Projects

The preparation of delay claim files must be undertaken by an expert thoroughly familiar with contract terms, project scheduling, execution status, and the root causes of delays. This is crucial because Article 30 of the General Contract Conditions contains ambiguities that require logical and technical justification during meetings. Success in such sessions often hinges on the preparer’s expertise, which can account for up to 70% of the outcome. An effective method for logical argumentation is using magnified examples of the claims in dispute. For instance, a contractor might claim delays due to late issuance of window detail drawings. While logically insufficient to justify allowable delays, the contractor could magnify this issue during discussions. Conversely, consultants may minimize the significance of such claims by referencing broader delays caused by the contractor, such as uncompleted structural works despite having 50% of the drawings issued. Avoiding unscientific or illogical claims is critical to maintaining the evaluator's trust. A balanced approach, like modestly inflating claims by 10%, can be strategically beneficial depending on project conditions.

The organization, structure, and presentation of the delay claim file significantly influence its reception by consultants and clients. Using tools like binders, dividers with labeled sections, and a clear layout signals professionalism and technical accuracy. The claimed allowable delays must not exceed the total documented delays. The reference for drawing issuance or error correction should be the most recent version, and reasons for such delays should not be explicitly stated in the file to provide the consultant time to prepare responses.

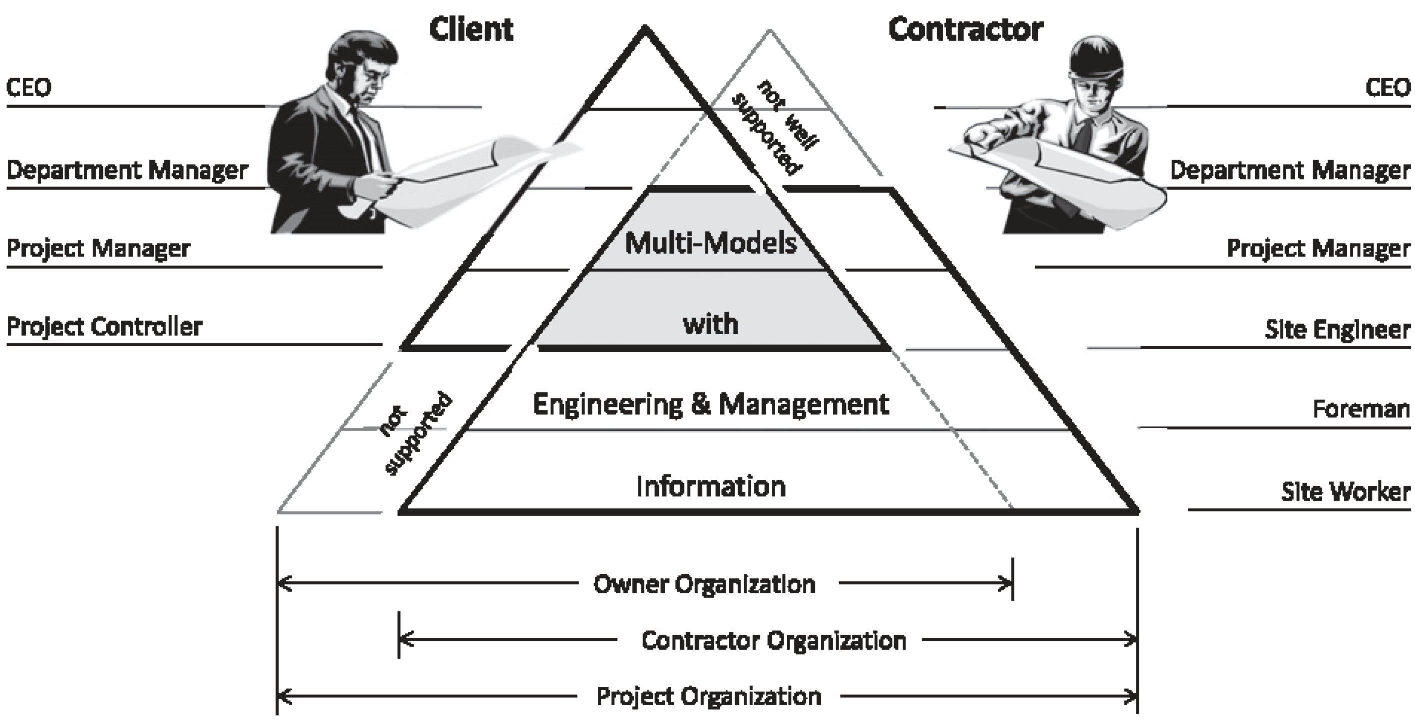

Fig. 1 Construction projects framework (Khahro et al., 2023)

