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Evaluating the efficiency of consulting officers in managing the implementation of engineering construction projects in Iraq

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Keywords: consulting project factors, TOPSIS, AHP, quality criterion, Delphi method.
Abstract: This research examined the engineering projects supervised by Iraqi internal management teams and evaluated the role of consulting firms in this area. The principal elements evaluated in analyzing engineering project execution management tools, methodology, objectives, resources, and success rates were time, cost, quality, and project scope. This research aims to create a detailed inventory of the services, functions, and requirements of the technical control and engineering consulting sectors in relation to national and international standards. This work utilized pertinent data and expert opinions to analyze the operations of consulting companies in Iraq via the Delphi method. The preliminary phase, considering workplace variations, was the creation of a related matrix utilizing local data to determine the relative significance of each component. After evaluating the second phase's data utilizing the Excel-based TOPSIS methodology, the factor ratings were calculated. The AHP-TOPSIS method assessed the ability to reason and resolve difficulties, handle conflicts, additional project expenditures, cost differences across four orders, and financial flow. In assessing variables, here is where the outcomes truly excelled. The research further concludes that the efficiency of consulting officers plays a pivotal role in overcoming the challenges of project execution in Iraq. Their ability to address time, cost, and quality issues directly influences the overall success of engineering construction projects.

1 Introduction

Engineering construction projects are one of the main pillars supporting Iraq's economic and social development. Under the current circumstances, where the country is facing significant challenges in the construction sector, the importance of assessing the efficiency of the consultant, which is a vital part of the project management process, is increasing [1,2]. The consultant assumes multiple responsibilities, including planning and design. In addition, the consultant supervises the implementation of work on-site. Factors management is also essential to his role, as the consultant identifies potential factors during the project stages and provides appropriate solutions to deal with them [3]. Evaluating the consultant's efficiency requires considering several main criteria. First, technical expertise is a basic factor. The performance record is also an important indicator, as it helps in reviewing previous projects managed by the consultant and their success in achieving the specified goals. Also, the consultant's ability to communicate effectively with different parties, such as the owner and the contractor, plays a crucial role in the success of the cooperation. In addition, the consultant must demonstrate the ability to manage time and costs, to ensure that the project is delivered on time and within the specified budget [4]. However, assessing consultant competence in Iraq faces several challenges. Among these challenges are economic instability that can negatively impact project budgets, as well as knowledge and skill gaps that some consultants may suffer from. Furthermore, the multiplicity of stakeholders and different interests can complicate decision-making and impact the effectiveness of joint work [5,6].

Quality is the state of conformity of the previously set requirements within the product/service [7]. Fraser [8] defined quality as "the ability to satisfy the needs at the time of purchase and during the usage at the best cost while reducing losses and increasing competitiveness." This definition points out the cost factor and loss reduction and improving competitiveness. Assaf and Al-Hejji [9]said that "quality, in general, is a set of activities that are carried out for the purpose of setting performance standards, monitoring and improving performance to make the provided service effective and efficient and also safe." This definition sets itself apart by combining performance requirements with quality. Quality is a collection of administrative procedures to provide clients the most accurate service possible. Rezaee [10] noted that despite that there is no universal concept agreed upon for quality, it can be enumerated certain elements that are shared in quality definitions as follows: Quality aims at satisfying customer’s expectations or more, applying quality could be generalized to commodities, services, operations, and

individuals, and quality is marked by continuity of change, as what is acceptable today may not be acceptable later. When these factors are taken into account, quality is defined by dynamic change rather than stability. It is connected to goods, services, people, and the environment in accordance with or even beyond what clients and management may anticipate. This definition is broad because it emphasizes that quality encompasses not only the caliber of goods but also the caliber of people and services. The concept also emphasizes continuity, which is seen as a crucial component of quality. The only definition that focuses on this idea is this one. For this reason, it is regarded as the finest option overall.

Upon closer inspection, the Joiner [11] concept is among the most thorough explanations of Total Quality Management. The following is their explanation of each word in the phrase Total Quality Management: Management: the preservation and organizational growth with the goal of consistently raising the standard. Quality is defined as satisfying the beneficiary's or client's demands and expectations while going above and beyond. Total: comprises putting into practice the idea that quality should be sought in every work, beginning with determining the beneficiary's requirements and concluding with the client's evaluation of whether or not they are happy with the goods and services they received. Ahcom [12] defines it as "a cultural revolution on the method that is used by the management on improving quality. It is a field of expressing more common sensation in management practices and the importance of statistical measures. It is a continuous change by the administration in view of the results through the management that understands and manages the operations to accomplish the goals. It is the outcome of management practices and the analytical methods that help in the process of continuous improvement, hence the cost reduction".

2 Literature review

In the literature, there are several research groups that deal with management quality. The study by Suwanda [13], "Assessing the Management Elements Affecting the Construction Project Delays." The research was carried out in Qatar. Examining the importance and influence of management elements on construction project performance in terms of project completion time is the aim of this research. Surveying a sample of project managers in consulting firms and construction businesses was the approach used. The study concluded that: a) There is a statistically significant effect on the time it takes to complete construction projects for leadership competence with its aspects (manpower selection, leadership talents, and leadership skills). b) There is a statistically significant influence on the time it takes to complete construction projects related to management efficiency and its dimensions (creating teams and knowing the contractor's internal environment). c) The influence of scientific and cognitive efficiency, including its dimensions of legal skills, scientific abilities, and human resource management, on the time it takes to complete building projects has been statistically shown. Nonetheless, the research has made a number of noteworthy suggestions, which include: a) The board of directors and the founders of construction enterprises should exercise caution when choosing the employees who will run their businesses. b) establishing corporations and partnerships between various domestic and foreign construction enterprises in order to carry out large-scale projects. As a result, it will facilitate experience exchange and education on the most recent scientific developments in project management. c) Expand academic professional training in order to equip personnel working in the construction sector with scientific, theoretical, cognitive, and professional experiences. Developing Internal Audit's Functions in the Light of the International Quality Standards Requirements (ISO 9000) is the title of the previous study. The International Quality Standards, or "ISO," 9000, were to be shown and examined in this research. Additionally, as its execution guarantees the provision of the proper environment for growing and enhancing Total Quality Management, it sought to examine and analyze the standards of the intellectual and philosophical frameworks of Total Quality Management. Nonetheless, the research findings suggest that the conventional internal audit approach has shortcomings and inadequacies when compared to the more sophisticated and contemporary ideas of Total Quality Management and International Quality Standards. Additionally, the study made clear how critical it is to update the conventional internal auditor framework, broaden the purview of financial auditing, and assess compliance with laws, rules, and policies in favor of a framework that is better suited to the concepts of audit quality systems [14,15]. Khalid [16] article is headed "Introduction to Total Quality Management to Enhance Internal Audit Management's Efficiency and Effectiveness." The goal of the research was to determine if the international quality certificate-holding organizations' internal audit management applies the principles of total quality management at the level of each variable or the overall level of the variables' performance. It also sought to determine whether the internal audit management effectively uses its human and material resources and whether the challenges it faces call for implementing Total Quality Management to help it overcome those challenges and increase effectiveness. The private enterprises in the Arab Republic of Egypt that possess an International Quality Certificate comprised the study's sample. There were 106 firms that participated in the study. The researcher made use of SPSS.

