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Impact of Contractor Selection Criteria on Project Delays in Jordanian Public Construction

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ABSTRACT

Delays in public construction projects remain a global challenge, with contractor selection playing a crucial role in mitigating or exacerbating such delays. This study examines the impact of contractor selection criteria on project delays in Jordan's public construction sector, offering insights applicable to similar contexts. By integrating Multi-Attribute Utility Theory (MAUT) and Analytical Hierarchy Process (AHP), this research develops a structured framework for contractor pre-qualification, enhancing decision-making processes. Using a mixed-method approach, data was collected from 250 industry professionals and two school construction case studies. Findings highlight quality commitment (RI 0.82), cost adherence (RI 0.77), and timely completion (RI 0.824) as key success factors. The study also quantifies the impact of contractor selection on project performance (impact index: 80.6%) and identifies critical pre-qualification attributes, including technical staff competency (27%), project planning (22%), and financial stability (20%). This research makes a significant contribution by introducing a standardized contractor selection framework that balances cost and quality considerations, addressing a critical gap in existing literature. The findings provide actionable recommendations for policymakers, advocating a shift from lowest-bid selection toward a more holistic contractor evaluation to enhance project success.

Keywords: Jordanian public construction projects, Project success, Contractor pre-qualification, Delays, Multi-attribute decision-making, Analytical hierarchy process.

INTRODUCTION

Government-sponsored construction projects in Jordan have often encountered significant challenges, particularly concerning delays and failure to meet project deadlines. This study delves into whether these issues stem from shortcomings in the contracting phase, where decisions are frequently driven by the desire to select the lowest-cost proposal, potentially neglecting other essential contractor attributes. Persistent project delays, leading to overruns, have become characteristic of such projects, serving as indicators of underlying factors shaping project outcomes. Addressing delays necessitates attention to contractor selection at project commencement.

The primary aim of this research is to understand the decision-making processes within governmental projects and to develop a comprehensive framework for contractor selection. This framework serves as a foundational tool, offering standards and components to streamline development processes based on contractor pre-qualification criteria. Attributes crucial to project success, such as risk management plans, technological utilization, and financial considerations, are integral to this framework. The study identifies eleven principal contractor pre-qualifications linked with project success, emphasizing the importance of robust project planning and other key criteria.

Despite their significance, contractor pre-qualifications often receive insufficient consideration during project awards in Jordan, where the lowest bidding price tends to be prioritized. The research argues for a systematic examination of contractor pre-qualification to improve project success prospects. Thus, the central research question addresses methods to enhance success in government-sponsored construction projects in Jordan.

This inquiry unfolds through an extensive literature review and consultations with construction experts, aiming to construct a conceptual model elucidating the underlying causes of project delays in the Jordanian context. This model is expected to generate hypotheses for empirical testing, leading to the development of a comprehensive decision-making framework tailored for contractor selection. The anticipated outcome is a decision support tool that directs attention to critical contractor pre-qualification attributes beyond the lowest offered price.

Numerous factors contribute to the success of a construction project. These success factors typically encompass time management, cost efficiency, commitment to quality, and effective communication among project stakeholders. Additionally, scholarly acknowledgement underscores the significance of contractors' attributes and capabilities in achieving project success (Hashim et al., 2024; Alzahrani & Emsley, 2013).

Time overruns represent a pervasive issue in the construction industry, reflecting underlying challenges that afflict projects globally, particularly evident in Jordanian public sector projects. Sweis (2013) observed significant delays in 65% of Jordanian projects, with only 35% meeting their deadlines, indicative of a substantial challenge, as elucidated in the forthcoming literature review.

Construction projects entail involvement from three key stakeholders, conceptualized in game theory terms as players: (a) the government, responsible for project ownership, financing, and contractor selection; (b) the consultant, tasked with project oversight on behalf of the government; and (c) the contractor, responsible for contract fulfilment. The agreement among these stakeholders regarding contractor selection and contract specifications significantly influences project success. Notably, the level of delays or overruns throughout project stages serves as a crucial measure of project success, highlighting the criticality of the contractor selection stage.

The primary objective of this study is to improve the likelihood of success in governmental construction projects (GCPs) within Jordan, acknowledging their crucial role in providing essential infrastructure, like schools and hospitals. Central to achieving this aim is the mitigation of delays through refining contractor selection criteria. Specifically, this research aims to enhance the current contractor selection method for Jordanian public construction projects (JPCPs) by constructing a comprehensive framework containing essential contractor pre-qualification requirements and procedures.

Utilizing core decision-making theories, the study aims to simplify the contractor pre-qualification process and subsequent decision-making, ensuring the exclusion of unqualified candidates. Notably, contractor pre-qualification significantly influences contractor performance, thereby impacting project success either positively or negatively (Kasabreh & Tarawneh, 2019). The research questions are:

1. Critical success factors for governmental projects: what are the most significant factors contributing to the success of governmental construction projects in Jordan?
2. Delays and impact on governmental projects: what are the primary factors responsible for delays in Jordanian public construction projects, and how do these delays impact project outcomes? Is there a correlation with contractor pre-qualification?
3. Contractor selection method and project delays: to

what degree does the method of selecting contractors influence delays in governmental construction projects in Jordan?

4. Applicability of multi-attribute decision-making: can the principles of multi-attribute decision-making be effectively employed to develop a decision-making framework that enhances the likelihood of success in governmental construction projects in Jordan?

These research questions aim to illuminate critical aspects of the construction industry in Jordan, particularly concerning delays, success factors, contractor pre-qualification, and decision-making processes, contributing to an improved understanding and potentially offering insights for enhancing project outcomes in the future. The research objectives are:

To achieve the overarching objective, this paper will devise a conceptual model derived from relevant theoretical frameworks outlined in academic sources and scholarly literature. Specific objectives include:

1. Identifying key success factors: pinpointing factors contributing to the success of governmental construction projects and correlating them with contractor attributes.
2. Analyzing delays and impact: investigating causes of delays in Jordanian governmental construction projects and their consequences on project costs and client interests.
3. Evaluating contractor selection method: assessing the current approach to selecting contractors and its influence on project success and delays.
4. Developing a pre-qualification framework: formulating a robust pre-qualification framework leveraging Multi-Attribute Utility Theory (MAUT) and Analytical Hierarchy Process (AHP) principles to aid governmental decision-makers in enhancing the contractor selection process.

LITERATURE REVIEW

Effects of Delays

A delay is defined as a period extending beyond the contractually agreed-upon date in the agreement between the contractor and the client, as well as the planned schedule, necessitating additional time for project delivery or completion. It is a recurrent challenge within the construction sector. For project owners, delays result in income loss due to idle manufacturing facilities and unrented space. Conversely, from the contractor's perspective, delays amplify losses due to prolonged work periods, delayed project handover, and labor costs exceeding budgeted amounts for the stipulated timeframe (Daba & Pitroda, 2018).

Project delays emerge as a substantial predicament in the construction domain, attracting scholarly attention from various authors, including Kraiem and Diekmann (1987). The issue of delays is pervasive across diverse countries. Assaf and Al-Hejji (2006) observed that approximately 70% of public sector construction projects in the KSA experienced delays attributable to multiple factors. Motaleb and Kishk (2010) revealed that a half of the construction projects in the UAE faced delays and failed to meet stipulated deadlines, with Kuwait encountering similar challenges. Koushki et al. (2005) reported that over 56% of projects exceeded their scheduled completion times. Conversely, in Turkey, only 22% of public projects were executed within their initially planned durations (Venkatesh & Venkatesan, 2017). Taking proactive steps and enhancing overall project performance are necessary (Selcuk et al., 2024).

On the other hand, in Norway, the results revealed that around a half of the projects are completed on time or even ahead of schedule, but a significant portion still experiences major delays. Defense projects, in particular, are especially prone to delay issues during delivery. These findings are consistent with those from other countries. Interestingly, there has been some improvement over the past 20 years, with the severity of delays appearing to decrease. However, contrary to expectations, delayed projects do not seem to be more likely to exceed their budgets (Tlemsani et al., 2020; Majdalawieh et al., 2017; Welde & Bukkestein, 2022).

Delays entail significant consequences that can ultimately lead to project failure, as depicted in Figure 1. These effects can indeed be regarded as tantamount to project failure, acting as barriers to successful project realization and running counter to success factors identified by Gunduz and Yahya (2018), such as meticulous planning, effective scheduling, unwavering commitment to the project, efficient communication among project participants, and a clear understanding of the project's mission. Meanwhile, Khlaifat et al. (2019) reaffirmed factors contributing to construction project failure in Jordan, which are juxtaposed with the aforementioned success factors.

Delay effects can oppose attributes of project success. For instance, time overruns stand in contrast to timely project submission, while cost overruns directly contradict budget adherence. Disputes, arbitration, and litigation oppose healthy communication and positive stakeholder relationships (Albtoush et al., 2022; Han et al., 2012).