Correspondences should be meticulously referenced and supported by examples to strengthen arguments. Numerous additional nuances in preparing delay claim files depend on specific project circumstances (Rashvand et al., 2015). It is essential to verify all correspondences with the company's registry (Semaan & Salem, 2017). Contractors may attempt to include fabricated documents that were never submitted during the project. Updated schedules should rely on the consultant's latest approved versions to prevent manipulation of critical paths by altering dependencies, which could inflate allowable delays (Olaniran, 2015). If multiple drawing revisions were issued to the contractor, their purpose whether to expedite work, reduce costs, or meet contractor requests; must be clarified (Semaan & Salem, 2017). Requests for corrections should also be assessed based on whether they address critical design issues or minor drafting details (Noorzai, 2020).

Contractor-induced delays refer to setbacks caused by the contractor during project execution. These delays can arise from various factors, including (Rashvand et al., 2015; Noorzai, 2020; Nov & Peansupap, 2020; Amireh, 2022):

- *Inadequate planning and project management*: Poor planning is a primary cause of delays. Contractors must devise precise schedules before commencing work and consistently monitor progress. Failure to do so often leads to delays in starting, completing various phases, and handing over the project.
- *Insufficient resource allocation*: Contractors require adequate human resources, equipment, materials, and machinery to execute projects. Resource shortages can force delays. For example, a lack of skilled labor might delay critical activities.
- *Natural factors*: Unforeseen natural events such as adverse weather conditions or natural disasters can disrupt project timelines. Heavy rains, for instance, may halt construction due to safety concerns.
- *Human errors*: Mistakes by personnel, inadequate supervision, or inefficiencies in the workforce contribute to project delays. For instance, calculation errors might necessitate rework, delaying completion.
- *Financial constraints*: Contractors struggling with cash flow or inadequate financial planning often fail to procure materials or pay subcontractors on time, significantly impacting schedules.

Contractors play a pivotal role in mitigating delays and ensuring projects remain on schedule (Olaniran, 2015). Poor adherence to contractual obligations can lead to significant setbacks (Khahro et al., 2023). Studies identify improper site management, lack of skilled labor, insufficient equipment, and unrealistic scheduling as recurring causes of delays (Razi et al., 2019). Additionally, contractors' inability to manage subcontractors, delayed reporting, and lack of coordination further exacerbate problems. Addressing these issues requires comprehensive planning, effective resource allocation, and robust communication strategies (Kumar & Roy, 2011). Numerous studies worldwide highlight contractor-related delays as a significant issue in construction. For example, research in Egypt post-revolution identified ineffective planning, weak site management, economic mismanagement, and rework due to errors as critical delay factors.

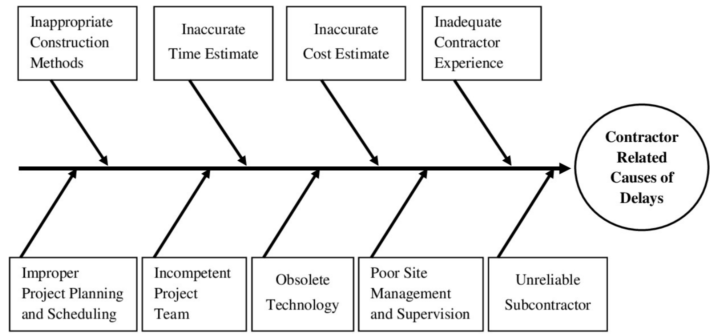

Fig. 2 Contractor-induced delay (Abedi et al., 2011)

Similarly, in Pakistan, improper construction methods, subcontractor changes, and poor communication were prominent causes. Subcontractor inefficiencies often stem from limited experience, inadequate resources, or lack of technical skills. Globally, contractor-related delays frequently lead to legal disputes and cost overruns. Effective management, coupled with technical expertise and robust supervision, is critical for timely project delivery. Proper preparation of delay claims and addressing contractor weaknesses are essential for mitigating risks and ensuring project success (Mohammed et al., 2019; Irfan et al., 2019).