The study recommended the following recommendations: a) extending the reach of internal audit services to cover senior management and the company's many divisions with advisory services. b) concentrating on enhancing internal auditors' abilities and acquainting them with contemporary management techniques. c)It is essential that internal auditors get training and strengthen

their statistical techniques abilities in order to effectively carry out their duties. d) advancements in the use of Total Quality Management in internal audit departments, especially in businesses that have obtained ISO 9000 certification. Ameed Fathi's [17] assessing the Effect of Applying Total Quality Concepts on Construction Project Execution in the Arab Countries and How It Relates to Engineering Code is the title of the study. The study's most significant conclusion is that, in order to improve the quality of construction project implementation, it is necessary to achieve integration with the Engineering Code and strengthen the application of Total Quality Management concepts in the environment of construction project execution. Al-zwainy and Mustafa [18] The principles of total quality and their effect on achieving the competitiveness priorities in factories. According to the report, manufacturers must use contemporary total quality management practices and modify their tenets in order to meet competitiveness objectives. Miozzo and Ivory [19] examines how long construction projects take to complete when there is inadequate planning. Project managers were included in the study's sample. The study's most significant discovery, however, is that construction firms' lack of understanding of the value of management and engineering planning is the primary cause of the delays in the completion of engineering projects management of total quality and exceptional performance [20]. The research's most important conclusion is that, in order to apply total quality, the scientific method must be modified. Additionally, enterprises must take all necessary steps to ensure that the principles of Total Quality are implemented correctly. Sweis et al. [21] enhancing the quality of construction project execution in Iraqi government contracting firms. The study included the project managers employed by the Iraqi Ministry of Construction and Housing. Nonetheless, one of the study's most important conclusions is that the most important variables influencing the standard of project execution are compensation and incentives [22]. The implications of recent advancements in projects and technology on restriction in the British construction industry. All parties engaged in construction—contractors, consultants, sole contractors, and suppliers—were included in the sample of the British research, which included questionnaires. The goal of the research was to draw attention to the administrative aspects of the building projects. The investigation found a substantial correlation between these elements in terms of [22]: a) How the stakeholders engaged in the building process interact with one another. b) The techniques used in project design tendering, project management, supervision, implementation, and funding at each stage. c)The usage of modern technologies that help the project outputs (cost, time, quality). However, the research suggested using contemporary technology to manage and plan building projects throughout every stage, from project conception to project delivery and investment. Through this study, the researcher has been able to better comprehend the components of building projects and identify strategies for maintaining harmony among all parties involved [23]. A Framework for Comparing Contractors' Project Management Components in Saudi Arabia. The research was carried out in the Kingdom of Saudi Arabia, where it included interviewing engineers and project managers from construction businesses and consulting firms that are in charge of managing certain government projects. Its goal was to create a model that construction companies might follow to enhance their administrative capabilities. It was shown that the causes of building project delays are closely tied to cost increases, which may be decreased by [23]: a) The project's appropriate and superb planning. b) The ongoing oversight of the project plan by the project management. c)The contractor's cooperation with other external project participants, such as suppliers and independent contractors, among others. d) The harmony among teamwork members. e) adherence to guidelines and laws issued by the government. f) The contractor's pledge is to supply highly productive cadres, competent workers, and premium materials on schedule. The report advised the contractor to assemble teams of highly skilled workers with a variety of specializations and to oversee efficient coordination, careful planning, and constant monitoring throughout the project's duration. However, the researcher benefited from this study by using many of the points as a standard for his own research, particularly in relation to planning and how it relates to the project execution time.

This work provides an extensive analysis of the variables, risks, and uncertainties in engineering, along with methods for their classification and mitigation. The aim of this work is to present a systematic approach to evaluating infrastructure development projects. A comprehensive literature review revealed the obstacles associated with infrastructure initiatives. Infrastructure projects are famously challenging to estimate because of the inherent difficulties in precisely evaluating site conditions. A study of the challenges related to the efficiency evaluation of consultants that have led to many factors. In this work, the essential factors will be selected and the main independent computational methods will be selected. The research will present the modern effective factors and combine two computational methods for evaluating and ranking the factors.

3 Methodology

The research procedure commences with the formulation of an extensive questionnaire designed to collect data on pertinent factors. These components are delineated and articulated comprehensively to guarantee a lucid comprehension of the elements influencing the investigation. A broad questionnaire is thereafter disseminated to gather preliminary replies. Two multi-criteria decision-making (MCDM) methodologies are employed to examine the data: the Analytic Hierarchy Process (AHP) and the Technique for Order Preference by

Similarity to Ideal Solution (TOPSIS). The Analytic Hierarchy Process (AHP) is initially employed to ascertain the relative significance of each element, followed by the application of the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) to rank these factors according to their proximity to an ideal solution. The integrated findings of AHP and TOPSIS elucidate the most significant elements affecting the outcome. Expert comments are subsequently solicited to authenticate the findings. Should the expert comments indicate that the outcomes are inadequate, the procedure will iterate by reassessing and enhancing the effective components. This recurrent feedback loop persists until the outcomes achieve the requisite degree of satisfaction, hence ensuring precision and pertinence in the identified factors. Upon achieving satisfactory outcomes, the process terminates
This section will describe the sequence of the methodology as shown in Figure 1.

