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# Prioritization of Influencing Factors on Interactive Role of Consulting-Contractors in Advancing Project Goals

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***Abstract*:** Civil projects play a critical role in shaping urban landscapes over time, serving as visible and enduring social structures. Given their public visibility, meticulous attention to planning and design stages is crucial. Collaboration among project stakeholders is a primary driver of success. Regular progress review meetings are essential, not only to monitor advancement but also to implement timely corrective and preventive measures. Continuous updates to project plans enhance the likelihood of successful completion. Supervision by specialized engineers ensures the safety and quality of constructed structures. This study employs the Analytic Hierarchy Process (AHP) to evaluate the interactive dynamics between consulting engineers and contractors, based on inputs from 217 experts involved in five urban projects in Mashhad, Iran. Pairwise comparison questionnaires were used for data collection, and analyses were conducted using ExpertChoice and SPSS software. The findings identified five main criteria (bid documents, consultant-contractor contracts, consultant requirements, contractor performance, and environmental conditions), along with 21 sub-criteria. Among these, bid documents were deemed the most influential, with a 53.7% weight, underscoring their significance in shaping consultant-contractor interactions. Contracts ranked second at 23.2%, emphasizing the economic and unilateral perspectives often prevalent in project execution. Environmental conditions, with a minimal 3.6% influence, were the least impactful, as they are typically integrated into contractors' operational designs. Overall, the study highlights the pivotal role of enhancing consultant-contractor collaboration in achieving project success.

***Keywords:*** Civil projects, Consultant-contractor collaboration, AHP model, Bid documents, Project success.

## I. INTRODUCTION

Today, countless civil projects are under construction in our country, encompassing a wide range of endeavors that drive progress, enhance infrastructure, and improve quality of life (Chan et al., 2004). These projects include building construction, residential complexes, road construction and paving, dam building, tunnels, bridges, water treatment plants, airports, and more (Peansupap & Walker, 2005). Over time, civil projects shape the identity of cities and nations, making careful planning and design an essential priority. As visible social structures, they demand precision and foresight during their development phases (Blayse & Manley, 2004).

Among all resources involved, human capital stands out as the most critical factor in ensuring the success of civil projects (Belay et al., 2022). However, due to the relatively lower costs of labor compared to materials and machinery, it often receives insufficient attention (Winch, 2012). Proper management and development of human resources, guided by strategic planning, can significantly enhance project performance (Kaufmann & Tödtling, 2001). In civil projects, consulting engineers and contractors play complementary yet pivotal roles (Winch, 2012). The consultant is responsible for technical, economic, and environmental studies and project design, while the contractor handles project execution (Chan et al., 2004). Both are fundamental pillars in determining the success or failure of a project (Aghazadeh & Yildirim, 2021). Consulting engineers ensure adherence to technical standards and provide advisory services to guarantee accurate implementation, whereas contractors are tasked with delivering high-quality results and meeting financial and technical commitments (Belay et al., 2022). All construction projects must be carried out under the supervision of skilled engineers to ensure safety and structural integrity (Winch, 2012). During project execution, consulting engineers employ specialized inspectors and quality control tools to oversee the work and safeguard the interests of stakeholders (Alavi et al., 2005). Collaboration and effective communication between consultants and contractors during this phase are critical to achieving project success. This partnership fosters efficient execution, ensuring both quality and adherence to project goals (Dai et al., 2009).

The contractor is responsible for preparing and executing the project design and specifications. This includes procuring materials and equipment, hiring personnel, carrying out construction operations, and adhering to applicable laws and regulations (Acheamfour et al., 2019). These regulations

encompass safety standards, environmental guidelines, and other relevant legal requirements (Winch, 2012). The contractor must ensure the project is executed with optimal quality, conduct necessary testing to verify the quality of materials and equipment, and oversee proper implementation and quality control throughout various project stages (Masengesho et al., 2020). Additionally, the contractor is obligated to fulfill all financial commitments outlined in the contract with the client, which affects payments for materials, equipment, labor, and other associated costs (Doloi et al., 2011). A cooperative and coordinated relationship between the consultant and contractor is essential (Owusu-Manu et al., 2017). The consultant should provide guidance and support to the contractor during project execution, while the contractor should trust the consultant's technical and financial recommendations. In cases of disputes between the two parties, the client must act as an arbitrator to resolve conflicts (Yong & Mustaffa, 2011).

Consultants and contractors are two key pillars in construction projects, playing vital roles in the success or failure of the endeavor (Phua & Rowlinson, 2004). The consultant ensures proper project execution and adherence to essential standards through technical expertise and advisory services. The contractor, on the other hand, contributes by delivering quality execution and fulfilling financial obligations, thereby ensuring the project's financial and technical success (Lehtiranta et al., 2012). Effective communication and collaboration between consultants and contractors are crucial within construction projects. This relationship fosters the following benefits (Winch, 2012):

- Enhanced project efficiency and quality.
- Improved compliance with technical and safety standards.
- Reduction in delays and unforeseen costs.
- Strengthened trust and mutual understanding, ensuring project success.

Effective communication and collaboration between consultants and contractors significantly contribute to the success of construction projects, ensuring client satisfaction. In project management systems, project managers serve as a coordinating and supervisory entity alongside the client, consultant, and contractor (Kometa et al., 1994). They integrate various project activities and ensure proper execution in line with the project's timeline and budget (Doloi et al., 2011). Construction projects encompass complex processes, from design to execution and completion, making the interaction between consultants, contractors, and clients essential (Owusu-Manu et al., 2017). Lack of coordination among these key players can lead to delays, cost overruns, and compromised quality (Alavi et al., 2005). This raises a critical question: how can these interactions be optimized to maintain project quality while effectively managing timelines and costs? (Belay et al., 2022). Thoroughly analyzing these relationships is crucial for addressing challenges and enhancing efficiency (Winch, 2012). Consultants and contractors play complementary roles in construction projects. The consultant is responsible for technical, economic, and environmental studies and designs, while the contractor oversees the project's execution based on the consultant's documentation (Acheamfour et al., 2019). The consultant collaborates with the client to identify needs and goals and translates them into actionable designs. The contractor then implements these designs to deliver the project (Aghazadeh & Yildirim, 2021).