IV. AHP AND TOPSIS

In the contractor qualification process, multiple evaluation criteria (often comprising both qualitative and quantitative data), may conflict (Hossen et al., 2015). In such cases, decision-makers face options with multiple indicators and can utilize Multi-Criteria Decision-Making (MCDM) models to identify optimal solutions. Prominent MCDM techniques include Multi-Attribute Decision-Making (MADM), AHP, Data Envelopment Analysis (DEA), and Technique for Order of Preference by Similarity to Ideal Solution, TOPSIS (Chalekaee et al., 2019). This section introduces two MCDM methods and their application. MCDM encompasses techniques that facilitate decision-making when evaluating alternatives based on multiple criteria or objectives. These methods assist decision-makers in selecting the best-performing option across all criteria (Kishore et al., 2020). Broadly, MCDM techniques are categorized into (Gunduz & Khader, 2020; Vardin et al., 2021):

- *MODM*: Focuses on optimizing multiple objectives, such as maximizing profits while minimizing costs.
- *MADM*: Aims to select the best alternative from a set of options, such as choosing the optimal location for a factory.
- *AHP*: A structured, hierarchical method that organizes criteria and options systematically.
- *TOPSIS*: A geometric method that ranks options based on their distance from an ideal solution.
- *Vlse Kriterijumska Optimizacija I Kompromisno Resenje (VIKOR)*: Ranks alternatives by considering both measurable and non-measurable criteria.

These MCDM methods provide robust tools for making decisions in complex environments by helping decision-makers identify the best option in terms of all criteria (Masengesho et al., 2020).

AHP is a widely used method for evaluating contractor qualifications and ranking them based on multiple criteria. It supports multi-criteria decision-making across various levels of project management. The method relies on pairwise comparisons to assign weights to criteria, simplifying the understanding of complex decisions. By consolidating judgments, AHP evaluates consistency and enables focused decision-making in diverse scenarios (El-Sayegh et al., 2021). As one of the most comprehensive systems for multi-criteria decision-making, AHP models the interplay between various criteria in unstructured and complex situations. It facilitates decision-making by organizing perceptions, judgments, and evaluations to identify influential factors (Saaty, 2008). Initially introduced by Thomas L. Saaty in 1980, AHP provides planners with a systematic approach to select the most suitable solution for a given problem (Bertolini & Braglia, 2006). The AHP process involves (Jabbarzadeh, 2018):

- Defining a hierarchical structure, including objectives, criteria, sub-criteria, and alternatives.
- Conducting pairwise comparisons to calculate weights and ensure consistency (with a consistency ratio below 0.1).
- Ranking options against the overall goal.

AHP is versatile and extensively used for ranking factors, determining their importance, and solving unstructured problems in management, policy, economics, social sciences, healthcare, and engineering. Its two key applications are (Erdogan et al., 2019):

- Determining the relative importance and ranking of criteria.
- Prioritizing alternatives to align with decision-making objectives.

AHP adheres to four fundamental principles (Abdullah et al., 2021):

- If criterion A is n times more important than B, then B is 1/n as important as A.
- Criteria must be comparable, ensuring no infinite disparity in significance.
- Each level in the hierarchy depends on the level above.

The hierarchical model includes criteria and alternatives derived from prior studies and expert input. A typical AHP model consists of levels such as (Erdogan et al., 2019):

- Goal (top level)
- Criteria and sub-criteria (intermediate levels)
- Alternatives (bottom level)

For example, a simple hierarchy might have one goal, four criteria, and three alternatives (Najiazarpour & Pouresfandyani, 2019). By employing AHP as a decision-making tool, a structured decision tree matching the problem's complexity is created (El-Sayegh et al., 2021). The top level represents the goal, intermediate levels include criteria, and the bottom level consists of competing alternatives (Jabbarzadeh, 2018). This systematic approach enables informed decisions, particularly when conflicting criteria complicate the evaluation process (Saaty, 2008).