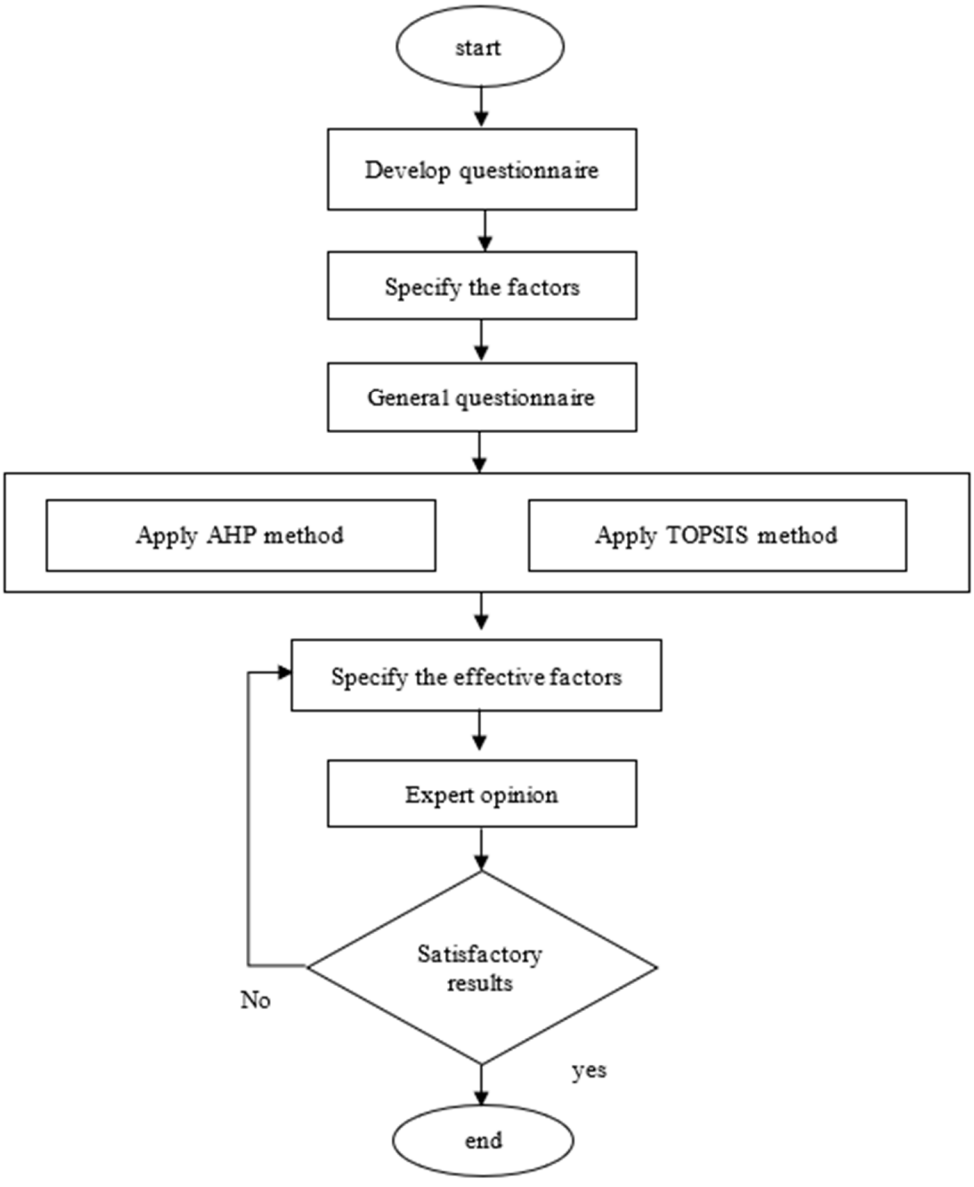

Figure 1 The Research Methodology

3.1 Developing the project questionnaire

The research articulates the primary concept prior to exploring the interview questions and subjects. The methodology portion of the article delineates the techniques employed to investigate the roles of project managers in Iraqi building projects. Employing certified architects and engineers is a customary practice in construction projects. These efforts may require the assistance of architects and general contractors. A little, uncomplicated consulting office assignment demands less time and work than a substantial, intricate one. Constructing in compliance with ranking system

requirements is customary; this approach yields documentation and proof of adherence. The resistance of a structure or its components is evaluated using a comprehensive scoring system throughout the whole process, including design, construction, manufacturing, and erection. The prompt and economical completion of a project relies on the proper oversight and management of several elements, including the grading system, credit registration and documentation, stakeholder communication, and the responsibilities of team members.

3.2 Target groups

Factors included in the study include company size and level, job title, experience, and years of working on projects.

3.2.1 Type of company

Table 1 displays the employment distribution of the respondents: three organizations were contracted with the government, and four organizations used subcontractors. This competency is found in all areas, although it is evaluated most thoroughly in the project planning and initial cost estimation portions. Understanding how to put together the parts and calculating the final cost quickly follows. The majority of responses coming from contracting firms rather than consultancy firms can be explained by the increase in contracting businesses in Iraq.

Table 1 The Distribution of Questionnaires by Firm Type.

No.	Company types	No. of companies
1	government companies	4
2	subcontractors	6

3.2.2 Job title

Table 2 demonstrates that the study involves individuals from several engineering specializations. The team was distributed as project managers, as the highest-ranking members of the team, have access to all financial data relevant to the project, as illustrated in this example.

Table 2 The Distribution of Questionnaires by Job Title.

No.	Job title	No. of engineers
1	Consultant engineers	26
2	Project managers	24
3	Planning engineers	15
4	Site engineers	8

3.2.3 Years of consulting offices activities project experience

The subjects' professional background is displayed in Table 3. Most respondents demonstrated sufficient expertise in consulting offices activities to identify the primary factors influencing project costs.

Table 3 The distribution of questionnaires based on the number of years of experience

No.	Experience time	Years of experience
1	High experience	20
2	Moderate experience	10-20
3	junior engineers	5-10

It was discovered that a large percentage of them had strong experience in the construction area and hold advanced positions in their jobs, which adds to the logic and reality of the survey results to some extent.

3.3 Developing the question aire

Surveys are a good technique to collect and arrange data for assessment and getting the best outcomes. However, researchers frequently abuse the process by using questionnaires to conduct field surveys in order to select a certain assignment under investigation or trial. They're also utilized to identify and assess changes by measuring the difference between the 'before' and 'after' states. The design of the questionnaire may be broken down into three parts:

a. Research and plan the questions that will be asked.
b. Choosing the right words for each situation.
c. Create an appropriate design for the question sequence.

To determine the research objectives, the researcher creates and executes a major connection connecting the research objectives and the specific questions. Questions and a combined process of exploring creative thinking may be used to identify goals and how to attain them. Different sorts of questions can be utilized, such as open-ended versus closed-ended questions, and replies can be single versus numerous, or grouped in a certain way. Analyzing, encoding, entering, and reviewing data using open vs closed questions is a way of analyzing, encoding, entering, and assessing data. To analyze the data and measure the prediction, an Excel application was created. In all cases, data may be entered directly or through other tools like Excel, and it's usually organized on the computer as a spreadsheet, with each row indicating a "case," or a single respondent. Each column represents a single variable, with data for that variable for all of the cases in question.

3.4 Ranking the factors

The primary objective of this study is to identify the most critical and crucial factors for infrastructure projects. We require a staff that is both proficient and trained to do the evaluation. The Delphi approach offers researchers a versatile and adjustable instrument for data collection and analysis. Several justifications for employing the Delphi approach include the following:

a. While precise analytical methods are not required, accumulated subjective evaluations may prove beneficial.
b. Individuals needed to occupy these positions will possess diverse backgrounds and areas of expertise.
c. In contrast to in-person gatherings, which may encounter issues such as interpersonal disputes and dominating speakers, the Delphi method is a qualitative approach for achieving group consensus. The Delphi technique was selected primarily because to the expert panel's composition, which predominantly includes persons with decision-making authority.
d. In contrast to a cautious institutional approach, experts may express their opinions more openly inside the Delphi method, facilitating the sharing of more personal perspectives.

The validity of the results is contingent upon maintaining the individuals' heterogeneity. This necessitates extreme prudence in exhibiting evidence of authority derived from mere force of character or numerical superiority. In summary, the Delphi procedure is one of the most used methods of forecasting in the technological domain and across many industries. Over 90% of all technical forecasts and analyses stem from it. The investigation started with the formulation, evolution, and execution of the Delphi method, emphasizing subject selection and timeframes as its primary focuses. Further measures must be implemented to prevent a diminished response rate, inadvertent influence on responses, and to address panelists on their insufficient competence on the topic rather than soliciting their expert opinions. The Delphi approach was employed in this investigation for the following reason:

a. Assemble a team to supervise the execution of a Delphi assessment of the prevailing issue.
b. Designate one or more specialists in the relevant field to participate in the panel.
c. Develop the inaugural Delphi survey.
d. Amend the questionnaire to guarantee accurate phrasing.
e. Distribute the preliminary questionnaire to the panelists to collect their information.
f. Evaluate the responses from the initial round and articulate your insights into the panel.
g. Request all panel members to evaluate and provide feedback on the initial questionnaire. The poll has now entered its second and concluding stage.
h. Kindly elucidate the findings of Questionnaire. The analytical group's report will convey the results of the activity.