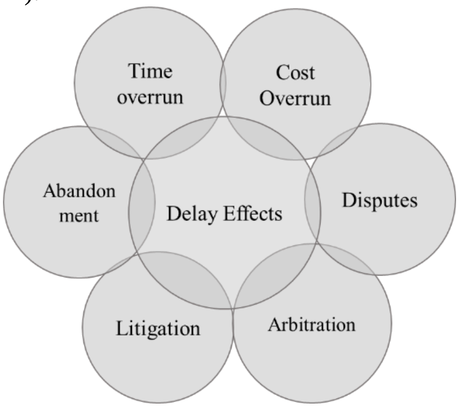

Figure (1): Delay effects (Haseeb, 2011)

Abandonment, resulting from neglecting to address delays, represents a failure to resolve project obstacles or conflicts, contrasting with success. However, Ika (2012) argued that assessing success solely based on project completion within cost, scope, and timelines is insufficient. Other factors can engender failure, as projects may falter in achieving their objectives due to various challenges. Project usefulness, learning potential, and organizational value must also be considered when evaluating project success, as depicted in Figure 2.

Additionally, it's noteworthy that a project could be submitted on time and still be considered a failure due to other success factors being negatively affected. This highlights the nuanced relationship between project failure and various factors. Factors like stakeholder engagement, ongoing conflicts, poorly managed requirements, and unclear project objectives can also contribute to project failure.

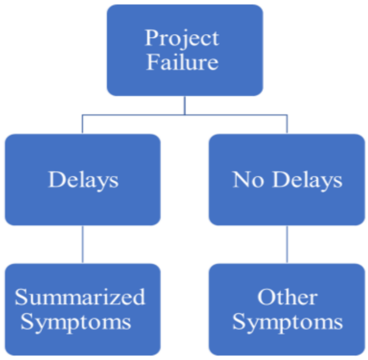

Figure (2): Project failure symptoms (authors' own)

Numerous authors from diverse countries, including (Kikwasi, 2012; Motaleb & Kishk, 2010; Alaghbari et al., 2007; Tlemsani, 2020; Haseeb, 2011), have noted striking similarities in the consequences of delays in construction projects. These shared effects are outlined in Table 1. It's noteworthy that abandonment often emerges as a solution when delays remain unaddressed by any party, while litigation becomes a recourse when complications escalate, and resolution processes extend over a prolonged period.

Table 1 is integrated into the study's questionnaire, tailored to the Jordanian context. This adaptation categorizes the effects of delays and potential solutions into distinct sections. Importantly, the impacts and efficacy of solutions may vary across projects and parties, a topic that will be explored comprehensively within the questionnaire. Abandonment may be a convenient solution in certain scenarios, while litigation might serve as a last resort when prior measures fail to resolve the underlying issue.

Table 1. Delay effects (Haseeb, 2011)

Delay Effects	
Time Overrun	Any delay in an activity inevitably impacts the subsequent tasks, ultimately leading to the project's failure to meet its scheduled submission deadline.
Cost Overrun	Extending the project will result in costs that surpass the initially specified project price.
Disputes	The causes of delays often give rise to disputes among the involved parties. If these disputes remain unresolved, they can escalate to the point of requiring arbitration or litigation for resolution.
Arbitration	Disputes between parties will be addressed through arbitration as an alternative to seeking a resolution in a court of law.
Litigation	Resorting to court proceedings will be considered the final option for resolving disputes between the involved parties.
Total Abandonment	When the underlying cause of delay is abandoned, either temporarily or permanently.

Delay Types

Tumi et al. (2009) classified delays into two primary types: inexcusable delays, characterized by a lack of reasonable justifications and their avoidable nature, and excusable delays, which fall beyond the contractor's control, encompassing unforeseen circumstances like extreme weather conditions. Within excusable delays, they further differentiated between non-compensable and compensable delays. Similarly, Enshassi et al. (2009) proposed a more comprehensive taxonomy of delay types, comprising five prevalent categories: critical and non-critical delays, concurrent delays, compensable delays, and excusable delays. This classification is summarized in Table 2. The current research focuses on avoiding non-excusable delays.

Table 2. Delay types (Durdyev & Hosseini, 2019)

Delay Types	
Critical	Any delay in progress or activity has an impact on the critical path and subsequently affects the overall project schedule.
Non-critical	Any delay in progress or activity does not affect the critical path and project schedule.
Concurrent	When two delays in activities coincide simultaneously.
Compensable, Excusable	Delays beyond the contractor's control, encompassing factors like weather conditions, political uncertainties, and unforeseen disruptions.
Non-excusable	Delays occur without justifiable reasons and within the contractor's realm of control.

Various scholars have identified and categorized reasons for project delays. Al-Momani (2000) cited poor design, change orders, weather conditions, site conditions, late delivery, economic conditions, and increased quantity as the main reasons. Odeh and Battaineh (2002) attributed delays to typical contract types and classified delay reasons into the following categories: client, contractor, consultant, material, labor, equipment, contract, contractual relationships, and external factors.

Sweis et al. (2008) identified reasons for project delays related to labor, materials, equipment, the internal project environment, and exogenous factors. Samarah and Bekr (2016) associated delays with the client, consultant, contractor, and external factors. Gomez-Cabrera et al. (2020) studied project delay reasons from 1988 to 2019 and found several common causes, including change orders/scope changes, poor site management/supervision, poor planning and scheduling, delays in progress payment, contractor's financial problems, material procurement delays, non-performance problems, sub-contractors, design changes, delays in decision-making, and unqualified workforce/productivity.

Durdyev and Hosseini (2019) analyzed delay reasons in construction projects globally, including weather and climate conditions, communication and coordination issues, planning challenges, construction materials, project finance, payment delays, construction equipment, experience and qualification, construction labor, and site management. Sanni-Anibire et al. (2022) identified contractors' financial difficulties, delays in approving completed work, and late delivery of materials as common delay causes over fifteen years globally.

Delays in construction projects often stem from various sources, including government-related factors, consultant-related issues, and challenges on the contractor's side. Government-related delays primarily arise due to design changes and payment delays. Design alterations, whether minor or major, are frequent in Jordanian construction projects and can significantly impact project timelines and costs. The incomplete tender stages and owner-driven requirements are cited as key causes of these design changes (Gharaibeh et al., 2021). Additionally, delays in government payments hinder contractors' ability to allocate resources and fulfill financial commitments, further exacerbating project delays.

Consultant-related delays are attributed to discrepancies in contract documents, incomplete design drawings, and inefficiencies in design management. Consultants must have a comprehensive understanding of project objectives to facilitate effective resource allocation (Atout, 2016). In both Dubai and Gulf nations, delays often arise from inadequate design provision and delays in drawing preparation and approval (Faridi & El-Sayegh, 2006; Tlemsani & Matthews, 2020; Al-Momani, 2000).

Contractor-related delays frequently result from the contractor's lack of experience and qualifications. This issue is observed globally, with variations across countries. For instance, in Saudi Arabia, delays are linked to the subpar performance of the lowest bidder in government tendering systems, while in Libya, delays stem from inadequate planning by contractors (Tumi et al., 2009). Similarly, cash flow problems among contractors contribute to delays in Jordan (Bekr, 2015), while in Malaysia, delays result from improper planning and subpar site management by contractors (Sambasivan & Soon, 2007).

On the other hand, Memon et al. (2023) divided the main reasons for delays into the following categories in Pakistan: client responsibilities, contract management, design and project management, information and technology, resource management, and site management. Finally, they found that information and communication play a significant role in the timely completion of construction projects. Moreover, Tariq and Gardezi (2023) have studied the relation between delays and conflicts for construction projects, where they have found that the most common causes of delays and conflicts (D&Cs) in global rankings include financial issues on the owner's side, change orders or project variations, and poor communication or weak relationships among stakeholders. Abdelalim et al. (2024) identified seven major factors driving cost overruns in the global construction industry, where thery are similar to dealy reasons: poor planning and scheduling, inaccurate project estimates, design flaws, bad weather, unclear project scope, contract ambiguities, and unexpected site conditions.

The causes of delays in construction projects vary across countries, as detailed in Appendix 1, which presents the findings of this research focusing on the case of Jordan. In Algeria, Qatar, and Tanzania, change orders and delayed decision-making were the primary causes of delay. Conversely, in Ghana and Iran, late payments from the owner were the predominant issue. In Saudi Arabia and Libya, the contractor's poor performance and inadequate planning that led to delays. In contrast, the situation in Jordan was characterized by the financial state of the contractor, along with delays in government payments and decision-making. In a case study of a public construction project in Ethiopia, conducting a comprehensive feasibility study, the following were found to be effective strategies for reducing delays: selecting experienced contractors, ensuring accurate drawings, preparing precise initial time and cost estimates, and maintaining strict schedule monitoring (Demissew & Abiy, 2023), where they underscored the importance of the contractor qualifications.

