Multi-Criteria Decision Making for Prioritizing Project Manager Skills according to Construction Project Success Factors

Maysoon Abdullah Mansor
Department of Civil Engineering, College of Engineering, Tikrit University, Iraq
dr.maysoonabdullah@tu.edu.iq (corresponding author)

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ABSTRACT

The possession of specific skills by the project manager is a critical factor in the success of construction projects at every stage of development. The objective of this research is to identify and prioritize the specific skills that a project manager must possess to ensure a successful construction project. A comprehensive theoretical review was conducted, leading to the identification of 22 soft skills and 10 technical skills that are essential for project managers to ensure the success of construction projects. A preliminary questionnaire was used to evaluate the relative importance and interrelationships among the identified skills. This was followed by an expert questionnaire, which was assessed utilizing two analytical methods: the Stepwise Weight Assessment Ratio Analysis (SWARA) for skills and the main success factors of the construction project, and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) for skills according to the success factors. The preliminary questionnaire revealed that all project manager skills were deemed to be of significant importance, with percentages ranging from 0.7 to 0.818. Additionally, a moderate to weak correlation was observed between soft skills, with values ranging from 0.005 to 0.686, while for technical skills, a medium correlation was observed (0.707). The top five skills were identified as coordination, general knowledge of project management, communication, dealing with others, and organization. The TOPSIS technique revealed the preference order of soft skills: coordination skill (0.98), supervision (0.552), and general knowledge of project management (0.473). Regarding the preference order of technical skills, the following were revealed: legal experience (0.672), oral skills and listening (0.369), and planning, strategic planning, and goal setting (0.359). The findings of this study assist those responsible for making decisions concerning the most essential skills required for a project manager and provide a framework for selecting a project manager based on these competencies.

Keywords-project manager skills; soft skills; technical skills; construction project success factors; TOPSIS; SWARA

I. INTRODUCTION

The construction industry plays a significant role in the economic and social progress of developing countries [1], contributing to employment, the national Gross Domestic Product (GDP), as well as capital formation [2]. However, the industry is confronted with challenges, such as schedule delays, design flaws, cost overruns, and disputes related to resource planning, logistics, and risk management [3]. These issues are made more complex by other factors, including underperformance, financial uncertainty, and technological challenges, as projects become increasingly intricate [4]. In the contemporary context of construction, contractors and clients encounter substantial challenges in successfully delivering projects, a task that is made arduous by the increasing intricacy of project design and the expanding role of stakeholders [5]. A primary concern among stakeholders in the construction industry is the frequent inability of project implementers to complete projects in a timely manner and within specified financial constraints [6]. The construction process is inherently dynamic and comprises a multitude of multidisciplinary activities that are conducted in a concurrent manner. The prevailing metric by which the success of a project is determined is its alignment with the client's quality expectations, within the constraints of budget, time, and other specified parameters. The pursuit of an ideal construction project is an elusive goal, and it is important to acknowledge that any project is inherently subject to risk and uncertainty. Nevertheless, these risks and uncertainties can be reduced if the project manager is better prepared to manage crisis situations. It is important for project managers to have a better understanding of the environment in which they operate, as the dynamics of each project change over time and space, and no project environment is the same as another [7]. Project success has traditionally been defined by the ability to surpass expected or standard results in terms of on-time completion, budget constraints, safety and quality standards, and achieving high levels of satisfaction among the project team, organization, and