V. Materials and Methods

The research employed a descriptive-survey method to systematically collect and analyze data related to the study's objectives. This approach was selected due to its effectiveness in capturing a comprehensive understanding of the phenomena under investigation, enabling the extraction of detailed insights into relationships between variables (Jadidi et al., 2014). A combination of quantitative and qualitative data collection tools was utilized to ensure robustness and accuracy in the analysis. The study adopted a sampling approach informed by the Morgan table to determine an appropriate sample size from the target population. In this study, the population consists of 10,000 individuals involved in construction projects. Based on project-related data, 384 participants were selected, including 289 from workshops and 95 from technical and managerial offices. Sampling was conducted using the Morgan Table, which simplifies the calculation of sample size and is particularly effective when the population size is known. This probabilistic sampling method ensured representativeness and validity while maintaining statistical reliability. The Morgan table, which derives its calculations from normal distribution principles, offered an optimal balance between sample size and acceptable error margins for a confidence level of 95%. This method ensured the findings could be generalized to the entire population with high confidence.

The target population included stakeholders relevant to the study's domain, with participants selected based on defined inclusion criteria. These criteria ensured that the sample captured diverse perspectives from individuals with relevant expertise or direct involvement in the subject matter. Efforts were made to maintain demographic and professional diversity within the sample to enhance the comprehensiveness of the findings. To gather the required data, the study utilized a combination of tools, including questionnaires, interviews, and observational methods. The questionnaires were developed using established guidelines and contained a mix of open and closed-ended questions to capture both quantitative and qualitative data. Interviews were semi-structured, allowing for in-depth exploration of participant perspectives while maintaining consistency across respondents. Additionally, observations were conducted to corroborate findings and provide contextual insights.

To ensure the reliability and validity of the instruments, the study adhered to rigorous testing and evaluation procedures. Content validity was established through expert reviews, ensuring that the questions were aligned with the research objectives and adequately covered the study's scope. Reliability was measured using test-retest methods and internal consistency metrics, such as Cronbach's alpha, ensuring the tools produced stable and consistent results over repeated applications. The data collection process involved multiple stages. Initially, a pilot study was conducted to refine the instruments and address potential issues in question clarity or structure. Following the pilot phase, the finalized tools were disseminated to participants. Data collection was conducted over a defined timeframe, with researchers maintaining close supervision to address participant inquiries and ensure compliance with ethical standards.

Ethical guidelines were rigorously followed throughout the research process. Participants were provided with detailed information regarding the study's purpose, scope, and expected outcomes. Informed consent was obtained prior to data collection, and participants were assured of the confidentiality and anonymity of their responses. Ethical approval was secured from relevant institutional review boards. The study employed a mixed-methods analytical framework to interpret the collected data. Quantitative data were analyzed using statistical tools, including descriptive and inferential techniques such as regression analysis and correlation coefficients. Qualitative data were subjected to thematic analysis, enabling the identification of recurring patterns, themes, and insights.

To enhance the rigor of the decision-making process, the study utilized a hybrid approach combining the AHP and the TOPSIS. This integration was designed to capitalize on the strengths of both methods, addressing the limitations of each individually. AHP facilitated pairwise comparisons and weight assignments for criteria, while TOPSIS ranked alternatives based on their relative proximity to an ideal solution. The hybrid AHP-TOPSIS approach involved a systematic process of data normalization, criteria weighting, and ranking. The AHP method was employed to prioritize criteria based on their relative importance, derived from expert judgments and participant inputs. The TOPSIS technique then processed these weights alongside performance metrics for alternatives, generating a ranked list based on calculated closeness coefficients.

The study's decision-making framework was applied to evaluate and rank alternatives within a specific context, such as project selection or resource allocation. Key factors, including cost, quality, risk, and feasibility, were identified and incorporated into the model. This structured approach ensured that decisions were grounded in objective criteria while accommodating subjective inputs from stakeholders.