Continue reading to evaluate the performance of the second set of responses.

3.5 The independent research factors

This section delineates the assumptions of the independent research variables on the many performance factors' viewpoints on the importance of project management, accompanied with the rationale for each factor's standpoint as explain in Tables 4-8. The below categories delineate the predominant factors identified as influential in the investigations undertaken by [1,24,25]:

Table 4 The first group of factors

Group 1	Consultant management skills
F1 1	Communication skill
F1 2	Motivation skill
F1 3	Conflict management skill
F1 4	Negotiation skill

Table 5 The second group of factors

Group 2	Consultant Leader skills
F2 1	Decision making and problem-solving skills
F2 2	Delegation skill
F2 3	Planning and goal-setting skill
F2 4	Team building skill

Table 6 The third group of factors

Group 3	Manpower effect
F3 1	Project labor cost
F3 2	project control system
F3 3	Project overtime cost
F3 4	Motivation cost

Table 7 The forth group of factors

Group 4	Planning and scheduling effect
F4 1	Material and equipment cost
F4 2	Cost of rework
F4 3	Cost of variation orders
F4 4	Escalation of material prices

Table 8 The fifth group of factors

Group 5	Finance factors effect
F5 1	Cash flow of project
F5 2	Profit rate of project
F5 3	Project design cost
F5 4	Regular project budget update

3.6 AHP-Topsis Method

In reality, the challenges will unavoidably be required to make a decision. The subject of how to make the optimal option by evaluating the relevant elements remains constant, whether choosing a product or determining a strategy. Currently, multifactorial decision-making is prevalent throughout several domains, including but not limited to business, commerce, and healthcare. Decision-making instruments such as AHP streamline complex issues into manageable tiers by creating a hierarchical structure comprising goals, criteria, sub-criteria, and options. The Analytic Hierarchy Process (AHP)

encompasses complex, unstructured decision-making that involves several attributes. These criteria do not define judgments linearly; instead, they involve a synthesis of physical and psychological elements. The Analytic Hierarchy Process (AHP) provides a method to quantify the subjective judgments of decision-makers. To evaluate and choose suitable stations for the development of cost systems, it is essential to create a mathematical and computational model. The Analytical Hierarchy Process (A.H.P.) model provided a systematic and rational method for organizing and prioritizing decision-making issues. The AHP paradigm is founded on four guiding principles. Figure 2 illustrates the AHP process flow diagram for material selection in construction.

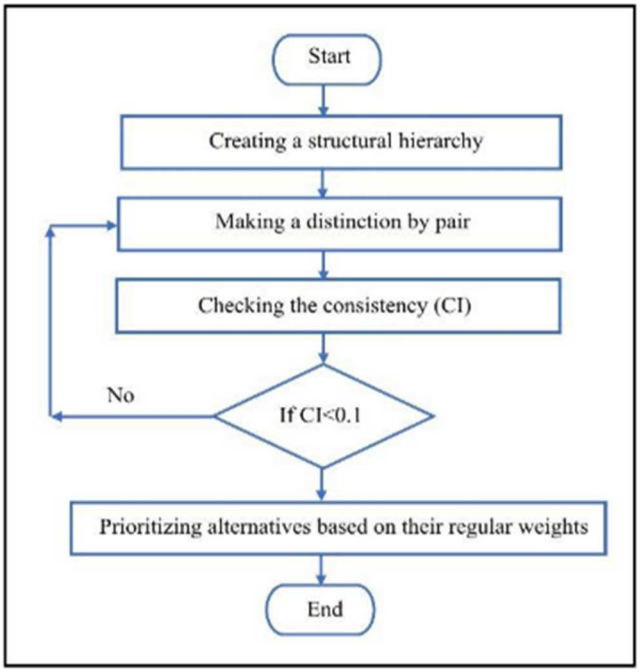

Figure 2 AHP method

For that, the priority AHP method was developed and applied to specify the required stations in the stages:
Stage 1: establishment of the pairwise comparison matrix, shown in equation (1),

$$AHP = \begin{bmatrix} a_{11} & a_{12} & \ldots. & a_{1n} \\ a_{21} & a_{22} & \ldots. & a_{2n} \\ a_{n1} & a_{n2} & \ldots. & a_{nn} \end{bmatrix} \quad (1)$$

Stage 2: calculation of the weights of the criteria presented in equations (2)-(7).

$$AHP_{sum\_1} = |\sum_{i=1}^{n} i1 \quad \sum_{i=1}^{n} i2 \quad \sum_{i=1}^{n} in| \quad (2)$$

$$AHP = \begin{bmatrix} a_{11} & a_{12} & \ldots. & a_{1n} \\ a_{21} & a_{22} & \ldots. & a_{2n} \\ a_{n1} & a_{n2} & \ldots. & a_{nn} \end{bmatrix} \times |\sum_{i=1}^{n} i1 \quad \sum_{i=1}^{n} i2 \quad \sum_{i=1}^{n} in|^{-1} \quad (3)$$

$$AHP_m = \begin{bmatrix} AHP_{m\_11} & AHP_{m\_12} & \ldots. & AHP_{m\_1n} \\ AHP_{m\_21} & AHP_{m\_22} & \ldots. & AHP_{m\_2n} \\ AHP_{m\_n1} & AHP_{m\_n2} & \ldots\ldots & AHP_{m\_nn} \end{bmatrix} \quad (4)$$

$$AHP_{sum\_2} = \begin{vmatrix} \sum_{j=1}^{n} j1 \\ \sum_{j=1}^{n} j2 \\ \sum_{j=1}^{n} jn \end{vmatrix} \quad (5)$$

$$AHP_{prio} = \frac{AHP_{sum\_2}}{\sum AHP_{sum\_2}} \quad (6)$$

$$AHP_{prio} = \prod_{St=1}^{n} St \quad (7)$$

This is the most important step in the procedure, and the outcomes are similar to a method of selection. The eight key modules were distributed among other variables referred to as "secondary" and "sub-factors." To ensure a comprehensive collection of necessary components, a statistical population consisting of specialists primarily engaged in Building Management Systems (BMSs) was selected. Quality environment modules are eight essential criteria used to evaluate IBs that impact the whole building life cycle. The TOPSIS approach was initially introduced by Yoon and Hwang in 1981. The basic concept (Figure 3) is that the selected solution needs to be close to optimal while being as distant from suboptimal as possible.

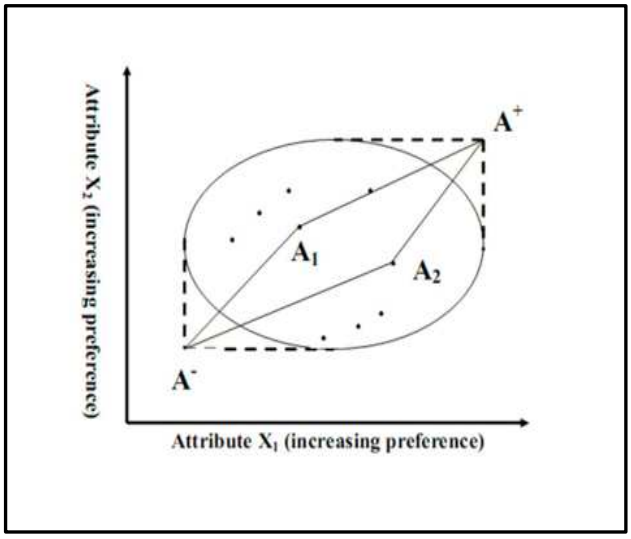

Figure 3 Basic concept of TOPSIS method

Fuzzy TOPSIS adheres to a procedure akin to the traditional method, as delineated by Chen's approach, which may be succinctly defined as follows:

a. Compile the normalized choice matrix: In a fuzzy environment, simplified equations are employed to transform many criterion scales into a unified scale, therefore circumventing the intricate normalizing calculations utilized in conventional TOPSIS.