end users. Success has been predicated on factors, such as schedule, cost, quality, safety, and reception. However, the evolving landscape of complex projects, involving multiple stakeholders, has resulted in the introduction of new parameters to the definition of success. This evolution has led to the emergence of a more nuanced understanding of project success, including criteria and metrics designed to guide project participants toward optimal outcomes [8]. Given the inherent complexity of construction projects, there has never been a single, traditionally accepted set of critical success factors [9]. The concept of project success and the critical factors that contribute to it have been a topic of debate for a considerable time [10, 11]. Despite the abundance of literature and research focusing on project success factors [12], a plethora of studies and research have produced conflicting results, leading to a lack of consensus and a unified definition of project success [13]. There is no comprehensive list of critical success factors that has gained widespread acceptance. Project success and its contributing factors are of significant importance to project management professionals [14]. However, as emphasized in [15], it is crucial to analyze and identify the factors of success and failure of construction projects. Authors in [10] suggested that it is important to compile a priority list of critical success factors that should be taken into account in order to ensure the successful performance of construction projects. Authors in [16] identified and ranked the top five critical success factors that significantly impact project outcomes, including meeting timelines, adhering to financial budgets, achieving desired outcomes for all stakeholders, managing risks effectively, and assembling the right team while optimizing resource allocation. The study proposed the implementation of rigorous oversight mechanisms to ensure the integrity of incomplete engineering designs and the prohibition of contractors handling design work autonomously to enhance project success. Additionally, a thorough examination of contractor qualifications and financial stability was identified as a critical factor in ensuring project success. Authors in [17] used Structural Equation Models (SEM) and found that critical success factors exerted a substantial influence on 70.8% of construction project success factors. Furthermore, it was determined that project management and team member-related factors had the most significant impact on the success of construction projects. Authors in [14] found that of the twenty critical success factors selected from the sixty factors identified in the literature, seven were considered by the survey participants to be the most important. Authors in [18] examined the combined effect of six factors that are commonly cited in the project management literature as factors that determine successful project management in construction projects. The results of the study indicated that the foundation of successful project management in construction projects in developing countries is the ability of opinion leaders and stakeholders, such as governments, senior managers, and clients, to provide relevant assistance in the form of systems and structures, financing, materials, manpower, and other material resources for project managers to operate effectively, while creating an enabling environment.

Authors in [19] applied fuzzy TOPSIS logic to construct a soft multi-criteria skills framework for selecting project managers. Authors in [20] revealed that project practitioners hold divergent views on critical success factors and project success. Project managers, for instance, perceive a limited number of critical success factors, contrasting with the extensive, comprehensive critical success factors enumerated in survey questionnaires. The study showed that, while the traditional constraints of the iron triangle are significant, they are insufficient to determine project success. The study underscores the importance of project managers in achieving construction project success, with most researchers identifying human factors as a key element in project success. Project success factors are typically identified in key areas, such as construction methods, personnel and work skills, jobs, methods, and techniques [10]. Authors in [9] found that effective and efficient risk management can enhance the success of construction projects in the Democratic Republic of the Congo (DRC). In addition, the efficacy of leadership, particularly transactional leadership, has been identified as a substantial factor in the success of construction projects. Furthermore, the degree to which the construction project personnel are experienced and skilled directly correlates with their ability to meet project success criteria, thereby influencing the overall project success. Finally, the success of construction projects appears to be contingent on the scale of the project, with small and medium-sized projects demonstrating a higher degree of success compared to large-scale projects, which often face challenges due to a lack of experience and skill capacity. Authors in [15] demonstrated that project managers have the capacity to enhance the probability of project success and ensure the fulfillment of project requirements by employing project management tools during the construction stages. A substantial body of research and professional consensus acknowledges the crucial role of the project manager in the success of construction projects, emphasizing their impact across all construction phases [14]. Authors in [21, 22] noted the significance of the project manager's role in the successful completion of projects. Conversely, Authors in [23] displayed that the primary factor in successfully completing a project within the constraints of cost, time, scope, and quality is the presence of managers who possess superior administrative and emotional competencies. These competencies and leadership styles are the result and experience of performance and practice achieved by managers over time during the implementation of the project. Authors in [14] underscored the significance of four distinct types of project manager skills—namely, technical, political, human, and conceptual—in determining project success within the Egyptian construction industry. Furthermore, authors in [24] emphasized the necessity for managers to possess effective planning and training skills, teamwork skills, effective communication skills with employees and contractors, effective resource management skills, and risk management skills. Authors in [25] highlighted the important attributes and skills of project management. A combination of interpersonal skills, leadership abilities, effective communication, and rapid technical proficiency is associated with the most successful project outcomes. According to the findings in [7], various criteria, including decision-making, communication skills, and leadership, emerged as the most crucial competencies for construction project managers. Furthermore, authors in [26] proposed a set of ten core competencies for project managers in cooperative

construction projects. In addition to these core competencies, a series of supporting skills were identified, collectively forming a comprehensive competency profile for project managers in cooperative construction projects.