As the client's technical representative, the consultant plays a vital role in translating project objectives into executable plans (Dadzie et al., 2012). Given clients' potential lack of technical knowledge, ongoing interaction between the consultant and client is necessary to establish realistic goals that align with technical and financial feasibility (Masengesho et al., 2020). The consultant also provides progress update, ensuring the client is informed throughout the project (Yong & Mustaffa, 2011).

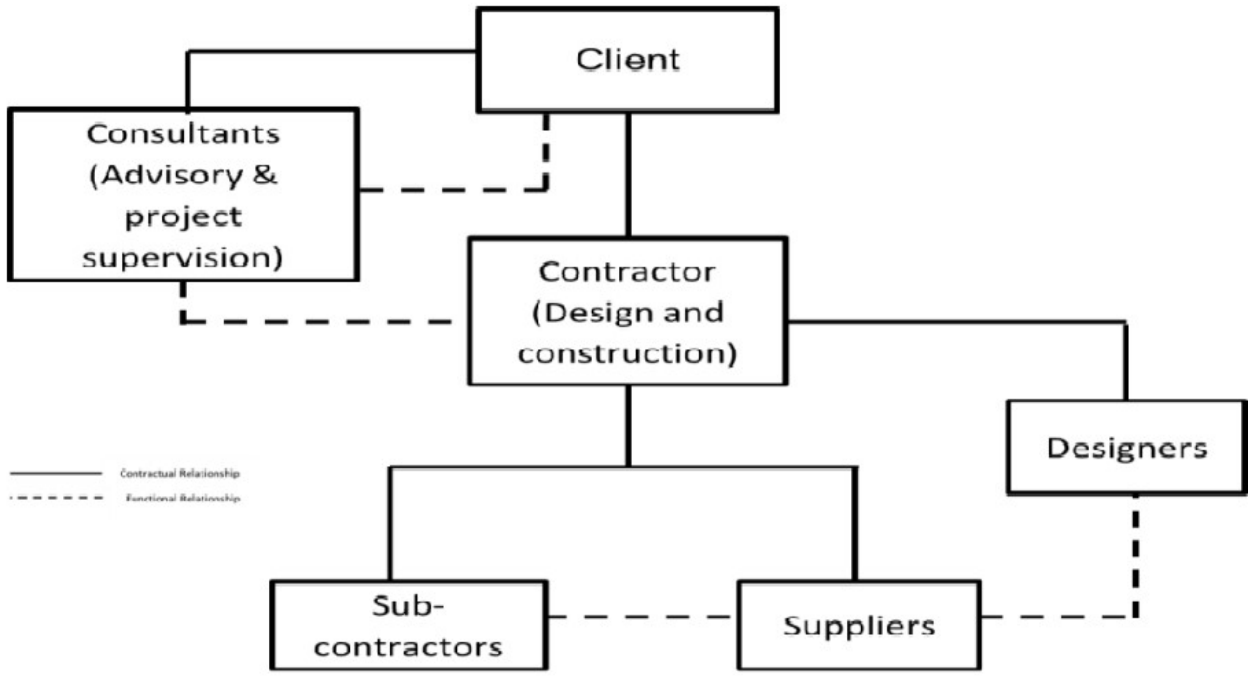


**Fig. 1** A topical relation between consultant contractor and client (Al-Harthi et al., 2014)

Additionally, the consultant supervises the contractor, ensuring alignment between implementation and project requirements (Winch, 2012). Close interaction between these parties allows the consultant to inform the contractor of design changes and address any technical or operational issues, preventing deviations and ensuring project quality (Phua & Rowlinson, 2004). For their part, contractors must maintain communication with the client to understand expectations and adapt to changes. Regular updates from the contractor enable clients to make informed management decisions. Continuous contractor-client interaction ensures projects are delivered on time and meet final specifications (Mathar et al., 2020). By fostering collaborative relationships among all parties, construction projects can achieve better outcomes, enhance quality, and maximize client satisfaction.

Ineffective collaboration among consultants, contractors, and clients can lead to significant challenges (Atout, 2016). For instance, a lack of coordination between consultants and contractors may result in execution errors and deviations from the initial designs (Kshaf et al., 2022). Similarly, if a contractor fails to communicate the client's needs to the consultant promptly, critical design modifications may be overlooked. Ultimately, such miscommunication can increase costs, delay project timelines, and diminish client satisfaction (Abeysinghe & Jayathilaka, 2022). A key solution to improving these interactions is establishing precise and collaborative planning from the outset of the project. Regular meetings among the three parties should be held to address changes or issues promptly (Alsugair, 2022). Additionally, leveraging management tools such as advanced project management systems and decision-making software can enhance these interactions, prevent conflicts, and mitigate errors (Kamal et al., 2022).

This study specifically focuses on analyzing factors influencing collaboration between consultants and contractors while also considering their indirect interactions with clients. Using the Analytical Hierarchy Process, AHP (an advanced decision-making method) the research aims to explore systematic interactions between these key stakeholders. As a case study, construction projects in the holy city of Mashhad have been examined to provide practical insights and actionable recommendations.

## II. Contractor-Consultant Relationship

The relationship between contractors and consultants is one of the most critical dynamics in construction projects. It directly impacts the project's quality, cost, and timeline. This partnership requires clear communication, mutual respect, and collaboration to ensure that the project aligns with the client's vision and meets regulatory standards (Kumaar et al., 2016). A well-established contractor-consultant relationship fosters a cooperative environment that benefits all stakeholders and ultimately leads to successful project delivery (Akintoye & Main, 2007). Consultants play a pivotal role in translating the client's ideas and needs into actionable plans and technical designs (Egemen & Mohamed, 2005). They are responsible for ensuring that the project adheres to safety, environmental, and quality standards while meeting the client's budgetary constraints (Mathar et al., 2020). On the other hand, contractors are responsible for executing the designs and plans provided by the consultant. Their expertise lies in construction techniques, resource management, and delivering the physical structure. The alignment of these roles is essential to ensure the smooth progression of the project (Lam & Wong, 2011).