The linear scale transformation (1) is depicted in equation (8):

$$\tilde{r}_{ij} = \left(\frac{a_{ij}}{c_j^*}, \frac{b_{ij}}{c_j^*}, \frac{c_{ij}}{c_j^*}\right), c_j^* = max_{ij} \quad (8)$$

Jahanshhaloo et al.formula (2) is depicted in equation (9):

$$\left(\tilde{r}_{ij} = \left(\frac{a_{ij}}{\sqrt{\sum_{i=1}^{n}\left((a_{ij})^2+(c_{ij})^2\right)}}, \frac{b_{ij}}{\sqrt{\sum_{i=1}^{n} 2b_{ij}}}, \frac{c_{ij}}{\sqrt{\sum_{i=1}^{n}\left((a_{ij})^2+(c_{ij})^2\right)}}\right)\right) \quad (9)$$

where $\tilde{x}_{ij} = (a_{ij}, b_{ij}, c_{ij})$ are the elements of the decision matrix.

b. Calculate the relative closeness to the ideal solution using equation (10), (11).

$$A^+ = \{\tilde{v}_1^+, \tilde{v}_2^+, \ldots \tilde{v}_m^+\} \quad (10)$$

$$A^- = \{\tilde{v}_1^-, \tilde{v}_2^-, \ldots \tilde{v}_m^-\} \quad (11)$$

where $\tilde{v}_1^+ = (1,1,1)$ and $\tilde{v}_1^- = (0,0,0)$, $j = 1,2, \ldots m$.

c. Rank the preference order using equation (12)-(16).

Ideal separation

$$S_i^+ = \sum_{j=1}^{m} s\left(\tilde{v}_{ij,}\tilde{v}_j^+\right) \qquad i = 1,2, \ldots n \quad (12)$$

Negative-ideal separation

$$S_i^- = \sum_{j=1}^{m} s\left(\tilde{v}_{ij,}\tilde{v}_j^-\right) \qquad i = 1,2, \ldots n \quad (13)$$

Where $s(\tilde{v}_{ij,}\tilde{v}_j^+)$ *and* $s(\tilde{v}_{ij,}\tilde{v}_j^-)$ are distance measurements calculated with the vertex method:

$$d(\tilde{X}_{ij,}\tilde{Y}_{ij}) = \sqrt{\frac{1}{3}\left[\left(x_{ij}^1 - y_{ij}^1\right)^2 + \left(x_{ij}^2 - y_{ij}^2\right)^2 + \left(x_{ij}^3 - y_{ij}^3\right)^2\right]} \quad (14)$$

$$\tilde{x}_{ij=}\ \left(x_{ij}^1, x_{ij}^2, x_{ij}^3\right) \quad (15)$$

$$\tilde{y}_{ij=}\ \left(y_{ij}^1, y_{ij}^2, x_{ij}^3\right) \quad (16)$$

d. Calculate the relative closeness to the Ideal Solution using equation (17).

$$C_i^* = \frac{S_i^-}{(S_i^+ + S_i^-)}, \qquad 0 < C_i^* < 1,\ i = 1,2,\ldots.,n \quad (17)$$

Where:
$C_i^* = 1$ if $A_i = A^+$
$C_i^* = 0$ if $A_i = A^-$

e. Rank the preference order as figure (Figure 4):

```
Algorithm TOPSIS

Input: Wind turbine criteria values x_ij
       Weight of each criterion w_j
Output: Best T    //T is the best tradeoff solution

Create a decision matrix D

//Calculate normalized decision matrix
FOR x_ij in D do
 Calculate n_ij
ENDFOR

//Calculate normalized weighted decision matrix
FOR n_ij in D do
 Calculate v_ij = w_j n_ij
ENDFOR

//Determine the positive and negative ideal solutions
FOR v_ij in D do
 Calculate S+ and S-
ENDFOR

//Calculate separations from S+ and S-
FOR v_ij in D do
 Calculate d_i+ and d_i-
ENDFOR

//Determine R_i
FOR v_ij in D do
 Calculate R_i
ENDFOR
```

Figure 4 Basic concept of TOPSIS method

A novel ranking method that considers the relative significance of each option inside a collection is now accessible. This strategy is predicated on the assumption that each criteria in the decision matrix exhibits a monotonically rising or decreasing utility. A decision matrix is necessary with n possibilities and m criteria, each with specific weights. When articulating a conclusion that cannot be quantified mathematically, the most suitable approach for its quantification must be utilized.

4 Results and discussion

It is expected that construction projects that use consulting companies would be finished on schedule and under budget. Projects related to transportation are notorious for having erratic schedules and budgets. Claims, cost escalations, and schedule delays in civil infrastructure development projects can result from a variety of potential causes. Change orders commonly result in additional costs for transportation projects. In construction projects, every change, no matter how little, might lead to disputes and lawsuits. This analysis's main goal is to pinpoint the causes of claims, rework, and budget overruns. The topics of cost overruns and claims in civil construction projects—including those involving buildings, consulting firms, tunnels, hydropower, or water infrastructure—are covered in a plethora of books and articles. Only a small number of research works have focused on claims, modification orders, and cost overruns that can be linked to Iraq. This study looks at pavement construction projects in the consulting sector with an emphasis on modification orders and claims. Six typical factors are covered by the management strategies used in consulting offices' construction operations, which begin with the feasibility study and continue through the maintenance phase with the goal of attaining efficient factor management. Three fundamental pillars support the factors-driven method: well-designed foundations, prompt and adequate site assessments, and efficient foundation construction supervision. A basic need of quality assurance is the systematic and thorough documentation of the whole factors management process. This paperwork attests to the investigation's correct execution. Important findings suggested steps for factor control, and an explanation of the study's methodology and data sources must all be included in the documentation. It is clear that there are benefits to characterizing probability and outcomes statistically. Concerns about the quality and sources of the data might make quantitative analysis challenging. In this case, a thorough qualitative investigation with comparable specificity would be suitable. This study provides a useful and practical method for assessing the risks associated with consulting office operations during building projects. In factor management, it is usual practice for the person with the best qualifications and competence to manage factors to take on that role. We can protect the project from potential dangers or lessen their effects by assigning certain of its tasks to a single entity. Due to differences in soil and working circumstances, this chapter began by defining the study area in the northern parts of Iraq using the Delphi method, pertinent research, and expert insights. Using regional data, an AHP for prospective changes was developed in the final phase. The factors' ratings were determined by using the TOPSIS technique to evaluate the data collected in the third phase. You will keep all of your AHP data when you switch to TOPSIS. Based on the analysis of variables, we determined and evaluated the variables that affect consultant projects.