Authors in [27], after a critical review of the extant literature and based on prior research, indicated that the success of any project is contingent upon several critical success factors. Among these, the selection of a competent project manager with proven leadership skills is of particular importance. Therefore, the selection of the right project manager is a key factor in the success of the project. The selection of the most suitable project manager from a pool of candidates presents a Multi-Criteria Decision-Making (MCDM) problem, an aspect that has been largely overlooked in contemporary research. The study revealed that the prevailing project manager selection model should not presume independence among criteria; instead, it should acknowledge it between them. The evaluation of these relationships is crucial for enhancing the objectivity of the decision-making process and for ensuring the efficacy of the multi-criteria project manager selection model. The present study addresses this limitation by establishing a hierarchical sequence for project manager competencies, grounded in criteria that embody the success factors of construction projects. The study's novelty stems from its usage of multiple decision-making tools, considering the selection of the project manager as a multifaceted decision problem, contingent on both soft and technical skills, and aligned with the success factors of the construction project. The SWARA technique was employed to ascertain the relative weight of soft and technical skills, and the success factors of the construction project. Subsequently, the TOPSIS technique was deployed to prioritize the project manager skills according to the success factors. The research attempted to explore and state the priorities of the project manager skills. The research gap lies in the prevailing focus of studies on either theoretical success factors or project manager skills, with few exploring the relative importance of both. The current research aims to address this gap by conducting a comprehensive theoretical review of both success factors and project manager skills. The existing literature has primarily focused on the theoretical review of success factors and project manager skills. This research aims to address this gap by examining the relative importance of both factors separately. It also seeks to determine the importance of project manager skills according to success factors. In addition, it explores the importance of project managers' soft and technical skills and their role in the success of construction projects and the correlation between them. The present study begins with an introduction to project success factors and the project manager's skills, which constitute a fundamental element within the project success factors. This is followed by a theoretical review of previous research because it represents the basis for exploring the success factors and the project manager's skills, as well as stating the research gap. The subsequent section details the methodology employed to ascertain the priorities of the project manager's skills in relation to the construction project success factors. This methodology uses a set of statistical tools, including the Relative Importance Index (RII), the SWARA, and the TOPSIS. Finally, a review of the results, a discussion of the findings, and the formulation of proposals are presented.

A. Research Questions

The following research questions serve to achieve the primary research objective, which is to ascertain the relative priorities of project manager skills according to success factors.

- What are the success factors of construction projects?
- Are project manager skills necessary for the success of construction projects?
- What are the skills that a project manager must have for the success of construction projects?
- What is the relative importance of project manager skills to achieve the success of construction projects?
- What are the types and degrees of correlation between project manager skills?
- What is the priority order of project manager skills to achieve the success of construction projects?
- What is the priority order of project manager skills according to each factor of construction project success individually?
- Does the priority order of project manager skills based on success factors differ using MCDM-SWARA-TOPSIS compared to their priority order according to each success factor separately?

B. Research Hypothesis

A comprehensive review of the extant literature reveals several key assumptions supporting the research:

- The project manager plays a pivotal role in the success of a construction project.
- A correlation exists between the project manager's soft skills and technical skills, as well as within each skill type.
- The skills of a project manager are of significant importance, making it challenging to establish a clear priority order through conventional methods.
- The relative importance of project manager skills exhibits minimal variation depending on the project success factors.

II. RESEARCH METHODOLOGY

As shown in Figure 1, the research methodology includes the following:

A. Theoretical Framework

A comprehensive and in-depth review of the existing theoretical literature concerning project manager skills and the factors contributing to construction project success was conducted, in order to identify the most critical skills of the project manager that exert the greatest influence on project success. As depicted in Table I, the most significant soft and technical skills are categorized. Additionally, the objective of this review is to identify the most significant primary factors associated with project success, and as illustrated in Table II,

seven key elements were identified. In this research, the primary categories of factors associated with project success were selected, and the intricacies of each factor were not examined in depth. This approach is motivated by the recognition that such an examination would result in the expansion of the research timeline, the augmentation of its intricacy, and the potential for it to become monotonous. Such an approach would also risk deviating from the primary objective of the research, which is to emphasize the relationship between skills and project success. Table III presents the tools and techniques employed in the research, along with their intended applications.