One of the common challenges in this relationship arises from differing perspectives. Consultants often prioritize precision and compliance with design specifications, while contractors focus on efficiency and cost-effectiveness (Bygballe et al., 2010). This difference can sometimes lead to conflicts, especially when unexpected site conditions or constraints necessitate deviations from the original design (Kshaf et al., 2022). Establishing a mechanism for resolving such issues early in the project can significantly reduce delays and disputes (Phua and Rowlinson, 2004). Clear and timely communication is the foundation of a successful contractor-consultant relationship (Winch, 2012). Miscommunication or a lack of transparency can lead to errors in execution, rework, and wasted resources (Alsugair, 2022). Regular meetings and progress updates allow both parties to stay informed about the project's status and any potential challenges. Using project management software can also facilitate seamless information sharing and documentation (Aghazadeh & Yildirim, 2021). Trust is another essential element in this relationship. Contractors need to trust that the consultant's designs are feasible and practical, while consultants must have confidence in the contractor's ability to execute the project as intended (Yong and Mustaffa, 2011). Building this trust requires professionalism, accountability, and a shared commitment to the project's success. Contractors and consultants should be willing to listen to each other's concerns and collaborate on finding practical solutions to challenges (Masengesho et al., 2020). Flexibility is key to addressing unforeseen circumstances in construction projects (Doloi et al., 2011). Both parties must be willing to adapt to changes in scope, design, or schedule while keeping the client's goals in mind. For example, if a material specified in the design becomes unavailable, the contractor and consultant must work together to identify an alternative that maintains the project's quality and integrity (Winch, 2012). This adaptability can prevent costly delays and ensure that the project remains on track (Kometa et al., 1994). The variety of influencing factors for contractor-consultant relationships is provided in Table 1.

Conflicts in contractor-consultant relationships are inevitable but manageable (Kumaar et al., 2016). Disputes can arise over issues such as design errors, delays, or cost overruns (Akintoye & Main, 2007). To mitigate these conflicts, both parties should establish clear contractual terms and responsibilities at the outset of the project (Egemen & Mohamed, 2005). A dispute resolution process, such as mediation or arbitration, should also be outlined to address disagreements efficiently and amicably (Abeysinghe & Jayathilaka, 2022). A strong contractor-consultant relationship can also lead to innovation in construction projects (Chan et al., 2004). When both parties collaborate effectively, they can identify opportunities to improve processes, reduce costs, or enhance the project's sustainability (Blayse & Manley, 2004). For instance, a contractor might suggest a more efficient construction method, which the consultant can assess and integrate into the project if it aligns with the overall goals (Lam & Wong, 2011).

**Table 1** Contractor-consultant-client relationships in consturction projects (Al Saadi & Rahman, 2019)

| Category | Respondents | Significant factors |
|---|---|---|
| Planning | Client | Lack of experience |
| | | Inadequate planning and scheduling |
| | Consultant | Change in the scope of the project |
| | | Frequent design changes |
| | Contractor | Slow information flow between parties |
| | | Frequent design changes |
| Designing | Client | Incomplete design at the time of tender |
| | | Lack of communication between parties |
| | Consultant | Lack of communication between parties |
| | Contractor | Incomplete design at the time of tender |
| | | Poor design and delay in designs |
| Construction | Client | Incomplete design at time of tender |
| | | Shortage of technical/skilled personnel |
| | Consultant | Financial difficulties of owner |
| | | Incompetent subcontractor |
| | Contractor | Mistakes and errors in design |
| | | Delay in preparation and approval of drawings |

The client plays an important role in supporting the contractor-consultant relationship. By fostering a culture of collaboration and providing clear expectations, the client can help ensure that both parties work towards common objectives (Mathar et al., 2020). Clients should also encourage open communication and provide prompt feedback to avoid misunderstandings and delays (Alsugair, 2022). So, the contractor-consultant relationship is a cornerstone of successful construction projects. It requires clear communication, mutual respect, and a collaborative mindset to overcome challenges and achieve project goals (Kshaf et al., 2022). By prioritizing trust, flexibility, and innovation, contractors and consultants can create a productive partnership that benefits all stakeholders and delivers high-quality results (Lehtiranta et al., 2012). This relationship, when managed effectively, is not just a transactional arrangement but a key factor in the long-term success of construction endeavors (Peansupap & Walker, 2005).

Conflicts in the contractor-consultant relationship can bring unexpected benefits when managed constructively. One of the key advantages is that they encourage problem-solving by prompting both parties to critically analyze project details and find innovative solutions (Peansupap & Walker, 2005). For instance, disputes over design changes or material selection may lead to discovering cost-effective or sustainable alternatives that improve project efficiency (Alsugair, 2022). These challenges push contractors and consultants to think creatively and collaborate more effectively (Aghazadeh & Yildirim, 2021). Conflict also enhances communication by exposing gaps or misunderstandings between the parties (Kumaar et al., 2016). Addressing these issues can lead to clearer and more efficient communication channels, fostering better coordination throughout the project (Abeysinghe & Jayathilaka, 2022). When contractors and consultants engage in dialogue to resolve disputes, they often develop a stronger working relationship, ensuring that future projects run more smoothly (Atout, 2016).