Table 1 Customized criteria/sub-criteria for analysis by AHP-TOPSIS

Criteria	Sub-criteria
Financial (C1)	Financial stability (S1)
	Financial strength (S2)
	Outsourcing costs (S3)
Management (C2)	Human resource management skills (S4)
	Flexible contracting (S5)
	Outsourcing relationship management (S6)
Resources (C3)	Technical and technological skills (S7)
	Intellectual capital (S8)
	Physical capital (S9)
Quality (C4)	Product quality (S10)
	High levels of service (S11)
Commitment (C5)	Timely response (S12)
	After-implementation services (S13)
	On-time delivery (S14)
Compliance (C6)	Adaptation from the consultant (S15)
	Having close relations with the employer (S16)
	Flexibility (S17)
Confidence (C7)	Public and professional credibility and trust (S18)
	Executive security (S19)
Ability (C8)	Desirable performance (S20)
	Use of new technology (S21)
	Amount of experience in outsourcing (S22)
	Innovation (S23)

To validate the findings, sensitivity analyses were conducted to assess the robustness of the results against variations in input parameters. Consistency checks were also performed to evaluate the reliability of expert judgments and ensure alignment with established thresholds. The hybrid AHP-TOPSIS model demonstrated high reliability and adaptability, providing actionable insights that informed strategic decision-making within the study's domain. This methodology provided a comprehensive framework for addressing the research objectives, combining robust data collection, ethical rigor, and advanced analytical techniques to ensure high-quality outcomes.

VI. Results and Discussion

In the construction industry today, selecting the best contractor among numerous candidates is a priority for organizations and companies, particularly those actively engaged in large-scale projects. This selection process becomes even more critical when senior managers and decision-makers are involved, necessitating meticulous decision-making through specialized methods and tools for analyzing various related factors. Consequently, contractor selection is inherently a MCDM challenge. Considering the multitude of criteria essential for making informed decisions, MCDM methods play a pivotal role in contractor selection. Technological advancements, a reduction in the number of high-quality contractors, increasing service costs, and the growing complexity of criteria identification and assessment have heightened the sensitivity surrounding project outsourcing. These challenges make decision-making increasingly intricate, emphasizing the need for a systematic and scientific approach to the contractor selection process.

In recent years, the necessity for developing and adopting systematic decision-making methods has grown significantly. Various methodologies have emerged, each tailored to address specific decision-making scenarios. Many scholars agree that decision-making is a fundamental component of management. It results from a process leading to decisions, distinguishing between those actively participating in the process and those merely observing its outcomes. Currently, no standardized mechanism for contractor selection exists in Iran, with diverse criteria applied across projects. This study identifies relevant criteria through an extensive review of resources (articles, books, and previous research) and expert opinions. The feedback from these experts was consolidated to define and rank the criteria for contractor selection. Subsequently, the AHP method was employed to assign weights to the identified criteria. To rank the alternatives (contractors), the TOPSIS method was utilized. This combined approach, integrating AHP for weighting and TOPSIS for final ranking, was implemented systematically as AHP-TOPSIS. The hybrid methodology enhanced the accuracy and consistency of the results, enabling precise evaluation and prioritization of contractors.

It can be stated that the more effectively and systematically contractors are selected based on appropriate evaluation principles, the likelihood of delays in construction projects can be significantly reduced. This issue directly impacts the success of projects. Therefore, considering the factors outlined in Table 1, substantial progress can be made in preventing delays within the studied region. Furthermore, relying on the results of the model presented in Table 2, it is evident that experts agree that in Mashhad's District 12, capability-related criteria, with a weight of 0.166, play the most critical role in achieving a successful construction project in the area. Conversely, the analysis also indicates that financial factors have the least impact on project success, with a weight of 0.073. Although it is acknowledged that construction projects in the country often face financial challenges, the primary issue lies in the lack of contractor competence and the excessive consumption of capital and resources. This inefficiency is a key factor contributing to project failures both nationwide and within the studied region.

By utilizing the factors identified and classified in this study, significant improvements can be achieved in reducing project delays and optimizing project success conditions. To this end, each contractor is individually assessed based on the identified criteria. The outlined priorities must be carefully considered, ensuring all aspects are thoroughly evaluated. In other words, by examining the various dimensions of the project and identifying and organizing the factors influencing it, project-specific criteria can be extracted. Using the factors identified in this study, the impact of these criteria on the project can be categorized and analyzed. This approach helps reveal problematic areas (deviations from project management plans), which can then be addressed and improved to implement the project more efficiently. This process plays a crucial role in reducing delays in the project timeline. For instance, the most critical evaluation factor—the contractor's capability in implementing and executing construction projects—must be carefully scrutinized. It is essential to ensure that the selected contractor possesses the ability to perform the work in compliance with established standards and evaluation frameworks. This method is applied to each criterion individually, ultimately leading to the selection of the best and most efficient contractor for the project.