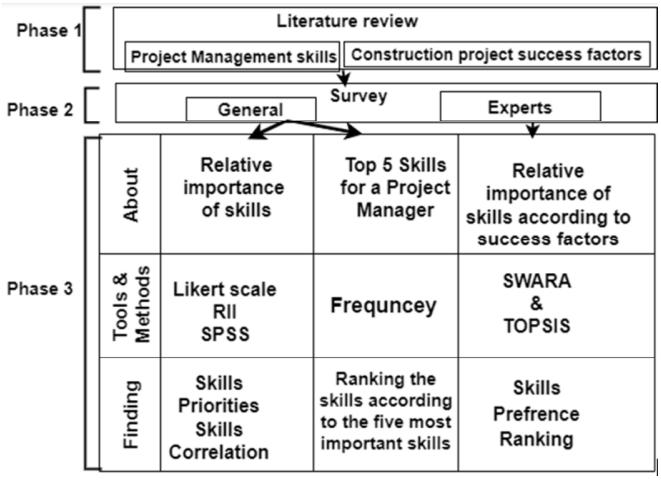

Fig. 1. Research methodology.

B. Survey

The second step in the research process is to conduct a field survey, which is based on the initial general and expert surveys. The following steps were taken during the field survey:

1) The initial general survey

Aimed to ascertain:

- the RII using:

$$RII = \sum W / AN \quad (1)$$

where W is the weighting given by respondents to each skill and factor, A is the highest weight (5 in this case) where a five-point scale was used (5 very important, 4 important, 3 moderately important, 2 unimportant, 1 very unimportant), and N is the total number of the samples.

- the project manager's soft and technical skills that were extracted from the theoretical framework,
- the correlation between skills within each type of soft and technical skills.
- the 5 most important skills for the project manager by calculating the frequencies.

2) The Expert Survey

The objective of the expert survey is to ascertain the relative importance of the primary categories of success factors and the relative importance of skills according to the primary categories of success factors. This is achieved by employing the SWARA method and the TOPSIS technique to accurately determine the order of skills.

TABLE I. THE MOST IMPORTANT SOFT AND TECHNICAL SKILLS

Code	Soft Skills	References No.					
		[7]	[14]	[28]	[29]	[30]	[31]
S1	Coordination skill		✓				
S2	Communication skills			✓	✓	✓	
S3	Skill in dealing with others		✓			✓	
S4	Conflict management/problem solving skill				✓		
S5	Managing relationships between individuals				✓		
S6	Organizational skills				✓		
S7	Team building skill					✓	
S8	Negotiation skills			✓	✓		
S9	Define the priorities				✓		
S10	Delegation				✓		
S11	General knowledge of project management				✓		
S12	Data analysis and interpretation				✓		
S13	Initiative and proactive				✓		
S14	Decision making				✓		
S15	Critical thinking				✓		
S16	Innovation				✓		
S17	Adaptability (flexibility)				✓		
S18	Supervision				✓		
S19	Oral and listening skills			✓			
S20	Motivation skill		✓				
S21	Political skills		✓				
S22	Legal experience				✓		
T1	Planning, strategic planning, and goal setting	✓			✓		✓
T2	Determine/the resources (human and financial) required to implement project activities			✓			
T3	Determine/schedules of activities and tasks		✓				
T4	Determine/quality standards		✓				
T5	Operations Management						✓
T6	Determine the time frame for project implementation						✓
T7	Develop budget estimates necessary to complete projects		✓	✓			✓
T8	Risk management skills		✓	✓			✓
T9	Project monitoring and control skills			✓			✓
T10	Feedback management				✓		