Another benefit of conflict is that it promotes accountability (Winch, 2012). Disputes often force contractors and consultants to reassess their responsibilities, ensuring that each party fulfills its obligations (Kometa et al., 1994). This heightened sense of accountability can lead to improved project quality and a greater focus on meeting deadlines (Akintoye & Main, 2007). Additionally, conflicts often expose weaknesses in project planning, such as unrealistic timelines or vague specifications. Addressing these shortcomings can lead to more robust strategies for current and future projects (Doloi et al., 2011). However, conflict in the contractor-consultant relationship also has significant downsides (Al Saadi & Rahman, 2019). One of the most immediate disadvantages is project delays. Prolonged disputes over technical details or execution methods can stall progress, potentially derailing the entire project timeline. These delays can be costly, particularly if they require rework, additional consultations, or changes to the project plan (Phua & Rowlinson, 2004). Another major drawback is the potential strain on relationships. Persistent or poorly managed conflicts can erode trust and create a hostile work environment, making collaboration difficult (Mathar et al., 2020). This strained relationship not only affects the current project but may also harm future partnerships (Lam & Wong, 2011). In severe cases, unresolved disputes may escalate into legal battles, further delaying the project and incurring significant financial and reputational costs for both parties (Akintoye & Main, 2007). Thus, conflicts in the contractor-consultant relationship present both opportunities and risks (Winch, 2012). When managed effectively, they can lead to better communication, accountability, and problem-solving. However, if left unresolved or poorly handled, they can result in delays, increased costs, and strained relationships (Bygballe et al., 2010). To mitigate these risks, it is essential to foster open communication, establish clear roles and responsibilities, and maintain a shared commitment to the project's success (Yong & Mustaffa, 2011). By approaching conflicts as opportunities for growth, contractors and consultants can strengthen their partnership and deliver better project outcomes (Winch, 2012).

The AHP is a multi-criteria decision-making (MCDM) tool that provides a structured framework for evaluating complex problems involving multiple stakeholders. In the contractor-consultant relationship, AHP serves as a valuable method for identifying priorities, resolving conflicts, and optimizing decision-making (Elsayah, 2016). Given the collaborative yet often challenging nature of their relationship, AHP offers a systematic approach to balance competing objectives and align goals (Winch, 2012). One critical aspect of contractor-consultant interactions is the necessity to make decisions that consider technical, financial, and environmental constraints (Abed et al., 2018). For instance, selecting the best construction materials or determining cost-effective project strategies often requires input from both parties (Mostafavi & Soranj, 2019). AHP facilitates these decisions by breaking them into a hierarchical structure, where objectives, criteria, and alternatives are evaluated. This hierarchy ensures that decisions are made transparently and that both contractor and consultant perspectives are incorporated into the process (Elsayah, 2016).

The importance of AHP lies in its ability to reduce subjectivity and bias in decision-making. Contractors may focus on execution efficiency and cost savings, while consultants prioritize design integrity and adherence to regulations. Without

a structured framework like AHP, these differences can escalate into conflicts. AHP helps quantify these qualitative priorities by assigning weights to each criterion, enabling both parties to assess their importance objectively and reach a consensus (Mostafavi & Soranj, 2019). A key necessity for using AHP is its potential to enhance communication and collaboration between contractors and consultants. Disputes in construction projects often arise due to misunderstandings or misaligned priorities (Elsayah, 2016). By involving both parties in the decision-making process, AHP fosters a culture of mutual respect and understanding. This shared framework encourages open discussions, ensuring that decisions are aligned with the project's overarching objectives and not driven by individual interests (Brown, 2003). Another significant application of AHP in this relationship is risk assessment and management. Construction projects inherently involve numerous risks, such as delays, cost overruns, and design flaws (Akbari et al., 2022). AHP enables contractors and consultants to systematically evaluate these risks, rank them by their potential impact, and prioritize mitigation strategies. For example, the process can help identify whether addressing environmental risks is more critical than mitigating schedule delays, ensuring that resources are allocated efficiently (Shahbaz et al., 2017).

Furthermore, AHP plays a pivotal role in contractor selection, particularly when consultants are tasked with recommending contractors for specific projects. The tool allows consultants to evaluate contractors based on various criteria, such as technical expertise, financial stability, and past performance, and weigh these factors systematically. This ensures that the selected contractor aligns with the project's technical and financial requirements, reducing the likelihood of disputes during execution. So, the application of AHP in contractor-consultant relationships is both important and necessary for improving decision-making, reducing conflicts, and enhancing project outcomes. Its structured, objective, and participatory approach enables both parties to navigate complex decisions effectively. By fostering better communication, aligning priorities, and ensuring transparency, AHP strengthens the collaborative foundation of construction projects, ultimately contributing to their successful completion.

## III. Materials and Methods

The AHP is a decision-making methodology that has gained significant recognition in the context of construction project management, particularly in evaluating contractor-consultant relationships. In a construction project, the relationship between contractors and consultants is crucial for the successful execution of the project, as it involves both collaboration and the resolution of complex challenges (Kamal et al., 2022). AHP helps assess and manage these relationships by providing a structured approach for evaluating various factors that influence decision-making processes, such as project quality, costs, timelines, and the overall working dynamics between the parties (Shahbaz et al., 2017). In construction projects, contractors and consultants are tasked with different roles, with contractors responsible for executing the construction work and consultants typically offering expertise in design, engineering, and project management (Elsayah, 2016). However, these roles must be well-coordinated to ensure the smooth progression of the project (Mostafavi & Soranj, 2019). AHP provides a method to break down these complex decision-making processes into smaller, manageable components, using a hierarchical structure that allows project managers to prioritize factors like trust, communication, and technical competency in the contractor-consultant relationship (Winch, 2012).