Table 2 Normalized weight AHP matrix and criteria

Criteria	Weights	Sub-criteria	Weights	Normalization
C1	0.073	S1	0.780	0.057
		S2	0.150	0.011
		S3	0.070	0.005
C2	0.157	S4	0.644	0.101
		S5	0.186	0.029
		S6	0.170	0.027
C3	0.114	S7	0.604	0.069
		S8	0.018	0.002
		S9	0.378	0.043
C4	0.156	S10	0.50	0.078
		S11	0.50	0.078
C5	0.098	S12	0.191	0.019
		S13	0.394	0.039
		S14	0.415	0.041
C6	0.118	S15	0.277	0.033
		S16	0.368	0.043
		S17	0.355	0.042
C7	0.118	S18	0.424	0.050
		S19	0.576	0.068
C8	0.166	S20	0.234	0.039
		S21	0.246	0.041
		S22	0.089	0.015
		S23	0.431	0.072

Table 3 Relative proximity of criteria to the ideal solution by TOPSIS

Criteria	Rank	Relative proximity	Distance from ideal condition	
			Positive (A^+)	Negative (A^-)
C1	7	0.344	0.036	0.068
C2	6	0.349	0.037	0.070
C3	8	0.322	0.034	0.069
C4	5	0.499	0.047	0.057
C5	4	0.532	0.055	0.050
C6	2	0.754	0.091	0.030
C7	1	0.842	0.091	0.017
C8	3	0.713	0.084	0.034

Based on the validity and reliability results of the proposed model, it can be stated that its effectiveness in selecting contractors within the study area is significant. In other words, the findings of this research can serve as a useful tool for categorizing and identifying capable contractors while distinguishing them from those unable to complete the project. By analyzing the various factors and dimensions presented in this study and applying the weighted impact coefficients provided in Table 2, it is possible to determine whether a contractor (any contractor) is capable of successfully executing a project (any project). Generally, the closer the calculated coefficient is to 1 (100%), the higher the contractor's capability. Conversely, the closer this coefficient is to zero, the greater the likelihood of the contractor's inability to perform and the risk of project delivery delays.

VII. Conclusion

This study provides a systematic framework for contractor evaluation and selection, addressing a critical challenge in construction project management. By leveraging a combination of multi-criteria decision-making methods, such as AHP and TOPSIS, the research demonstrates a robust approach to ranking contractors based on identified and weighted criteria. The model's results emphasize the importance of contractor competency, with a focus on their technical ability as a primary factor for ensuring project success. The findings reveal that prioritizing capable contractors significantly reduces the risk of project delays, a key factor in achieving overall project success. Notably, the ability of contractors emerged as the most influential criterion in the studied region, while financial factors had a comparatively lower impact. This underscores the importance of effective resource management and skill-based evaluation over purely financial considerations. The proposed model serves as a valuable tool for project managers and decision-makers, enabling precise classification and selection of contractors. By identifying influential factors and their respective weights, the model not only helps mitigate delays but also optimizes project delivery. Moreover, the results advocate for the adoption of scientific and systematic approaches in contractor selection to ensure consistent and reliable project outcomes. Future research can build upon this framework by expanding its application to different regions and project types, refining the criteria, and integrating emerging technologies such as artificial intelligence for enhanced decision-making. Ultimately, this study contributes to advancing construction management practices, fostering efficiency, and improving the success rate of construction projects.

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Authors' contributions

Mohammadreza Tayebi conducted the main data analysis, contributed to the data collection, preprocessing, and interpretation, and was responsible for drafting the initial manuscript. Sanaz Farshad and Shahram Pourakaber assisted in the development of the methodology and performed validation checks, provided supervision, conceptual guidance, and critical revision of the manuscript. All authors read and approved the final manuscript.

Conflict of interest

The authors have not disclosed any competing interests.

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