4.1 The weight of factors results

The purpose of AHP is to construct a data-friendly matrix that can be used to calculate the appropriate cost factor weights. Using the geometric mean of individual assessments, this approach allows for collective decision-making by consensus. AHP is a multi-objective algorithm that generates value scales using pairwise comparisons and ratings. The situations were created in two phases. After all of the information has been acquired, the following step is to rate the expenses using the AHP method. The ability of AHP to check and reduce the inconsistency of expert perspectives is its primary benefit. The first step is to identify significant value differences that may be used to prioritize cost components. Several questionnaires and interviews with Iraqi managers and engineers were conducted to arrive at this conclusion. Decision-makers employ their judgments about the relative worth of the elements in the comparison process. The AHP method starts with describing the problem and assessing the knowledge needed to solve it. The aim is at the top of the decision hierarchy, followed by consulting office activities objectives, intermediate levels (criteria for subsequent portions), and finally, the lowest level (typically a set of choices). The weighting of the priorities at the level below is based on the priorities generated from the comparisons. The researcher then utilized the AHP approach to quantify the influence of cost on project costs. The most challenging aspect of this project is determining how to handle such vast amounts of data. The researcher organizes and classifies the data in order to provide a good representation of existing practices. AHP is used in cost-group decision-making when a group of decision-makers employs pair-wise comparisons to evaluate the expert's responses to questionnaires (comparing items to one another two at a time). In terms of priority, each piece is given the same weighting. The weighted values of each element in the level below are combined together to produce the overall or global priority. Continue to weigh and add until the researcher has determined the ultimate. The pairwise of first-fifth groups of factors are shown in Tables 9-13, the weighted result is plot in Figure 5, and the numerical weight results of all groups of factors are stated in Table 14.

Table 9 The pairwise of first group of factors

	Project cost criterion	**Project implementation quality criterion**	**Project completion time criterion**	**Project profit return criterion**
Project cost criterion	1	0.2	0.2	0.33
Project implementation quality criterion	5	1	0.33	0.2
Project completion time criterion	5	3	1	3.03
Project profit return criterion	3	5	0.33	1

Table 10 The pairwise of second group of factors

	Project cost criterion	**Project implementation quality criterion**	**Project completion time criterion**	**Project profit return criterion**
Project cost criterion	1	0.333	0.2	0.333
Project implementation quality criterion	3	1	0.143	0.143
Project completion time criterion	5	7	1	0.111
Project profit return criterion	3	7	9	1

Table 11 The pairwise of third group of factors

	Project cost criterion	**Project implementation quality criterion**	**Project completion time criterion**	**Project profit return criterion**
Project cost criterion	1	0.33	0.2	0.33
Project implementation quality criterion	3	1	0.2	0.11
Project completion time criterion	5	5	1	0.33
Project profit return criterion	3	9	3	1

Table 12 The pairwise of forth group of factors

	Project cost criterion	**Project implementation quality criterion**	**Project completion time criterion**	**Project profit return criterion**
Project cost criterion	1	1	0.11	0.2
Project implementation quality criterion	1	1	0.2	0.33
Project completion time criterion	9	5	1	0.33
Project profit return criterion	5	3	3	1

Table 13 The pairwise of fifth group of factors

	Project cost criterion	**Project implementation quality criterion**	**Project completion time criterion**	**Project profit return criterion**
Project cost criterion	1	0.143	0.2	0.2
Project implementation quality criterion	7	1	0.143	0.143
Project completion time criterion	5	7	1	1
Project profit return criterion	5	7	1	1

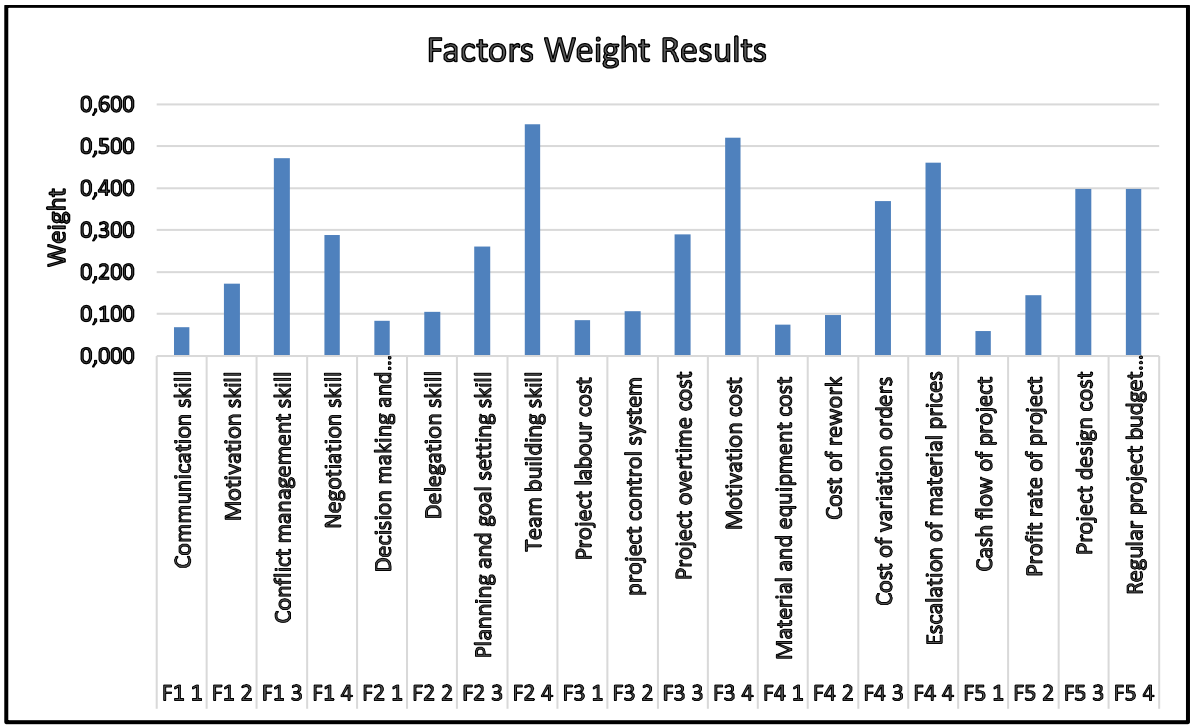

Figure 5 The weight results plot

Table 14 The numerical weight results of all groups of factors

	factor	Weight
F1 1	Communication skill	0.068
F1 2	Motivation skill	0.172
F1 3	Conflict management skill	0.471
F1 4	Negotiation skill	0.288
F2 1	Decision making and problem-solving skill	0.084
F2 2	Delegation skill	0.105
F2 3	Planning and goal setting skill	0.260
F2 4	Team building skill	0.552
F3 1	Project labour cost	0.085
F3 2	project control system	0.106
F3 3	Project overtime cost	0.289
F3 4	Motivation cost	0.520
F4 1	Material and equipment cost	0.074
F4 2	Cost of rework	0.097
F4 3	Cost of variation orders	0.368
F4 4	Escalation of material prices	0.461
F5 1	Cash flow of project	0.059
F5 2	Profit rate of project	0.144
F5 3	Project design cost	0.398
F5 4	Regular project budget update	0.398

An empirical survey's data was used to demonstrate the suggested AHP paradigm. The consultant factors impacting the project's success are depicted using a consultant-centric hierarchy. The project's consulting team had an impact on the development of the three-tiered organizational structure. The matrices make it easier for the expert to compare two hierarchical members at the same time. Microsoft Excel may be used to see the preference score of the model. Below is a thorough summary of the AHP analysis's findings. The outcomes of the AHP analysis are shown in tables for each category. The consultant's assessment of the effects revealed that the five

categories that were chosen had very high priority levels. The project variables were ascertained by computing the AHP for every consultant component. These qualities were ranked according to the AHP results.