The methodology works by structuring the decision problem into a hierarchy, starting with the overall goal at the top, followed by criteria, sub-criteria, and alternatives at lower levels. In the case of the contractor-consultant relationship, the goal could be to ensure successful project delivery (Amireh, 2022). The criteria could include factors like communication effectiveness, quality of work, adherence to deadlines, and the level of technical expertise (Winch, 2012). By evaluating each of these factors based on their relative importance, AHP helps to identify the most critical aspects that influence the success of the partnership (Akbari et al., 2022). AHP then uses pairwise comparisons to assess the relative importance of these criteria. For instance, project managers might compare the importance of timely completion against quality control. These comparisons are weighted and used to generate a final set of priorities, which ultimately guide decision-making (Shahbaz et al., 2017). By implementing this structured approach, construction managers can make informed decisions on how to manage contractor-consultant interactions, ensuring that both parties are aligned toward achieving project objectives and resolving potential conflicts in a timely manner (Alsugair, 2022). Ultimately, AHP offers a powerful framework for improving contractor-consultant relationships by promoting transparency, objectivity, and collaborative decision-making (Yong & Mustaffa, 2011). The methodology provides a tool for both parties to align their expectations, improve their communication, and focus on the most critical factors for project success (Kamal et al., 2022). By using AHP, project managers are better equipped to navigate the complexities of the construction industry, where the dynamics between contractors and consultants often determine the overall outcome of a project (Peansupap & Walker, 2005).

In this study, data were collected is through a questionnaire. The questionnaire begins with a brief introduction explaining the purpose of the study, emphasizing the confidentiality and anonymity of the responses. Completing the questionnaire takes approximately 20 minutes. The questionnaire consists of two main sections: the first section gathers demographic information about the sample population, such as age, education, etc., and the second section includes the main research questions designed to measure the study's variables. Standardized questionnaires were used for the variables in the second section. To ensure the questionnaire was valid for hypothesis testing, its content, structure, and question types were reviewed and refined through multiple revisions with the guidance of the supervisor and experts in the field. After necessary adjustments and approval from the supervisor, the finalized questionnaire was distributed to the expert sample. The completed questionnaire is provided in the appendix of this work. This combined questionnaire initially asks demographic questions and then proceeds to questions related to the research variables. After finalizing and obtaining approval for the questionnaire, it was distributed among the target sample of experts. The sample population for this research

consists of professionals working in the fields of consultancy and contracting for construction projects in Mashhad. It is important to note that the sample population in this study consists of 217 specialists, selected based on the sample size determined from the Morgan table, considering the total target population. Detailed information about these specialists is provided in the following section. Given that our target population consists of experts, it is expected that the dispersion of information and supplementary data provided by the specialists will be minimal. The validity and reliability tests conducted in this study strongly support the credibility of the methodology and the low dispersion of the data. Figures 2 to 5 present the statistical characteristics of the individuals involved in the study.