Contractor Pre-qualification

Pre-qualification criteria hold a significant predictive value regarding a contractor's performance, providing clients with insights into potential project outcomes. The performance of contractors serves as a pivotal indicator of project success or failure, monitored through various tools, such as reporting, meetings, and quality control. However, it's crucial to recognize that external factors can also influence contractor performance.

Numerous authors in previous studies across different countries have emphasized the importance of contractor pre-qualification criteria in project selection. They have linked qualifications to theories, like the Multi-attribute Utility theory and the Analytical Hierarchy Process theory, categorizing contractor attributes into defined criteria and sub-criteria. This approach aligns with the primary research objective of establishing connections between the Multi-attribute Utility theory and critical contractor features.

For instance, Holt et al. (1994) explored the impact of contractor attributes on construction project success in the UK, while Idrus et al. (2011) examined decision criteria for selecting main contractors in Malaysia. Similarly, Fong and Choi (2000) investigated contractor selection using the Analytical Hierarchy Process in Hong Kong, and Al-Tmeemy (2017) studied the effects of incompetent contractors on project schedules in Iraq. Appendix 1 showcases variations in contractor pre-qualification factors across different countries, categorized by their significance.

Multi-attributes Utility Theory

The utilization of the Multi-attribute Utility Theory (MAUT) in selecting contractors for Jordanian governmental projects extends beyond price considerations to encompass aspects like quality and performance assessment (Papageorgiou et al., 2016). MAU serves as a decision-making method suitable for scenarios with limited alternatives (Jansen, 2011). Recent applications encompass procurement methods in construction projects and project procurement systems for Greek highway projects. However, MAU theory stems from the Analytic Hierarchy Process (AHP) theory, which can be more intricate (Table 3).

Despite its advantages, MAU theory comes with limitations. It necessitates the definition and evaluation of attributes, requiring considerable time and effort, while the importance of attributes may vary among decision-makers (Papageorgiou et al., 2016).

Table 3. Contrasting MAU theory and AHP theory (adapted from Shanmuganathan et al., 2018)

Aspect	Definition and Context
Substitutes	Alternative options represent the various contractors competing for selection in a project.
Attributes	Characteristics and aspects measured to make decisions, representing pre-qualifications for evaluating and selecting the contractor.
Weight	The process of assigning importance to each attribute by dividing an attribute's importance by the summation of all attributes' importance. Used to assess and evaluate each contractor's attributes.
Attribute Levels	Division of each attribute into defined levels or categories, aiding in assessing and comparing the contractors' performance on each attribute.
Attribute Values	Numerical values (typically on a scale from 0 to 100) are assigned to each attribute level. Higher values indicate more favorable assessments for that attribute level, used to evaluate and compare contractor performance.
Attribute Importance	Numerical values (often ranging from 0 to 100) are assigned to indicate the level of importance of each attribute. Higher values signify greater significance in the decision-making process, guiding the evaluation of contractors.

Important stages in implementing MAU theory involve identifying pertinent attributes, evaluating each alternative's performance on these attributes, assigning weights to attributes, integrating weights with individual assessments, and conducting sensitivity analyses (Jansen, 2011).

Sherif and Abdelalim (2023) have identified three main theories that can help prevent delays. The first is the Construction Management Theory, which ensures that all necessary knowledge about project requirements and construction procedures is well understood. The second is the Project Management Theory, which emphasizes having a project leader who understands the main goal and guides the project toward the desired outcomes through effective planning, monitoring, and control. The third is the Stakeholder Theory, which highlights the importance of involving stakeholders throughout all project stages to prevent delays and ensure smooth execution.

The study recommends applying MAU theory for contractor selection, particularly when the Ministry of Public Works and Housing acts as the owner/client, and contractor applicants serve as substitutes. This approach aids in assessing contractor pre-qualification attributes, accounting for differing importance levels across projects.

Analytical Hierarchy Process Theory

The Analytical Hierarchy Process (AHP) theory stands as a robust decision-making tool designed for hierarchical processes. It finds application in both primary and secondary criteria, exhibiting versatility across various industries and compatibility with other methodologies (Darko et al., 2019). AHP follows a structured process involving assigning importance values, consolidating judgments and weights, facilitating transparent final comparisons, and evaluating consistency.

Advantages of AHP encompass its suitability for small-scale sample selection (typically from four to nine samples), maintenance of consistency through a defined threshold, accommodation of both subjective and objective approaches, ease of use with straightforward calculations, and support from user-friendly software programs (Darko et al., 2019).

However, AHP does present drawbacks. Complex decision matrices arise from numerous attributes, subjective judgments potentially introducing ambiguity, variability in importance values among decision-makers, time-intensive nature in reaching final values, and a tendency for decision-makers to prefer AHP over MAU when lacking familiarity with both theories (Gass, 2005). Shanmuganathan et al. (2018) have conducted comparisons between these two theories (Table 4).

Table 4. Contrasts between MAU theory and AHP theory (adapted from Shanmuganathan et al., 2018)

AHP	MAU
Involves a limited number of factors	Can accommodate a larger number of factors
Does not account for uncertainty and risks	Takes into account uncertainty and risks
Employs pairwise comparison and eigenvalue for weight assignment in decision-making	Assigns weights to prospects for decision-making
Utilizes the eigenvalue to emphasize alternative options	Utilizes fuzzy judgment to highlight alternative options
Uses a weighted sum model for priority calculations	Applies a weighted sum model for priority calculations
The conclusion relies on the decision-makers' experience	The conclusion is reached by quantifying facts and considering the decision-makers competence
Combines subjective and objective methods	Rooted in a normative approach

The proposed contractor selection framework significantly advances existing models by shifting the evaluation criteria beyond the lowest bid price, incorporating a more comprehensive assessment of contractor qualifications. Unlike traditional models that prioritize cost minimization, our framework integrates MAU theory and AHP theory to systematically weigh factors, such as technical expertise, financial stability, risk management, and past performance.

Existing models in other contexts, such as those employed in the UK (Holt et al., 1994), Malaysia (Idrus et al., 2011), and Hong Kong (Fong & Choi, 2000), emphasize pre-qualification criteria, but often lack a standardized weighting mechanism that accommodates both quantitative and qualitative factors. Our model refines this approach by introducing a structured decision-making process, ensuring that contractor capabilities are objectively measured against project-specific needs.

Additionally, this framework addresses key limitations of previous selection methods by integrating empirical data from Jordan's public construction sector, where delays are often linked to inadequate contractor evaluation. By balancing cost considerations (30%) with contractor qualifications (70%), the model provides a more equitable assessment, reducing project risks associated with financial instability and poor performance.

In contrast to existing frameworks, which are often context-specific or industry-segmented, our model is designed to be adaptable across various governmental construction projects. This adaptability allows for its potential application in other regions facing similar procurement challenges, making it a valuable contribution to both academic research and industry practice.

Research Gaps

Despite the contributions of this study, several research gaps remain. First, the study focuses primarily on Jordan's public construction sector, where procurement regulations heavily influence contractor selection. However, its applicability in the private sector remains unexplored, where selection criteria may prioritize different factors, such as innovation, sustainability, or strategic partnerships.

Second, while the research integrates MAU and AHP methodologies for contractor evaluation, it does not account for the potential impact of emerging technologies, such as artificial intelligence, machine learning, and blockchain. These technologies could transform contractor assessment by improving predictive analytics, automating bid evaluations, and enhancing procurement transparency.

Additionally, the study identifies key contractor qualifications, but does not incorporate external factors such as market fluctuations, regulatory changes, and geopolitical risks that may impact contractor performance over time. A more adaptive model that integrates real-time data could help decision-makers navigate these uncertainties.

Moreover, the study is geographically limited to Jordan, raising questions about its generalizability. Differences in regulatory frameworks, labor availability, and procurement practices across regions may influence the effectiveness of the proposed framework, requiring further validation in diverse contexts.

Finally, the study does not fully examine the behavioral and institutional barriers to implementing a qualification-based contractor selection approach. Resistance from procurement officials, contractors, and policymakers could hinder adoption, necessitating further research into the challenges of transitioning away from cost-dominated selection practices.

METHODOLOGY

The methodology section of this research outlines the approach to understanding delays in Jordanian public construction projects. It employs a theoretical model (Figure 3) to analyze how contractor selection directly and indirectly affects project delays. To contextualize these findings, a comparative analysis with other settings will be conducted. The qualitative approach will gather insights from project managers to establish causation. The methodology involves three key components:

1. Association: Identifying the relationship between project delays, contractor selection practices, and governmental prioritization of cost over qualifications.
2. Intervention: Reviewing literature and data systematically to uncover causes and develop a theory explaining delays.
3. Counterfactual: Integrating hypothetical scenarios into the decision framework to propose solutions.