4.2 Final ranking results

The outcomes of the AHP-TOPSIS analysis are detailed in the subsequent section. Presented below are tables elucidating the results of the AHP-TOPSIS investigation for each specified reason. The ranking findings indicated that the 20 selected parameters were very pertinent to the evaluation of infrastructure projects, derived from the outcomes of construction activities conducted by consulting firms. A connection exists between the AHP weight and TOPSIS results in the initial group. The prevalence indicates a significant response in the processes.

Group 1:

Table 15 The questionnaire results of first group of factors

	Project cost criterion	Project implementation quality criterion	Project completion time criterion	Project profit return criterion	sum
F1 1	22	6	21	24	73
F1 2	27	21	15	10	73
F1 3	2	2	37	32	73
F1 4	13	27	24	9	73

Table 16 The matrix results of first group of factors

	Project cost criterion	Project implementation quality criterion	Project completion time criterion	Project profit return criterion
F1 1	0.040	0.03	0.194	0.164
F1 2	0.050	0.104	0.138	0.068
F1 3	0.004	0.01	0.341	0.219
F1 4	0.024	0.134	0.221	0.062

Table 17 The AHP-TOPSIS results of first group of factors

Si+	Si-	Pi	Rank
0.192	0.119	0.382	3
0.258	0.094	0.267	4
0.124	0.261	0.678	1
0.199	0.151	0.432	2

The findings show that, even in the absence of information technology, the work system technique may be used as a framework for evaluating and enhancing organizational processes. Contentious because it suggests that profitable businesses must adhere to the same rules. The work system process includes a static and dynamic representation of how a system evolves over time as a result of both deliberate and inadvertent changes. Any analysis or comprehension of a work system must start with the "work system framework," which is the foundation of the static perspective. The first group's results show that the most important ability is conflict management. This is explained by the element's significance to the operation of building projects and consulting organizations.

Group 2:

In order to fulfill the requirements of the customer and achieve the project's objectives from start to finish, the project firm assigns a group of project consultants who are subject to contractual obligations. Even if it means lowering their own company's financial returns, they have to maximize the project's profitability in order to satisfy the needs of the client organization and the project's overall management expectations. Thus, a number of elements may have an impact on the project consultants' team's effectiveness in Iraqi building efforts.

Table 18 The questionnaire results of second group of factors

	Project cost criterion	Project implementation quality criterion	Project completion time criterion	Project profit return criterion	sum
F2 1	2	25	18	28	73
F2 2	16	5	37	15	73
F2 3	18	6	39	10	73
F2 4	27	4	23	19	73

Table 19 The matrix results of second group of factors

	Project cost criterion	Project implementation quality criterion	Project completion time criterion	Project profit return criterion
F2 1	0.0046	0.099	0.076	0.403
F2 2	0.0369	0.02	0.157	0.216
F2 3	0.0415	0.024	0.166	0.144
F2 4	0.0623	0.016	0.098	0.273

Table 20 The AHP-TOPSIS results of second group of factors

Si+	Si-	Pi	Rank
0.089	0.278	0.757	1
0.206	0.111	0.351	3
0.272	0.092	0.253	4
0.178	0.131	0.425	2

An essential step in the project development process, material evaluation and issue resolution are indicated by the AHP-TOPSIS findings. Making decisions and addressing problems are critical skills in this process. In the process of developing consulting office projects, this capability is essential. A maximum level of continuous production may be achieved with the help of an ideal workplace and excellent management. Rework, supplies, tools, heavy machinery, crew interference, quality control inspections, management interventions, and inspections are some of the factors.

Group 3:

Respondents to the survey were open about the advantages of using project consultants in building projects, which clarified the need for these experts in Iraq's construction sector. The factors that made hiring project consultants attractive for the construction company are outlined in the following tables. As per the responses provided, project consultants can aid in accomplishing the goals of construction projects by taking on relevant responsibilities in the field.

Table 21 The questionnaire results of third group of factors

	Project cost criterion	Project implementation quality criterion	Project completion time criterion	Project profit return criterion	sum
F3 1	29	19	9	16	73
F3 2	25	19	21	8	73
F3 3	11	12	40	10	73
F3 4	21	21	17	14	73

Table 22 The matrix results of third group of factors

	Project cost criterion	Project implementation quality criterion	Project completion time criterion	Project profit return criterion
F3 1	0.054	0.056	0.053	0.335
F3 2	0.047	0.056	0.124	0.168
F3 3	0.021	0.035	0.236	0.21
F3 4	0.039	0.061	0.1	0.293

Table 23 The AHP-TOPSIS results of third group of factors

Si+	Si-	Pi	Rank
0.186	0.169	0.476	3
0.203	0.074	0.267	4
0.129	0.19	0.597	1
0.143	0.138	0.49	2

Project overtime costs suggest that the work system method is a set of ideas that can be used to any company's systems for analysis and improvement. Contentious because it suggests that profitable businesses must adhere to the same rules. The work system process includes both static and dynamic depictions of how a system develops over time as a result of both deliberate and inadvertent modifications. Any analysis or comprehension of a work system must start with the "work system framework," which is the foundation of the static perspective. In the process of developing consulting office projects, this capability is essential. A maximum level of continuous production may be achieved with the help of an ideal workplace and excellent management. Rework, supplies, tools, heavy machinery, crew interference, quality control inspections, management interventions, and inspections are some of the factors.

Group 4:

"Variation Costs" refers to the direct expenses and revenue losses that are justifiably incurred as a result of or associated with a variation. These costs may include extra expenses related to design, construction, manufacturing, commissioning, decommissioning, Through Life Support, or financing. "Cost variance" describes the difference between project expenses that were actually incurred and those that were anticipated. If the variance is positive, it means the project stays inside the allocated budget; if it is negative, it means the opposite.

Table 24 The questionnaire results of forth group of factors

	Project cost criterion	Project implementation quality criterion	Project completion time criterion	Project profit return criterion	sum
F4 1	31	31	9	2	73
F4 2	11	34	21	7	73
F4 3	23	5	21	24	73
F4 4	33	20	16	4	73

Table 25 The matrix results of forth group of factors

	Project cost criterion	Project implementation quality criterion	Project completion time criterion	Project profit return criterion
F4 1	0.044	0.06	0.095	0.036
F4 2	0.016	0.065	0.221	0.127
F4 3	0.033	0.01	0.221	0.436
F4 4	0.047	0.038	0.169	0.073

Table 26 The AHP-TOPSIS results of forth group of factors

Si+	Si-	Pi	Rank
0.42	0.05	0.106	4
0.309	0.168	0.353	2
0.058	0.419	0.878	1
0.369	0.087	0.191	3

"Cost variance" refers to the difference between actual project spending and the pre-project budget. For this calculation, the difference between the planned cost of work done (BCWP) and the actual cost of work finished (ACWP) is used. The study determined that the owner's financial difficulties, the difficulty of establishing a consistent design across different districts, design errors and omissions, the contractor's pursuit of profitability, and the lack of an appropriate site prior to the design phase of the construction project were the main causes of variation orders. The creation of standard designs for different districts and the owner's financial restrictions are the most common owner-related grounds for change orders; inadequate staff expertise and difficult access to the project site are the least common. The most common reasons for variation orders are conflicts in contract agreements and inadequate coordination between contract parties, whereas consultant-related concerns include time constraints during the design process and design flaws and omissions. The two most typical variation orders pertaining to contractors

are those pertaining to intended profitability and substantial changes to the bill of quantities; the less frequent ones, on the other hand, have to do with the contractor withdrawing from design and, if relevant, asking to be compensated for low price.