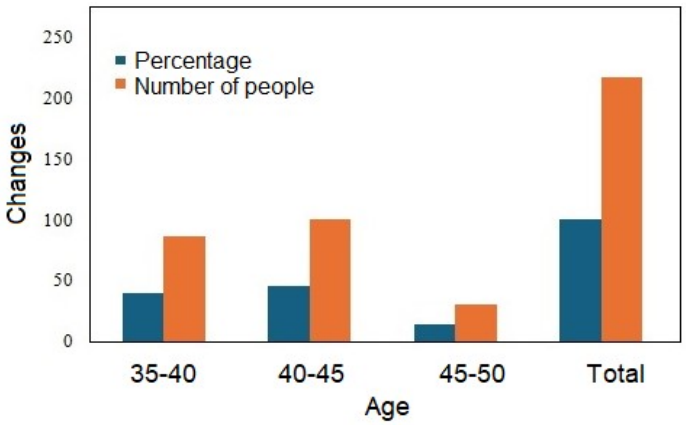


**Fig. 2** Statistical characteristics of the population for age

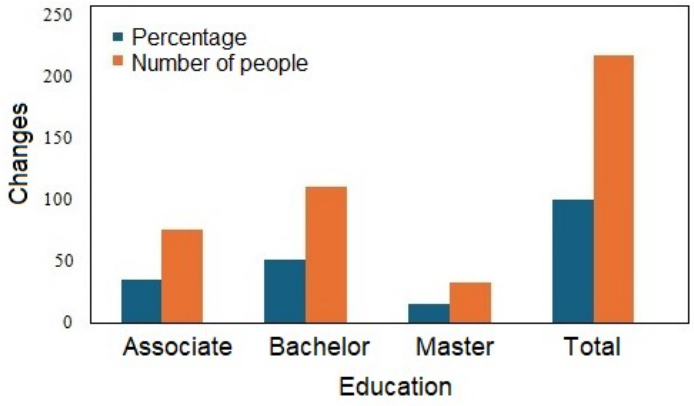


**Fig. 3** Statistical characteristics of the population for educations

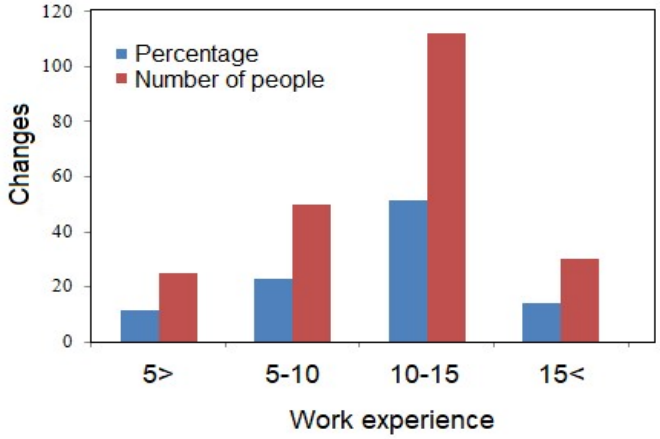


**Fig. 4** Statistical characteristics of the population for work experience

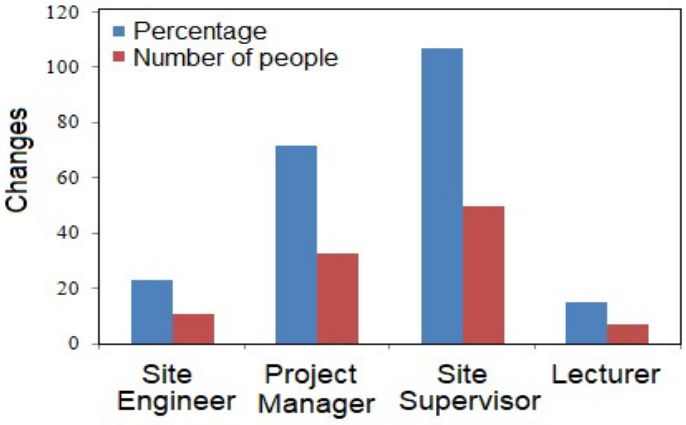


**Fig. 5** Statistical characteristics of the population for work position

In this study, two types of scaling methods were used to gather information. The first scale is the Likert scale, which is a 5-point scale (Allen & Seaman, 2007). The second scale used is the 9-point hourly scale. Each of these scales plays a crucial role in modeling for this study, providing important insights for analysis. The results from these scales are used as input data in the AHP model (Çalişkan et al., 2019). The Likert scale, developed by Rensis Likert (1981-1993), is one of the most used measurement scales in questionnaire-based research (Allen & Seaman, 2007). In this scale, the researcher provides a set of statements related to the research topic, and participants are asked to indicate their level of agreement. The responses are usually multiple-choice, and in the case of a 5-point scale, options such as 'Strongly Disagree', 'Disagree', 'Neutral', 'Agree', and 'Strongly Agree' are used (Boone Jr & Boone, 2012). Recent studies have shown that a 5-point scale yields more reliable results compared to 7-point or 10-point scales. Therefore, Likert scales with five response options are commonly employed in questionnaires. Each statement is then numerically rated, and the average of these numerical ratings by the sample population reflects the respondents' attitudes (Tanujaya et al., 2022). Typically, to prevent respondents from being influenced by numbers, the statements are not assigned numerical values directly. Instead, appropriate words and phrases are used in place of numbers. Table 2 shows how the Likert scale is valued in this study.

The tools used for data collection must first be valid (reliable) and then reliable. Validity refers to how well the method or tool measures the intended characteristic, while reliability refers to the consistency or repeatability of the method or tool. Since the primary data collection tool in this study is the questionnaire, its validity is of particular importance. The formulation of clear and unambiguous questions is crucial for ensuring the validity of the questionnaire. To assess the validity of the questionnaire, this study utilized two common approaches: face validity and content validity. First, the questionnaires were completed, and then, after a gap of 6-8 weeks, 15% of the expert sample completed the questionnaires again randomly. This approach aligns with recommendations for assessing face validity. By comparing the content and face validity, the correlation between the questions is analyzed, which can then be used to estimate the validity rate of the study. Based on the validity assessment conducted, the study achieved a validity score of 0.86, which is considered acceptable.

**Table 2** Likert scale application and evaluation in this study

| Score | Impact | Statement |
|---|---|---|
| 1 | Very low | Strongly disagree |
| 2 | Low | Disagree |
| 3 | Moderate | Neutral |
| 4 | High | Agree |
| 5 | Very high | Strongly agree |

There are various methods to calculate the reliability coefficient of a measurement tool, including test-retest, split-half, the Kuder-Richardson method, and Cronbach's alpha (Bujang et al., 2018). Since Cronbach's alpha is a widely accepted indicator for assessing the internal consistency of a measurement tool, it is used to evaluate the reliability of the questionnaire in this study. Cronbach's alpha, which ranges from 0 to 1, measures the internal consistency of a tool that assesses various attributes. A value of 1 represents perfect consistency, and 0 indicates no consistency (Agbo, 2010). Generally, a Cronbach's alpha value between 0.6 and 0.8 is considered acceptable, and above 0.8 indicates high reliability. The closer the value is to 1, the greater the internal consistency of the questions, making the questionnaire more homogeneous (Bujang et al., 2018). The results from the reliability analysis of the questionnaire in this study showed a Cronbach's alpha of 0.839. Since this value is greater than 0.8, it can be concluded that the questionnaire used in this research has very high reliability. To estimate the Cronbach's alpha coefficient, the classification shown in Table (3-4) is typically used. In general, the higher the alpha value, the higher the reliability of the data and the tool used for data collection. Various approaches are employed to determine the Cronbach's alpha in computational models, and one of the most important methods is using statistical analysis software like SPSS. SPSS, a statistical software developed by IBM in the 1960s, is widely used for data analysis and report generation. Due to its high capability in analyzing various data types, such as multivariate, dichotomous, and categorical data, SPSS is one of the most popular and widely used statistical tools globally. Figure 6 shows the Cronbach's alpha evaluation results for this study.

**Reliability**

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[DataSet2] D:\documents\spss--alpha_faq\spss_faq.sav
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**Warnings**

No SCALE subcommand was found. Scaling will be done on all specified variables.

**Scale: ALL VARIABLES**

**Case Processing Summary**

| | | N | % |
|---|---|---|---|
| Cases | Valid | 712 | 100.0 |
| | Excluded[a] | 0 | .0 |
| | Total | 712 | 100.0 |

a. Listwise deletion based on all variables in the procedure.

**Reliability Statistics**

| Cronbach's Alpha | N of Items |
|---|---|
| .839 | 8 |

**Fig. 6** Cronbach's alpha calculated for this analysis by SPSS

As previously mentioned, after collecting data through various tools and questionnaires, the results are used as inputs for AHP models and decision-making frameworks. It is understood that the statistical population of this research for completing the AHP pairwise comparison questionnaire includes managing directors of contractor companies in Khorasan Razavi, as well as managers and experts involved in contractor-consultant interactions, along with specialists from engineering consulting firms in the region. A total of 500 expert individuals were selected as the main statistical population. To perform the AHP and complete the pairwise comparison questionnaire, a sample of 217 experts and graduates in civil engineering and specialists engaged in construction projects was utilized. This section of the questionnaire is based on AHP analysis and follows a hierarchical structure. A sample of the prepared questionnaire is provided in the appendix of this study.