The conceptual model posits that prioritizing cost over contractor pre-qualifications leads to project failures. The proposed solution involves elevating pre-qualification in the decision-making process. Multi-attribute Utility Theory (MAUT) and Analytical Hierarchy Process (AHP) are suggested as tools to achieve consensus on contractor selection.Furthermore, the research focuses on three primary stakeholders: owners, consultants, and contractors, each with distinct preferences. Empirical data from questionnaires and case studies are used to understand these preferences. The challenge lies in reconciling their differing objectives in contractor selection. The conceptual model (Figure 3) investigates the impact of contractor selection on project delays in Jordan, with contractor pre-qualification as a mediating factor influencing both selection criteria and delays.

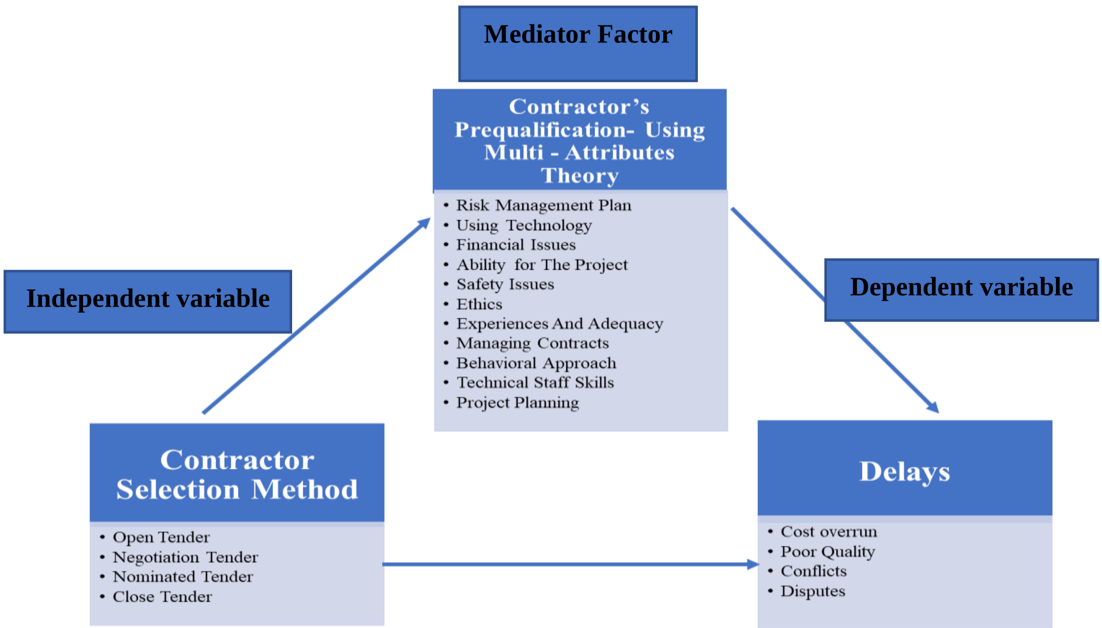

Figure (3): Conceptual model (authors' own)

The research methodology employed various strategies to ensure effective data collection through questionnaires. Pilot studies were initially conducted to refine and finalize the questionnaire, which was organized into five sections covering demographic information, project success factors, contractor selection, delays, and additional feedback. Each question was systematically coded to facilitate subsequent analysis, providing clarity for ease of reference during data analysis. Quantitative data was analyzed using SPSS.For the qualitative aspect, two case studies (Ali bin Abi Talib and Ali Al-Khasawneh Schools) were selected from the authors' ongoing work. Schools are vital to education and social development, and the timely completion of school projects impacts students, teachers, parents, and the community, highlighting their social significance. School projects also provide access to diverse participants, such as government officials, project managers, and consultants, facilitating data collection from various viewpoints, Appendix 03.

Three in-depth interviews were conducted for each case study, involving interviews with the client representative (The Ministry of Public Works & Housing), the project manager from the consultant's side, and the site engineer from the contractor's side. This study aims to validate the following hypotheses:

$\boldsymbol{H_{01}}$**:** Delays indicate construction project failure. Analysis of interview data will identify correlations between delays and project outcomes.

$\boldsymbol{H_{02}}$**:** Delays significantly affect Jordanian governmental construction projects. Comparison of delay data with industry benchmarks will confirm their impact.

$\boldsymbol{H_{03}}$**:** Contractor pre-qualifications are crucial for project success. Analysis of interview data will establish their relationship with project outcomes.

$\boldsymbol{H_{04}}$**:** Contractor selection methods need to prioritize pre-qualification. Reviewing contractor selection processes will support this assertion.

$\boldsymbol{H_{05}}$**:** Contractors are primarily responsible for project delays. Analysis of interview data will determine their accountability for delays.

Jordan Engineers Association reports a total of 4,508 engineering companies, including consultant and contracting firms, involved in both public and private construction projects. These companies are distributed as follows: 1,244 consultant offices across Jordan and 3,264 contracting offices, with 1,810 located in Amman. The classification of contracting offices in Jordan is detailed in Table 5.

Table 5. Contractor companies' classification (Jordan Engineers Association)

Company Type	**Number**
Consultant	1244
Contracting – First Class	216
Contracting – Second Class	156
Contracting – Third Class	450
Contracting – Fourth Class	1225
Contracting – Fifth Class	627
Contracting – Sixth Class	590

Approximately 800 companies were exclusively engaged in public projects, falling into the first, second, and third classifications. The total numbers for contracting, consulting, and owners' companies were determined with a 95% confidence level and a 5% margin of error. To achieve this, 250 responses were needed. The survey was distributed to all 800 companies to obtain the required number of responses.

FINDINGS AND ANALYSIS

The analysis covers four key sections of the questionnaire and interviews: demographic data, project success factors, contractor selection methods, and delays and their effects. These findings are then compared with those of existing literature to gain deeper insights.

Beginning with gender identity, it's observed that Jordan's construction industry is male-dominated, echoing global trends. Women face barriers entering the field, including dealing with aggressive behaviour and coping with long work hours and site isolation, as seen in other countries like Australia (Rosa et al., 2017). Moreover, Arditi et al. (2013) noted a mere 5% female representation among construction managers in Sweden, citing harsh working conditions, discrimination, and long hours as deterrents. Stress in the industry poses a significant threat to gender diversity (Sunindijo & Kamardeen, 2017).

In Jordan, governmental projects, primarily schools, dominate construction, aligning with previous reports highlighting school projects' frequency and significance (Sweis, 2013). Notably, most respondents collaborate with contractors falling under the first classification.

Project Success Factors

Success perceptions vary among stakeholders, with contractors generally viewing projects as more successful than owners and consultants, reflecting differing perspectives. Despite this, all stakeholders agree on crucial success factors, with high-quality commitment topping the list. Time and cost commitments follow, with owner and consultant emphasis on timely completion. Hiring a qualified contractor is underscored as pivotal for project success, aligning with research hypotheses.

Table 6a shows the importance ranking for the project success factors according to all the parties together. Table 6b shows the importance ranking for the project success factors individually for the owner, the consultant, and the contractor, as high-quality commitment was the most important factor for all the parties together and for each party separately.

Table 6a. RII for project success factors' importance, whole sample (authors' own)

Project Success Factor	Mean	RII	Ranking
Project Success Factor-Time Commitment	3.84	0.768	3
Project Success Factor- Cost Commitment	3.86	0.773	2
Project Success Factor-High-quality Commitment	4.12	0.824	1
Project Success Factor-Client's Satisfaction	3.76	0.751	4
Project Success Factor-Project Sustainability	3.75	0.750	5
Project Success Factor-Project Profit	3.33	0.666	7
Project Success Factor-Limited Variation Orders	3.48	0.696	6

Table 6b. Project success factors importance according to the company type, comparison ratings (authors' own)

Project Success Factor	Owner			Consultant			Contractor		
	Mean	RII	Ranking	Mean	RII	Ranking	Mean	RII	Ranking
Time Commitment	3.97	0.794	2	3.92	0.785	2	3.74	0.748	3
Cost Commitment	3.95	0.791	3	3.92	0.785	3	3.77	0.754	2
High-quality Commitment	4.24	0.848	1	4.20	0.839	1	3.92	0.785	1
Client's Satisfaction	3.82	0.765	5	3.80	0.761	4	3.72	0.745	4
Project Sustainability	3.91	0.781	4	3.58	0.715	6	3.71	0.742	5
Project Profit	3.17	0.633	7	3.29	0.658	7	3.66	0.732	6
Limited Variation Orders	3.57	0.715	6	3.73	0.745	5	3.11	0.622	7

Case studies validate these findings, emphasizing strict adherence to deadlines, quality, and cost objectives, alongside effective project management. Contractors stress qualifications' importance, emphasizing financial stability and skilled labor. Notably, success factor variations across countries highlight contractor attributes' significance. Contrary findings in Jordan reveal primary project failure factors, including poor planning, financial difficulties, and payment delays, highlighting systemic issues. Research elsewhere echoes these challenges, attributing schedule delays to funding issues and quality problems to construction errors (Larsen et al., 2016). Governmental project challenges in Jordan, such as variation orders and late payments, underscore the industry's complexities.