Group 5:

In this group**,** cash flow is the entrance and outflow of money related to a construction project over a given time period. When running a construction company or project, it is essential. The careful management of a construction project's financial resources is essential to its sustainability and profitability. The movement of money into or out of a business is referred to as cash flow. When a project brings in money, its cash flow is positive. Exiting the project with funds results in negative cash flow. Adding the time element yields the flow velocity. Cash flows are used by project and business managers to track income and expenses. Project cash flow may be seen as the owner's payment plan for the project's completion over a certain amount of time. It is a part of the long-term financial strategy of an organization or enterprise. When assessing a project's appropriateness, organizations often use the term "relevant cash flow" to indicate the financial evaluation of the endeavor.

Before moving further, the top management of the organization must assess the project's benefits and cash flow and provide their approval. An examination of the project's cash flow may not be as important when collaborating with outside suppliers or providers. If there were no agreements with other parties, there would be no need to spend any money. An examination of project cash flow is useful for allocating project resources, particularly when contractors are not present.

Table 27 The questionnaire results of fifth group of factors

	Project cost criterion	**Project implementation quality criterion**	**Project completion time criterion**	**Project profit return criterion**	**sum**
F5 1	4	32	33	4	73
F5 2	29	21	20	3	73
F5 3	7	32	31	3	73
F5 4	5	35	31	2	73

Table 28 The numerical matrix of fifth group of factors

	Project cost criterion	**Project implementation quality criterion**	**Project completion time criterion**	**Project profit return criterion**
F5 1	0.008	0.076	0.225	0.2585
F5 2	0.056	0.05	0.136	0.1939
F5 3	0.014	0.076	0.211	0.1939
F5 4	0.010	0.083	0.211	0.1293

Table 29 The AHP-TOPSIS results of fifth group of factors

Si+	**Si-**	**Pi**	**Rank**
0.007	0.166	0.959	**1**
0.124	0.065	0.342	**4**
0.067	0.111	0.624	**2**
0.13	0.094	0.42	**3**

The goal of the inquiry was to clarify the role that project consultants play in the cash flow construction sector. Based on participants' assessments of the advantages of employing project consultants, we were able to collect precise data. An estimate of cash flow can be used to assess the operational and financial stability of a project. These estimates assist the availability of enough money and the early detection of potential financial dangers, providing as a strategic foundation for financial decision-making. These reports help with effective cash flow management, which is necessary to avoid underfunding or improper resource allocation throughout development.

4.3 Overall ranking factors

Analyzing the whole AHP-TOPSIS data for each responder element allowed us to analyze the consultant's effect on the success of the project. You can see all the results of the AHP-TOPSIS investigation in the figure (Figure 6). According to these rankings, the five criteria were considered very important in light of the project's potential impact.

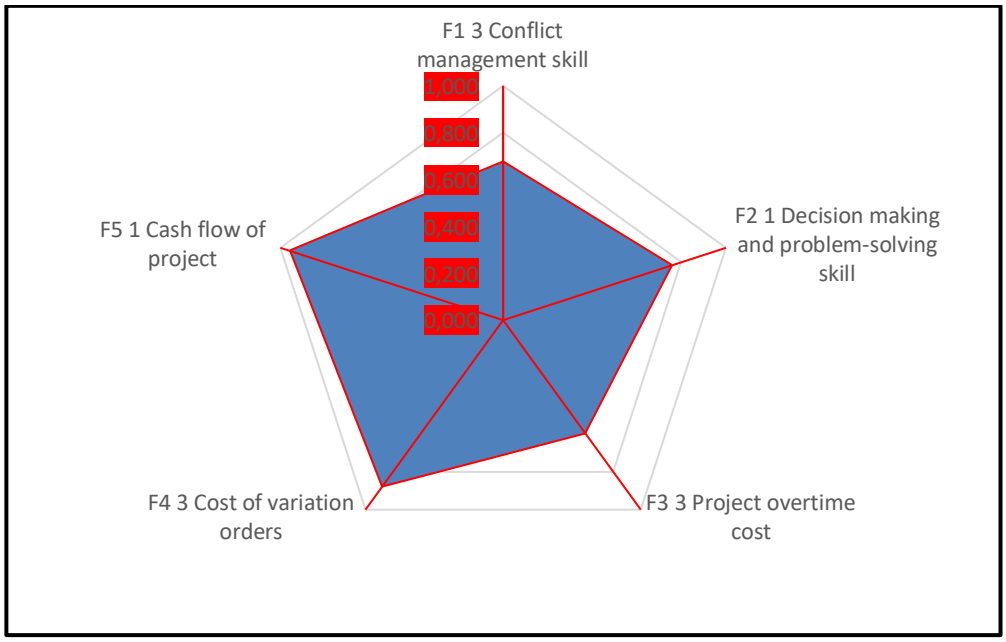

Figure 6 The overall effect of the main factors

In the building sector, the services provided by project consultants are crucial. From the very beginning of a project all the way to its conclusion, consultants offer their specialized knowledge. The use of project consultants greatly enhances the efficiency and effectiveness of construction projects. Project consultants' efficacy and efficiency in connection to the final product quality in Iraqi construction projects is the primary focus of this research. This research made use of a dataset that was compiled from a variety of primary and secondary sources. Secondary data was gathered by conducting a thorough literature review of relevant books, journals, and articles in order to outline and clarify the primary ideas of this study.

5 Conclusion

Delays in building projects and consulting office operations provide substantial obstacles, necessitating a thorough investigation of the underlying causes. This study used the AHP-TOPSIS approach to systematically detect, rank, and mitigate these delays, providing a formal framework for decision-making in project management. The integration of this approach allows for a systematic investigation of disparities, prioritizing numeric risks while resolving qualitative concerns using the Ishikawa diagram.

The study identified 20 significant risk factors influencing the efficiency of consulting firms and building projects using surveys, expert interviews, and exploratory research. These components were evaluated for influence using the AHP-TOPSIS factor ranking system and Microsoft Excel, yielding important insights into critical areas such as conflict resolution, problem-solving capacities, additional project expenses, cost fluctuations, and financial flow management. The methodology was evaluated in an Iraqi consulting firm to ensure its applicability in real-world scenarios by categorizing risks based on environmental factors. The findings revealed that a systematic review procedure considerably enhances project operations while reducing inefficiencies.

To reduce project failures and operational setbacks, it is critical to address common difficulties such as ineffective supervision, insufficient documentation, a lack of motivation, and confusing instructions. Continuous monitoring of construction processes, combined with structured training and professional development programs for supervisors, particularly foremen, is critical to increasing staff productivity. By employing these tactics, consulting firms and construction companies can improve their operations, reduce delays, and achieve long-term success in an increasingly complicated sector.

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