In this study, the AHP model was implemented to evaluate the decision-making process between contractors and consultants in construction projects. The initial step involved gathering data through a pairwise comparison questionnaire, which was distributed among 217 experts, including project managers, engineers, and specialists from construction companies and consulting firms in Khorasan Razavi. This sample was carefully selected to ensure the participants were knowledgeable and experienced in the construction industry, allowing for informed and accurate responses during the evaluation process. The questionnaire was designed with a 5-point Likert scale, focusing on the various criteria and sub-criteria that impact the contractor-consultant relationship in construction projects. The data collected through these surveys were then inputted into the AHP model to perform the necessary calculations. In this study, ExpertChoice 11, widely used software for decision analysis, was employed to process the data. ExpertChoice 11 was selected due to its robustness in handling complex decision models and its ability to easily structure and visualizes the hierarchy of criteria, sub-criteria, and alternatives.

To begin the AHP implementation, the first task was to define the decision hierarchy. The top level consisted of the overall goal, which was to assess the effectiveness of contractor-consultant collaboration in construction projects. Beneath this, several criteria were established, such as communication, project management efficiency, trust, and mutual goals, among others. These criteria were further broken down into sub-criteria, representing more specific aspects of each factor. The hierarchical structure allowed for a clear, systematic approach to evaluating the different elements that contribute to the overall goal. Table 3 provides the criteria and sub-criteria identified for this study. Once the hierarchy was set, pairwise comparisons of criteria and sub-criteria were conducted using the responses from the questionnaire.

ExpertChoice 11 allowed the researchers to input these comparisons, where each pair of criteria was evaluated based on their relative importance to the decision-making process. The software then calculated the weights for each criterion and sub-criterion, indicating their relative importance in achieving the overall objective. This process helped quantify the subjective judgments made by the experts and facilitated a structured decision-making approach.

**Table 3** Factors affecting the interaction of contractor-consultant relationship

| No. | Criteria | Symbol | Sub-criteria | Symbol |
|---|---|---|---|---|
| 1 | Tender Documents | M1 | Errors in submitting documents and requirements | A1 |
| | | | Uncertainty in project requirements and technical specifications | A2 |
| | | | Inaccuracies in data delivered to the contractor | A3 |
| | | | Defects and uncertainty in contractual obligations | A4 |
| | | | Different interpretations, ambiguity in the contract | A5 |
| 2 | Consultant and Contractor Contract | M2 | Delay in approving and approving plans | B1 |
| | | | Non-issuance or delay in obtaining necessary executive permits | B2 |
| | | | Non-delay in delivering materials or machinery to the contractor | B3 |
| | | | Contractor's delay in implementing plans | B4 |
| 3 | Consultant Requirements | M3 | Imposing additional and non-contractual work on the contractor | C1 |
| | | | Change in execution planning | C2 |
| | | | Change in design and implementation conditions | C3 |
| | | | Instruction to accelerate project implementation | C4 |
| | | | Delay in approving and consulting on project implementation | C5 |
| 4 | Contractor Performance | M4 | Stopping project implementation | E1 |
| | | | Delay in providing tools | E2 |
| | | | Lack of proper cooperation with the consultant | E3 |
| | | | Non-fulfillment of contractual obligations between the contractor and the consultant | E4 |
| 5 | Environmental Conditions | M5 | Occurrence of force majeure events such as war | F1 |
| | | | Occurrence of natural disasters such as earthquakes, storms and floods | F2 |
| | | | Occurrence of problems caused by the existence of underground facilities | F3 |
| | | | Existence of problems caused by the existence of deliveries to the contractor | F4 |

After the pairwise comparison and weight calculation, the next step was to assess the alternatives. In this study, the alternatives were potential strategies for improving the contractor-consultant relationship, such as enhancing communication channels, adopting collaborative project management tools, or establishing clearer contractual terms. ExpertChoice 11 allowed for the evaluation of these alternatives based on the weighted criteria, helping to identify the most effective strategies for improving collaboration in construction projects. Finally, the results of the AHP analysis were interpreted to provide actionable insights. By evaluating the alternatives through the weighted criteria, the study was able to highlight the key factors that influence successful contractor-consultant relationships in construction projects. The findings indicated which strategies were most likely to improve collaboration and efficiency. These results are critical for both contractors and consultants in developing more effective partnerships, ultimately leading to more successful project outcomes.

## IV. Results and Discussion

The research adopts a descriptive-analytic approach, which integrates both qualitative and quantitative methods for comprehensive data analysis. Following the literature review and the completion of questionnaires by experts, the findings were categorized into five main criteria and 21 sub-criteria. These categories reflect the relationship between contractors and consultants in effectively implementing and ensuring the success of construction projects, with a specific focus on projects within Mashhad, Iran. The study utilizes AHP methodology to compare the importance of various criteria and sub-criteria affecting the contractor-consultant relationship. The first step in the analysis is the pairwise comparison of the factors that impact on the selection of the best supplier, followed by the comparison of the sub-criteria. Each of these comparisons helps in determining the relative weight of the criteria. Once the pairwise comparisons of both the main criteria and the sub-criteria are completed, a final weight for each criterion is derived by synthesizing the results from both levels of comparison. Subsequently, using a hierarchical approach, the study compares different alternatives based on the weighted criteria. These alternatives represent potential strategies or actions to improve collaboration between consultants and contractors. The weights derived in the earlier stages of the AHP process serve as inputs to the final decision-making matrices, which will be modeled to evaluate the effectiveness of each alternative in achieving project goals. The result of this study is illustrated in Figure 7 and Table 4 for various criteria. The estimated relationship between target of study (contractor-consultant relationship) and criteria/sub-criteria are provided accordingly.