Interconnected challenges' delays, cost overruns, and poor quality underscore project dynamics. Contractors' optimistic outlook necessitates nuanced understanding, crucial for effective communication. Comparing success factors globally illuminates diverse practices, encouraging further research into country-specific success drivers.

Contractor Selection Method

Qualitative findings reveal that contractor selection in Jordanian governmental projects heavily relies on open tenders aiming for the lowest price, often overlooking technical aspects. Potential improvements include considering past performance and qualifications and establishing a blacklist for underperforming contractors. Hatamleh et al. (2018) highlighted factors influencing cost estimation accuracy in Jordan, including detailed drawings, prior pricing experience, and accurate estimation. Contractors and consultants prioritize similar factors despite differing rankings.

Studies emphasize the significant role of contractor capability in project success, advocating for technical evaluation in selection processes. Jordan's private and public sectors prioritize different criteria, with the former emphasizing technical capabilities, past performance, and financial stability.

This study underscores the prevalent practice of prioritizing low cost in contractor selection, associating it with project delays. Similar challenges are noted internationally, necessitating appropriate tender types to avoid project failure. Contractor attributes, such as financial stability, past experience, and technical proficiency, significantly impact project success globally. Discrepancies in selection criteria between Jordan's private and public sectors highlight the importance of understanding client preferences across contexts.

Delays: Causes and Implications

Construction-project delays have varied origins across countries, as detailed in Appendix 1, relevant to the Jordanian context. Major delay factors include:

- In Algeria, Qatar, and Tanzania, delays often stem from changes in project orders and delayed decision-making.
- Ghana and Iran cite late payment by project owners as a primary cause of delays.
- Saudi Arabia and Libya experience delays due to low contractor performance and inadequate planning.
- In Jordan, delays are mainly attributed to contractor financial constraints, delays in governmental payments, and governmental decision-making delays.

Case studies highlight a range of delay factors linked to project characteristics, implicating stakeholders, like owners, consultants, and contractors. Issues, such as design errors, contractor financial constraints, and prolonged payment cycles to sub-contractors, are identified. The COVID-19 pandemic significantly impacted the construction sector, causing disruptions in project timelines, labor availability, and supply chains. Lockdowns and mobility restrictions led to workforce shortages and delays, while factory closures and transportation restrictions strained material supply chains, increasing costs. Compliance with new health and safety regulations further escalated expenses and prolonged project durations (Islam et al., 2017). Additionally, legal and contractual disputes arose over force majeure clauses and payment delays, creating financial and operational uncertainties.

Despite these challenges, the pandemic also brought some positive changes. It accelerated digital transformation, with increased adoption of remote project management tools, automation, and prefabrication methods to enhance efficiency. The crisis also underscored the need for resilient supply chains, flexible contracts, and improved risk management strategies. Moreover, sustainability and worker well-being gained greater attention, influencing future construction policies and practices. While the pandemic posed severe short-term challenges, it also drove long-term innovations that could enhance the efficiency, resilience, and adaptability of the construction industry.Delays associated with project owners are significant, with issues such as regulatory changes and overly optimistic project duration estimates contributing to delays (Mecca's projects). Late governmental payments are a recurring problem affecting project timelines globally. Consultant-related delays often result from inefficient approval processes for shop drawings and materials, compounded by deficiencies in drawing detailing. Similar challenges are observed in various countries, including Nigeria, Turkey, and Malaysia.

Contractor-related delays frequently lead to cost overruns and disputes among stakeholders. Studies have highlighted repercussions, such as legal actions, cost escalation, project abandonment, and compromised project quality.

The Relative Importance Index (RII) rankings for delay reasons are illustrated in Table 7, categorized by the involved parties. Notably, perspectives vary: the owner views the contractor's financial situation as the primary cause of delays, while the consultant cites improper project planning by the contractor. Conversely, contractors attribute delays primarily to late payments by the owner. These findings reflect each party's perspective, as no party would willingly fault its own side.

Table 7. RII for the delays related to contractor, government & consultant (authors' own)

Reasons for Delays	Delays by	Mean	RII	Ranking
Financial Situation	Contractor	3.92	0.7848	1
Delay in Payments	Government	3.90	0.78	2
Delay in Decision-making	Government	3.89	0.7776	3
Improper Project Planning	Contractor	3.82	0.7632	4
Approval Procedures	Government	3.76	0.7528	5
Risk Management Plan Is Not Performed	Contractor	3.65	0.7296	6
Unqualified Staff	Contractor	3.60	0.7208	7
Lack of Experience	Contractor	3.48	0.696	8
Design Changes	Government	3.46	0.6912	9
Design Changes According to Design Errors	Consultant	3.45	0.6896	10
Hiring Unqualified Engineers	Consultant	3.43	0.6856	11
Delays for Approving the Shop Drawings	Consultant	3.20	0.6392	12
Unrealistic Contract Duration	Government	3.18	0.636	13
Design Drawings Are Not Compatible with Site Conditions	Consultant	3.14	0.6272	14
Delays for Approving Inspection Requests	Consultant	2.91	0.5824	15

Table 8a and Table 8b show the importance ranking for the delay results, individually for the owner, the consultant, and the contractor, and according to the whole sample. For owners, delays result mostly in disputes, and for consultants and contractors, delays result in cost overruns.

Table 8a. Means, RII values and rankings for the delay results according to the party (authos' own)

Delay Results	Owner			Consultant			Contractor		
	Mean	RII	Ranking	Mean	RII	Ranking	Mean	RII	Ranking
Cost Overrun	3.77	0.754	2	3.92	0.785	1	3.78	0.757	1
Poor Quality	3.45	0.691	3	3.48	0.697	3	3.06	0.612	4
Conflicts	3.39	0.678	4	3.36	0.673	4	3.18	0.637	3
Disputes	3.88	0.776	1	3.62	0.724	2	3.28	0.655	2

Table 8b: Means, RII values and rankings for the delay results according to the whole sample (authos' own)

Delay Results	Mean	RII	Ranking
Delay Results - Cost Overrun	3.77	0.7544	1
Delay Results - Poor Quality	3.37	0.6736	3
Delay Results - Conflicts	3.34	0.6672	4
Delay Results - Disputes	3.64	0.7272	2

Resolving the Problem of Delays

In addressing the problem of delays in construction projects, various solutions have been considered, including total abandonment, communication, arbitration, and litigation. According to Table 9, arbitration emerges as the most preferred method for resolving delays (37.6%), followed by communication between parties (33.4%), with litigation and abandonment being less favored options (13.6%).

Table 9. Delay solutions (authos' own)

Delay Solutions		
	Frequency	**%**
Abandonment	52	13.6%
Communication	128	33.4%
Arbitration	144	37.6%
Litigation	52	13.6%
Other solutions	7	1.8%
Total	383	100.0%

The preceding section underscores the significance of understanding the causes of construction project delays in Jordan relative to other countries. Key factors contributing to delays in Jordan include the contractor's financial situation, improper planning, and lack of experience. Additionally, delays attributed to site conditions and delayed government responses involve multiple stakeholders, including the government, consultants, and project owners.

This analysis offers valuable data for government departments to develop strategies aimed at preventing delays, such as ensuring timely payments to contractors. Emphasize the importance of precise and comprehensive contract agreements is crucial to minimize delays. Contracts should delineate payment procedures, consequences of modifications, and associated costs and delays.

By comprehensively examining delay causes and their effects, this analysis provides insights into the complex dynamics of construction projects. Understanding the interconnected nature of delay factors and their implications lays a foundation for addressing and mitigating delays, not only in Jordan, but also globally. Further research is needed to explore specific delay factors and their relative impact on project outcomes, enabling targeted interventions and strategies to enhance project delivery efficiency.

Contractor Attributes: Pre-qualifications

Table 10 shows the relative importance index according to the mean scores and the importance of ranking the contractor's qualifications relating to all the parties together.

Table 10. RII for contractor's qualification importance (authos' own)

Contractor's Qualification	Mean	Relative Importance Index	Ranking
Technical staff Skills	4.30	0.8584	1
Project Planning	4.28	0.8568	2
Financial Issues	4.28	0.856	3
Experience and Adequacy	4.28	0.8552	4
Managing Contracts	4.13	0.8256	5
Availability for the Project	3.92	0.7856	6
Risk Management Plan	3.84	0.7696	7
Technology	3.77	0.7608	8
Ethics	3.73	0.7544	9
Safety Issues	3.71	0.748	10
Behavioural Issues	3.65	0.736	11

Confirmatory Factor Analysis

The Confirmatory Factor Analysis (CFA) process commenced by inputting the eleven qualifications into the AMOS program, categorized under the contractor's qualifications, as delineated in Model A, is illustrated in Figure 4. This step aimed to scrutinize the relationship between the primary variable and its associated factors, pooling responses from the entire sample without stratification into distinct groups.

Notably, from Table 11, it is evident that the most crucial factors in many different countries over the years have alternated between the contractor's financial situation, past experience, and the skills of his/her technical staff.

These findings are consistent with the results of this research, as indicated in the first column of Table 11.

Regarding the differences between contractor selection procedures in the public and private sectors, in the case of private projects in Jordan, Kasabreh and Tarawneh (2021) found that "the contractor's technical capabilities, past performance, and financial capabilities are the most critical factors in determining contractor selection". Furthermore, the private sector heavily relies on the qualifications and capabilities of the contractor, taking into account recommendations and word-of-mouth referrals, which can lead to improved performance.

Hwang et al. (2011), in their study in the United States covering 21 states, affirmed that private projects exhibited greater commitment to project cost schedules and fewer changes compared to public projects.

Table 11. Most crucial contractor's attributes in different countries (authos' own)

Study	Country	Main Four Points
Amireh (2022)	Jordan	Technical Staff, Project Planning, Financial Issues, Experience
Al-Tmeemy (2017)	Iraq	Security & Safety, Financial Stability, Past Performance, Relevant Experience
Alzahrani & Emsley (2013)	UK	Financial Turnover, Management, Technical Ability, Experience
Idrus et al. (2011)	Malaysia	Track Performance, Financial Capacity, Technical Capacity, Bid Price
Salama et al. (2006)	Egypt	Experience in Similar Projects, Resources, Financial Status, Firm's Structure
Ogunsemi & Aje (2006)	Nigeria	Past Performance, Contractor's Experience, Workmanship Quality, Tender Sum
Fong & Choi (2000)	Hong Kong	Tender Price, Financial Capability, Past Performance, Past Experience

Key observations regarding the contractor selection procedure and the importance of contractor qualifications are as follows:

- The impact index of the contractor selection method on success is notably high at 80.6%.
- The importance of contractor qualifications varies among parties. Owners prioritize the contractor's financial stability, experience, and technical staff skills. Consultants value technical staff skills, contractor experience, and project planning. Contractors prioritize project planning, financial stability, and technical staff skills.
- A significant portion (71.6%) of responses suggest room for improvement in the contractor selection procedure.

Further analysis involved several tests, including chi-square value (CMIN), degrees of freedom (DF), probability value (P), CMIN/DF ratio, root mean square error of approximation (RMSEA), comparative fit index (CFI), and Tucker Lewis index (TLI). Results failing to meet acceptable thresholds led to the elimination of factors weakly correlated with contractor qualifications (Table 12). Acceptable outcomes, outlined in Table 13, adhere to specific criteria: a low percentage for chi-square value (CMIN), non-statistically significant degrees of freedom (DF) and probability value (P), a CMIN/DF ratio below 5, an RMSEA below 0.05, and CFI and TLI values exceeding 0.9. Upon inspection of Model A in Figure 4, it was evident that factors, such as behavioral issues, ethics, project availability, and safety concerns, exhibited relatively lower correlations with the main variable (qualifications). These attributes were consequently identified as less pivotal qualifications. The model was reconstructed by eliminating these four factors and recalculating standardized estimates. Covariance between certain error terms was introduced to address inter-factor relationships, as depicted in Model B in Figure 5. Model B underscores three vital attributes significantly linked to contractor qualifications: technical staff skills, experience and adequacy, and contract management. Following these adjustments, the results met satisfaction and compliance with acceptance criteria.

In summary, technical staff skills, experience and adequacy, and contract management emerged as the most significant qualifications, while factors like technology utilization and risk management plans appeared less crucial. Integrating survey and interview findings from case studies is essential for devising the final model, guided by the multi-attribute utility theory to assign specific weights to attributes based on perceived importance. This synthesis will facilitate a comprehensive analysis in the subsequent discussion section, consolidating data from case studies for further scrutiny.

Table 12. Test results for the existing model

Test	Result	Acceptable Results
CMIN	289	Low %
DF	44	non-statistically significant
P	0.000	non-statistically significant
CMIN/DF	6.789	Less than 5
CFI	0.880	More than 0.9
TLI	0.850	More than 0.9
RMSEA	0.152	Less than 0.05

Table 13. Test results for the updated model

Test	Result	Acceptable Results
CMIN	14.56	Low %
DF	12	non-statistically significant
P	0.266	non-statistically significant
CMIN/DF	1.213	Less than 5
CFI	0.998	More than 0.9
TLI	0.997	More than 0.9
RMSEA	0.029	Less than 0.05

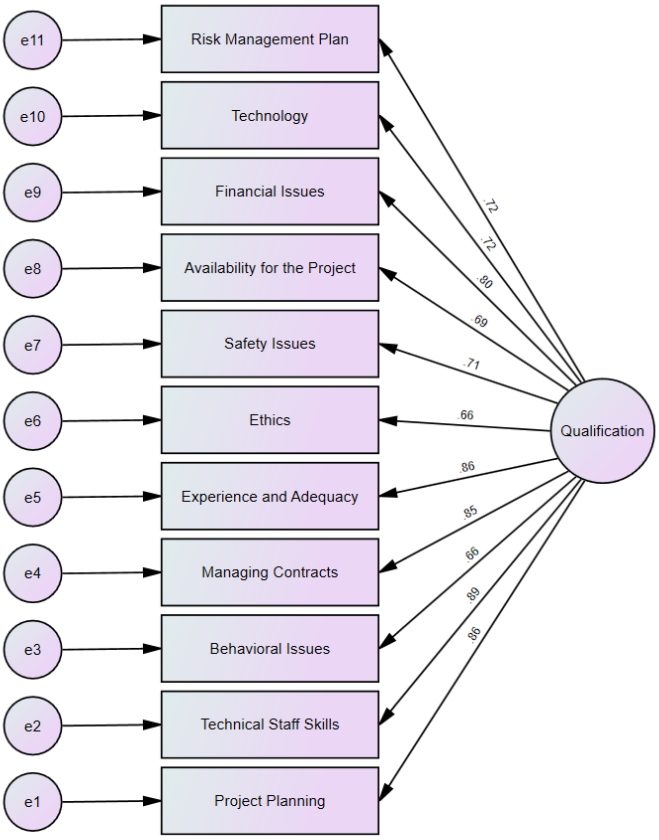

Figure (4): Confirmatory analysis/model A

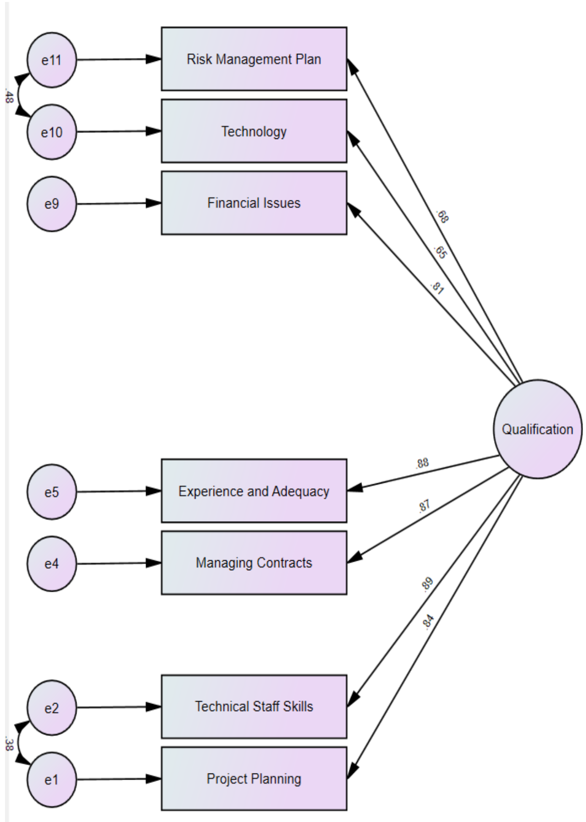

Figure (5): Updated confirmatory analysis/ model B

Case Studies

Case Study One: Ali bin Abi Talib School in Jerash

Case Study One: Ali bin Abi Talib School in Jerash provides insight into the project's timeline, bid process, staffing requirements, and encountered delays. The tender for this medium-sized project was publicly announced on the Ministry of Public Works and Housing website on October 15, 2019. The winning bid, awarded to the contractor on December 18, 2019, amounted to 1,332,055 JD. Notably, the discrepancy between the winning bid and the higher bid was significant, standing at 273,750 JD. The government allocated funds of 1.6 million JD.

Staffing requirements specified by the contractor included a representative with ten years of experience, civil and electrical engineers each with five to seven years of experience, a quantity surveyor with five years of experience, and a foreman with a decade of experience. The project was scheduled to span 360 days or 12 months from the commencement date, with a submission deadline of March 10, 2021. However, significant delays, primarily due to unforeseen events, the contractor's financial issues, a shortage of skilled labor, and design flaws, extended the completion date by approximately one year. Managers anticipate project submission by March 3, 2023, reflecting an additional year of delay.