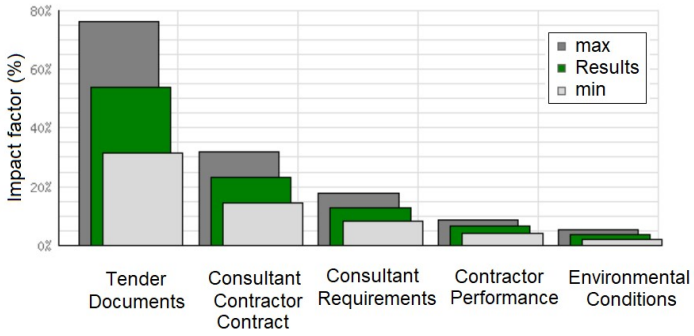


**Fig. 7** Results of criterion analysis by AHP for influencing factors (criteria)

**Table 4** Structured hierarchical evaluation-prioritization matrix

| Cat No. | Influencing factors | Priority (%) | Rank | Variation (%) (+) | (-) |
|---|---|---|---|---|---|
| 1 | Tender Documents | 53.7 | 1 | 22.4 | 22.4 |
| 2 | Consultant-Contractor Contract | 23.2 | 2 | 8.7 | 8.7 |
| 3 | Consultant Requirements | 13.0 | 3 | 4.7 | 4.7 |
| 4 | Contractor Performance | 6.6 | 4 | 2.2 | 2.2 |
| 5 | Environmental Conditions | 3.6 | 5 | 1.7 | 1.7 |

$$T = 0.537M1 + 0.232M2 + 0.13M3 + 0.066M4 + 0.036M5 \quad (1)$$

$$M1 = 0.541A1 + 0.25A2 + 0.108A3 + 0.067A4 + 0.034A5 \quad (2)$$

$$M2 = 0.572B1 + 0.285B2 + 0.097B3 + 0.046B4 \quad (3)$$

$$M3 = 0.528C1 + 0.239C2 + 0.126C3 + 0.067C4 + 0.039C5 \quad (4)$$

$$M4 = 0.581E1 + 0.241E2 + 0.13E3 + 0.048E4 \quad (5)$$

$$M5 = 0.539F1 + 0.271F2 + 0.148F3 + 0.042F4 \quad (6)$$

$$D = T \pm S' \quad (7)$$

where, T is the target, other parameters was provided in Table 3.

This research highlighted the significant role that clear and transparent documentation, including tender documents and contracts, plays in fostering effective collaboration between consultants and contractors in construction projects. The use of the AHP methodology, with the support of ExpertChoice software, demonstrated that this approach can precisely identify key criteria and sub-criteria, allowing for a more systematic prioritization of factors influencing project success. The study revealed that the most impactful factor in the collaboration between consultants and contractors is the tender documents, with a weight of 53.7%. This finding underscores the critical role of clear, well-structured documents in outlining expectations and establishing a framework for cooperation. Moreover, the study emphasized that when contracts between consultants and contractors are drafted transparently and fairly, they can significantly reduce conflicts and enhance collaborative efforts. With a weight of 23.2%, contracts are identified as the second most influential factor in improving interactions. On the other hand, environmental conditions, while still important, were found to have the least impact on project interactions, with a weight of just 3.6%. This reflects the fact that environmental factors are often accounted for early in the design process and have a lesser direct impact on ongoing interactions between the parties involved. The research also utilized data from five construction projects in Mashhad, Iran, to develop a practical relationship model. The analysis revealed that the correction index (S') for these projects ranged from 0.4 to 0.5, indicating a moderate degree of alignment between the proposed model and real-world project conditions. This suggests that while the model is effective, further refinements could enhance its applicability across various contexts. One of the most significant findings of this study was that one-sided views and a narrow focus on economic benefits could create challenges in contractor-consultant interactions. However, with more precise drafting of documents and contracts, it is possible to create positive and goal-oriented collaborations. The AHP method proved to be a powerful tool in prioritizing factors and analyzing data, providing valuable insights into the relationships between key criteria and their influence on project success. The results of this study provide valuable insights into the factors that most significantly influence the success of contractor-consultant collaboration. These insights can help inform decisions on how to strengthen these partnerships and improve project outcomes in the construction industry, particularly in the context of Mashhad's building projects. By focusing on the relationship dynamics between contractors and consultants, the study contributes to optimizing the management and execution of construction projects, thereby improving their overall success rates.

## V. Conclusion

This study has demonstrated the critical role of clear communication and well-defined processes in the successful collaboration between consultants and contractors in construction projects. Using the AHP methodology, supported by ExpertChoice software, the research effectively identified and prioritized key factors influencing project success. The findings indicated that tender documents play the most significant role in shaping the collaboration between consultants and contractors, accounting for 53.7% of the total influence. This emphasizes the necessity for transparent and comprehensive documentation, which provides a solid foundation for mutual understanding and reduces the potential for disputes. In addition, the research revealed that contracts, when drafted with clarity and fairness, serve as the second most influential factor, with a weight of 23.2%. Clear contracts are essential in ensuring that both parties understand their roles and responsibilities, thereby fostering a cooperative environment. While environmental conditions did play a role in project success, their impact was found to be minimal in comparison to documentation and contractual elements, with only a 3.6% influence. This result highlights the importance of focusing on aspects that directly govern the interaction between the parties involved. Furthermore, the data gathered from five construction projects in Mashhad helped refine the model and align it with real-world scenarios. The analysis showed that the S' for these projects ranged between 0.4 and 0.5, indicating that the proposed model was reasonably accurate but could benefit from further adjustments for improved application across various contexts. Ultimately, the study demonstrated that while economic considerations are important, focusing on one-sided goals can hinder effective collaboration. A more balanced, transparent approach, especially through the careful development of tender documents and contracts; can foster positive, goal-oriented relationships between consultants and contractors. By implementing AHP and other analytical tools, project management can be optimized, resulting in more efficient execution, better conflict resolution, and higher quality outcomes.

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## Authors' contributions

Mohammadreza Arjmand conducted the main data analysis, contributed to the data collection, preprocessing, and interpretation. Mohammadreza Arjmand and Negar Hosseinian were responsible for drafting the initial manuscript. Sanaz Farshad performed checks, 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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