Case Study Two: Ali Al-Khasawneh School in Al-Karak

Case Study Two: Ali Al-Khasawneh School in Al-Karak provides insights into another medium-sized project, spanning four floors and an outdoor area, with a total area of 4554 m². The tender for this project was announced by the Ministry of Public Works and Housing on February 5, 2020. Nineteen companies submitted bids. The winning bid, awarded on May 28, 2020, amounted to 1,997,889 JD; the discrepancy between the winning bid and the higher bid was significant, standing by 515,397 JD compared to the lowest bid. with the government allocating funds of 2.5 million JD.

Staffing requirements included a contractor representative with ten years of experience and engineers with specified years of experience. Financial arrangements granted 56 days for payment request reviews, with penalties for delays and cost adjustments for drawing modifications. Funding was provided by the

Arab Potash Company. The project's duration was set at 540 days, with a submission deadline of January 27, 2022. However, a predicted delay of six months pushed the anticipated completion to July 2022. Delays were primarily attributed to unforeseen events, contractor financial weaknesses, a shortage of qualified labor, and failure to thoroughly review drawings.

Summary of Case Studies' Analysis

Thematic analysis of the two case studies revealed eleven key areas, including project success, challenges, impacts of contractor selection methods, qualifications, disparities between public and private sector selection, and proposed solutions to mitigate delays. The synthesized thematic analysis results are outlined below:

Project Success

- In Case Study One, significant delays and non-compliance with the original schedule led the owner to perceive the project as hardly successful.
- Similarly, Case Study Two's owner didn't consider the project successful due to delays caused by site conditions and the COVID-19 pandemic.
- Consultants generally viewed the projects positively, emphasizing selected criteria for success, with delay being crucial.
- Contractors in both cases perceived the projects as failures, primarily due to significant delays encountered.

Success Factors

- Identified success factors in both case studies include meeting cost and quality goals, adhering to project schedules, effective project management, and contract compliance.
- Case Study Two's consultant highlights additional success factors, such as innovative design and efficient site management.
- Contractors stress the importance of adequate resources, efficient management, financial stability, technical staff availability, and timely material delivery.

Challenges

- Common challenges across both case studies include unexpected events, site conditions, and delays impacting project success.
- Case Study One highlights design errors, unexpected events, like the COVID-19 pandemic, and delays due to sub-contractors' timetables.
- Financial challenges and inaccurate pricing estimates are recurring issues for contractors in both cases.
- Case Study Two's challenges stem from site conditions, exacerbated by inadequate site assessment by the owner and the consultant.

Contractor Selection

- The lowest bid is the primary criterion for contractor selection in both case studies.
- Case Study One reveals a lack of consideration for contractor's echnical capabilities.
- Suggestions for improving contractor selection include assessing technical capabilities and establishing a blacklist for unqualified contractors.

Contractor Selection in Public Sector *vs*. Private Sector

- Differences in contractor selection criteria exist between the public and private sectors, with the private sector prioritizing quality and previous experience.

Improvement in Contractor Selection Method

- Recommendations for improving contractor selection methods include assessing technical personnel availability and comparing initial price estimates with projected budgets.

Delays and Causes

- Delays stem from various factors, such as financial issues, site conditions, and project requirement changes.
- Case Study Two attributes delay to site conditions, inaccurate pricing estimates, and delayed government responses.
- Case Study One cites COVID-19-related suspensions, incomplete designs, contractor financial instability, and delayed sub-contractor payments as causes for delays.

Delay Consequences

- Project delays can tarnish reputation, lead to cost overruns, increase operational expenses, and hinder future funding for governmental projects.
- Both case studies experience financial losses and cost overruns due to delayed project phases and additional expenses.

Delay Solutions

- Strategies for delay resolution include collaboration, communication, and arbitration, albeit with potentially lengthy resolution periods.

In conclusion, these case studies underscore the complexity of building projects and the importance of effective management, clear communication, and proactive problem-solving. Given the frequency and severity of delays, robust project management and conflict resolution procedures are vital.

Creating a New Model for Contractor Selection Using AHP and MAU

Creating a new model for contractor selection using AHP and MAU involves a structured methodology integrating Analytical Hierarchy Process (AHP) and Multi-attribute Utility (MAU) techniques. This part of the study outlines the process of attribute prioritization and decision-making in contractor selection processes:

The developed model is a culmination of a thorough literature review, survey analysis, and case study insights, identifying key contractor attributes crucial for project success. These attributes include risk management planning, technology adoption, financial stability, project capacity, experience and adequacy, contract management, technical staff competency, and project planning.

A. Multi-attribute Utility (MAU) Technique: This approach integrates contractor pre-qualifications and pricing proposals, emphasizing contractor qualifications over cost considerations. A panel of 10 experts from the Ministry of Public Works and Housing determined the weighting of 70% for qualifications and 30% for pricing, recognizing the importance of both factors.

B. Analytical Hierarchy Process (AHP): A structured approach to attribute prioritization is established through AHP, determining the relative importance values across various contractor attributes. Key steps include establishing importance scale values and ranking attributes based on their significance (Figure 6), and Appendix 02.

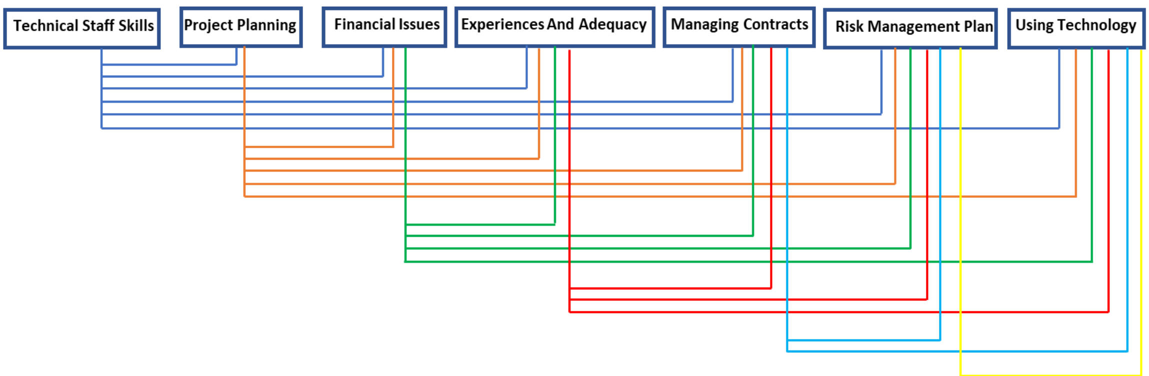

Figure (6): Attributes in relation to others (authors' own)

The attributes considered in this process encompass technical staff skills, project planning, financial considerations, experience and adequacy, contract management, risk management planning, and technology adoption.

The empirical inquiry identified eleven qualifications for assessing contractors' suitability, with four eliminated following confirmatory analysis. The remaining qualifications were hierarchically ranked, 1) technical staff skills; 2) project planning; 3) financial considerations; 4) experience and competence; 5) contract management; 6) risk management planning; and 7) technology proficiency.

The subsequent parts will provide practical examples and delve into model development intricacies, offering a comprehensive understanding of the model's conceptual framework and operational mechanics.

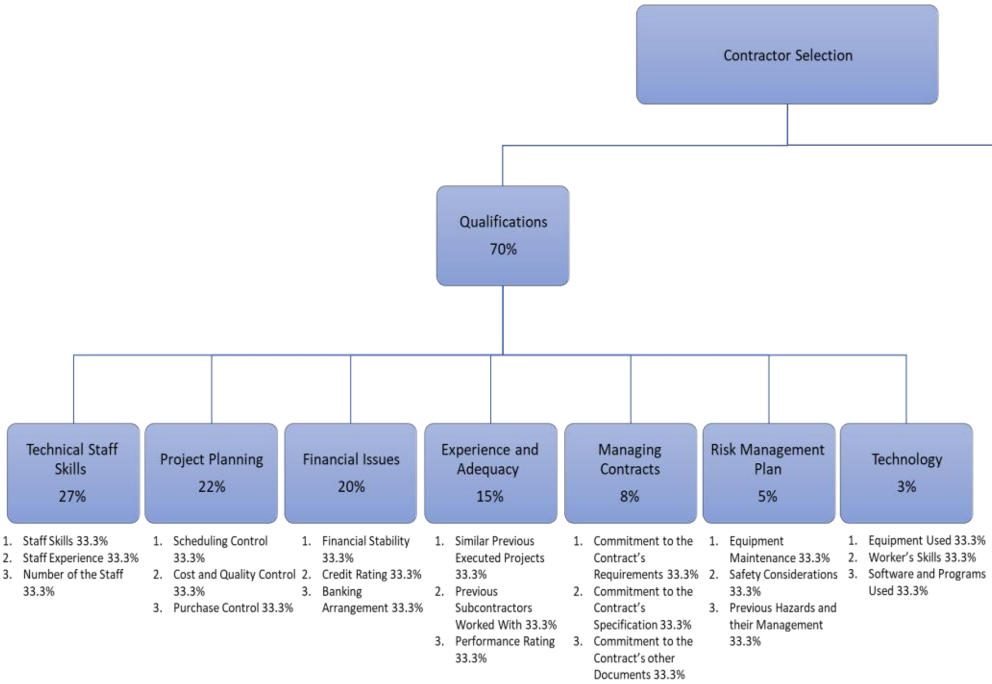

Figure (7): The final model for choosing the appropriate contractor (authors' own)

The current contractor selection method significantly impacts the success of governmental construction projects and delays in Jordan, indicating the necessity for a new selection model, as illustrated in Figure 7. This model prioritizes two key aspects: price, accounting for 30% of the evaluation, and qualifications, holding a substantial weight of 70%. The Analytical Hierarchy Process (AHP) theory was applied, employing a matrix approach and specific calculations to determine the importance percentage for each qualification, as depicted in the accompanying image.

This model stands as the primary conclusion and core contribution of this research, holding practical value, particularly for the Ministry of Public Works and Housing, the decision-maker responsible for selecting contractors for governmental projects. Its simplicity and utility render it an invaluable tool, as demonstrated in the previous part of the study. Ultimately, the aim is to enhance the likelihood of project success.

The implementation of the proposed contractor selection framework in practice requires a structured approach that accounts for both technical and institutional challenges. A key obstacle is potential resistance to change from stakeholders, particularly procurement officials and contractors accustomed to cost-driven selection methods. To mitigate this obstacle, awareness campaigns and training programs can help demonstrate the benefits of a more holistic evaluation process, emphasizing long-term project success over short-term cost savings.

Institutional challenges, such as aligning procurement regulations with the framework's criteria, may require policy adjustments and integration into existing tendering procedures. This can be achieved by gradually incorporating weighted qualification metrics into contractor assessments, ensuring a smooth transition. Additionally, adopting digital procurement platforms can enhance transparency and facilitate structured evaluation processes.

To address implementation barriers, pilot projects can be introduced to validate the framework's effectiveness in real-world settings before full-scale adoption. Collaboration with industry stakeholders, including governmental agencies, contractors, and professional bodies, will be essential to refining the framework and ensuring its practical feasibility.

In summary, the research findings align with the primary objectives, highlighting the urgency of addressing project delays, understanding their causes and impacts, evaluating the existing contractor selection methodology, and emphasizing the significance of contractor pre-qualification. These findings underscore the need for refining the existing contractor selection process, emphasizing attributes, such as technical proficiency and project planning, in order to improve project success rates.

CONCLUSIONS

This study was motivated by firsthand observations of contractor selection practices in Jordan's construction sector, where an overemphasis on the lowest bid price frequently leads to project delays and associated risks. To address this issue, the research developed a decision-making framework using MAUT and AHP to optimize contractor selection by balancing price and qualifications. The framework identifies key contractor attributes and benchmarks them against international standards to highlight both commonalities and contextual differences.

The proposed model aims to assist governmental decision-makers in shifting from a cost-centric approach to a more comprehensive evaluation of contractor capabilities. Given the contractor's critical role in project execution, the study underscores the importance of pre-qualification and quality assurance in improving project outcomes, particularly in large-scale public sector developments.

Empirical findings reinforce the significance of contractor selection, revealing the risks of prioritizing cost over essential qualifications. The study highlights the need to integrate qualification assessments early in the procurement process, mitigating the adverse effects of price-driven selection. Recognizing the inherent uncertainty in construction projects, a probabilistic approach to success is emphasized.

The MAU and AHP methodologies serve as robust decision-making tools within this framework. MAUT enables evaluation based on weighted attributes and probabilities, while AHP facilitates structured ranking through pairwise comparisons. The adaptability of this approach allows for continuous refinement based on evolving project needs, industry feedback, and insights from policymakers, particularly within the Ministry of Public Works and Housing. By incorporating these methodologies, the framework enhances the resilience and efficiency of contractor selection, ultimately contributing to improved project success rates.

Research limitations include the sample size of 250 responses that was determined using a 95% confidence level and a 5% margin of error, ensuring a representative dataset for Jordan's public construction sector. However, we acknowledge that the geographical focus may limit broader applicability.

Construction procurement practices vary across regions due to differences in regulations, economic conditions, and industry dynamics. While our model integrates widely recognized decision-making theories (MAUT and AHP), its application in other contexts may require adaptation. Nonetheless, the core principles prioritizing contractor pre-qualification, technical expertise, and financial stability over a cost-driven approach remain relevant for public procurement systems facing similar challenges.

Future research can explore the integration of advanced technologies, such as virtual reality (VR) and real-time sensors, to enhance contractor selection and project monitoring. For instance, VR-based simulations could provide more accurate pre-qualification assessments, while sensor-driven performance tracking may help mitigate delays by offering real-time insights into contractor efficiency. Additionally, machine learning algorithms could refine selection models by predicting contractor reliability based on historical data.

To build on this study, future research could test hypotheses such as whether VR assessments improve project success rates or whether sensor-based tracking significantly reduces delays. By advancing these areas, future studies can further optimize contractor selection frameworks and enhance public construction procurement practices.

In conclusion, this study provides a comprehensive framework for improving contractor selection processes in Jordan's construction sector, with implications for project success and public welfare. Continued research and refinement of these methodologies promise to contribute to more efficient and effective construction project management practices.

Data Availability Statement (DAS)

All the data is available upon request from the corresponding author.

Acknowledgements

The authors would like to thank everyone who contributed to the accomplishment of this research, whether directly or indirectly. Additionally, the valuable and constructive feedback provided by the reviewers of the Jordan Journal of Civil Engineering is greatly appreciated.

Appendix 1. Delay reasons in different countries in different years

Study	Country	Main Delay Factors
Jordan, Amireh F. (2022)	Jordan	1. Financial Situation- Contractor 2. Delay in Payments- Government 3. Delay in Decision Making- Government
Rachid et al. (2019)	Algeria	1. Slow Change Orders 2. Unrealistic Contract Duration 3. Slow Variation Orders in Extra Quantities
Gunduz and Abu Hassan (2016)	Qatar	1. Delay in Decision Making 2. Poor Site Management and Supervision 3. Shortage of Construction Material
Kikwasi (2012)	Tanzania	1. Design Changes 2. Delays in Payment to Contractors 3. Information Delays
Albogamy et al. (2012)	Saudi Arabia	1. Low Performance of the Lowest Bidder in the Government Tendering System 2. Delays in Sub-contractors' Work 3. Poor Qualification, Skills, and Experience of the Contractor's Technical Staff
Fugar and Agyakwah Baah (2010)	Ghana	1. Delay in Honoring Payment Certificates 2. Underestimation of the Cost of Projects 3. Underestimation of the Complexity of Projects 4. Difficulty in Accessing Bank Credit
Khoshgoftar et al. (2010)	Iran	1. Finance and Payments of Completed Work 2. Improper Planning 3. Site Management
Tumi et al. (2009)	Libya	1. Improper Planning 2. Lack of Effective Communication 3. Design Errors
Abd El-Razek et al. (2008)	Egypt	1. Financing by Contractor during Construction 2. Delays in the Contractor's Payment by the Owner 3. Design Changes by the Owner or His/Her Agent during Construction
Alaghbari et al. (2007)	Malaysia	1. Financial Difficulties and Economic Problems 2. Financial Problems 3. Too Late Supervision and Slowness in Making Decisions
Faridi, and El-Sayegh (2006)	UAE	1. Preparation and Approval of Drawings 2. Inadequate Early Planning of the Project 3. Slowness of the Owner's Decision-making Process

Appendix 2. The AHP procedure involves several key steps to determine the percentage of the importance values of the final attributes, all summarized in Appendix 2 below

Step	Description
Pairwise Comparison	Attributes are compared using a scale from 1 (equal importance) to 9 (extreme importance)
Normalization	Each value in the comparison matrix is divided by the sum of its column
Criterian-weight Calculation	The row sum is divided by the total number of attributes (7)
Weighted Value Calculation	Each value is multiplied by its corresponding criteria weight
Principal Eigenvalue (λ) Calculation	The sum of weighted values is divided by the criterian weight for each row
Consistency Check	**Consistency Index (CI)**: Measures the consistency of comparisons **Consistency Ratio (CR)**: Ensures decision reliability (CR < 0.10 indicates acceptable consistency)

In the final step, each attribute is assigned a defined value for use by decision-makers. This assigns each attribute an importance percentage, as illustrated in the table below. Attributes' Importance (%).

Qualification	Percentage
Technical Staff Skills	27.00%
Project Planning	21.83%
Financial Issues	20.19%
Experience and Adequacy	15.00%
Managing Contracts	7.56%
Risk Management Planning	5.00%
Technology	3.43%

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