TABLE II. CONSTRUCTION PROJECT SUCCESS FACTORS

Code	Main Success Factors Categories	References No.								
		[5]	[9]	[18]	[20]	[32]	[33]	[34]	[35]	[36]
EX	External environment	✓		✓	✓	✓	✓	✓		
PR	The project		✓	✓	✓	✓	✓	✓	✓	
PU	Purchases	✓		✓	✓			✓		
WE	Work environment	✓		✓	✓	✓		✓		✓
MS	Project Manager	✓	✓		✓	✓		✓	✓	
CL	Client	✓			✓	✓		✓		
CO	Contractor			✓	✓	✓		✓		
PM	Project management	✓		✓	✓	✓	✓	✓	✓	✓

C. Using Stepwise Weight Assessment Ratio Analysis to Find the Relative Importance

The SWARA, used to find the RII [37], is an MCDM method [38] that is employed to determine the weight of a

criterion [39]. Experts deploy the SWARA approach to prioritize criteria based on their importance. The SWARA method includes [40,41]:

- Ranking of criteria: In this stage, criteria are ranked according to their importance in descending order. Experts assign a rank to each criterion based on its importance, with the most significant criteria receiving the highest rank and the least significant criteria receiving the lowest rank.
- Calculating the comparative value of each criterion *Sj*: The relative value assigned to each criterion is determined in relation to the criteria that preceded it. Beginning with the second criterion, i.e., determining the importance of criterion *Cj* compared to the importance of criterion *Cj*+1, as:

$$Sj \leftrightarrow j + 1 = \sum_{k=1}^{r} C_j \leftrightarrow j + 1/r \quad (2)$$

- Estimating the coefficient *Kj*: It represents the relative importance of each criterion:

$$K_j = \begin{cases} 1, & j = 1 \\ S_j + 1, & j > 1 \end{cases} \quad (3)$$

- Calculate the weight of each criterion q_j: The first criterion has the highest importance and is equal to 1:

$$q_j = \begin{cases} 1, & j = 1 \\ q_j - 1 \ /kj & ,j > 1 \end{cases} \quad (4)$$

- Calculate the final normal weight: The final weight of the standards is:

$$W_j = q_j \sum_{k=1}^{m} q_j \quad (5)$$

TABLE III. THE TOOLS AND TECHNIQUES USED IN THE RESEARCH

Tools and techniques	Defined	Reasons for using each technique
SPSS	Statistical Package for the social sciences	Analysis of the initial general survey (Cronbach's Alpha values, mean, standard deviation).
RII	Relative Importance Index	Finding the relative importance of skills generally.
SWARA	The Stepwise Weight Assessment Ratio Analysis is one of the MCDM methods	Finding the relative importance of the main categories of success factors and the relative importance of skills according to the main categories of success factors in expert survey analysis.
TOPSIS	Technique for Order of Preference by Similarity to Ideal Solution .	Finding the order of preference for skills accurately according to the success factors in expert survey analysis.

D. Using TOPSIS Preference Ranking Technique to Preference Skills according to Success Factors

In the context of MCDM methodologies, the preference ranking technique similar to the ideal solution (TOPSIS) is selected in the analytical stage to prioritize alternative solutions based on a predetermined set of criteria [42]. The TOPSIS method measures the degree to which an alternative solution is closest to the optimal ideal solution, thereby identifying the most optimal alternative within the available range [43]. The TOPSIS method quantifies the geometric distance of the alternatives from their positive and negative ideal solutions, and selects the best alternative based on the shortest distance from the positive ideal solution and the longest distance from the negative ideal solution. The TOPSIS method is characterized by its rationality, simplicity, ease of understanding, and ease and efficiency of its calculations [44, 45]. The TOPSIS method is easier to use and more powerful in evaluating more criteria. This method is also known to result in a clear and objective ranking of alternatives [46, 47]. The steps for analysis using TOPSIS are [43, 44, 48, 49]:

- Creating a decision matrix: This is achieved by initially selecting the criteria and extracting the weights. Thereafter, the decision matrix D = ([*xij*]mn) is created in a manner that the rows are the alternatives (i=1,….m) and the columns are the criteria (j=1,…n). Each alternative is then assigned a score in each criterion, denoted as *Xij*. In this research, the decision matrix is expressed by the criteria, which embody the success factors of the construction project, and the alternatives, which signify the soft skills of the project manager at one time and the technical skills of the project manager at another time Therefore, two decision matrices are used, as shown in Figure 2. The creation of two decision matrices was driven by the objective of reducing the number of alternatives, i.e., skills. The rationale behind this approach is that the utilization of a single matrix encompassing both soft and technical skills would result in an augmentation of the alternatives. An increase in the number of alternatives, in turn, would lead to a reduction in the efficiency of the TOPSIS method.
- The calculation of the normalized decision matrix is achieved by normalizing the weights to eliminate the effect of different measures. This process also ensures that the values range from 0 to 1. In the present study, this step was omitted due to the similarity of all measures:

$$R_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad (6)$$

where $R_{ij:}$ is the normalized value, $X_{ij:}$ is the value of each alternative (skill) according to each criterion (each success factor), i is an alternative (skills), and j are the criteria (factors for the success of the construction project).

- Calculate the best ideal value (highest V+ value) and the worst ideal value (worst V- value):

$$Vij = Rij \ x \ Wj \quad (7)$$

where V_{ij} is the value of alternative in each criterion and W_j is the weight of the criteria for all *j*.

- Calculate the Euclidean distance from the best ideal value Si+ as:

$$S_i{+} = \sqrt{\sum_{j=1}^{m} (V_{ij} - V_j^+)^2} \quad (8)$$

- Calculate the Euclidean distance from the worst ideal value Si- as:

$$S_i -= \sqrt{\sum_{j=1}^{m}(V_{ij} - V_J^-)^2} \quad (9)$$

- Calculate the performance score Ci as:

$$C_i = \frac{s_i^-}{s_i^+ + s_i^-} \quad (10)$$

- Rank the performance score.
- The option with the highest performance score should be selected as the optimal alternative.

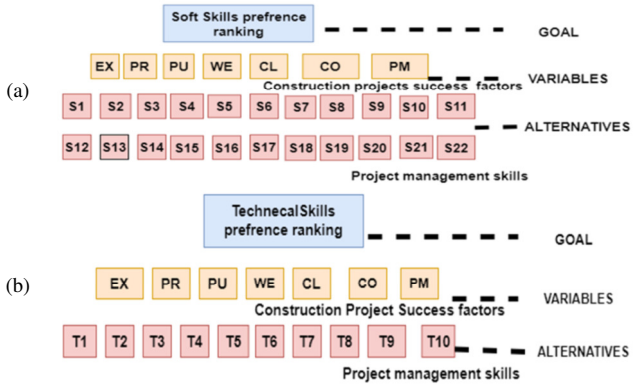

Fig. 2. TOPSIS (a) soft and (b) technical skills matrices.

III. RESULTS AND DISCUSSION

A. General Questionnaire Results

The SPSS (V26) program was used to assess the reliability of the questionnaire by calculating the Cronbach's Alpha values for its constituent axes, as portrayed in Table IV. The obtained values are indicative of excellent and good reliability, with Cronbach's Alpha (α) ≥ 0.9 signifying excellent reliability and 0.9 ≥ α ≥ 0.8 indicating good reliability [50].

TABLE IV. THE CRONBACH'S ALPHA VALUES

Skills	No. of items	Cronbach's Alpha
Soft	22	0.904
Technical	10	0.825

The results of the general questionnaire are:

- Questionnaire sample: Table V presents the information of the general questionnaire respondents. The study attempted to cover all Iraqi provinces, and many paper questionnaires were distributed, in addition to preparing the questionnaire in the form of a link. Thirty-one complete answers were obtained, and incomplete answers were ignored. The general questionnaire did not specify the years of experience of the respondents. However, after filtering the results, the researcher resorted to the experts' questionnaire. The sample size of this study is 32 respondents, with the majority, 87%, coming from Salah al-Din province. The remaining 10% and 3% hail from Kirkuk and Baghdad, respectively, thereby covering the northern and central regions of Iraq. Regarding the respondents' years of experience, the majority, 79%, have been in the construction sector for over a decade, with 28% having accumulated over 21 years of experience and 16% having between 16 and 20 years of experience. The remaining 35% have been in the construction sector for a time period between 11 and 15 years, indicating a substantial and considerable experience in Iraq's construction sector. This suggests that a significant percentage of the sample possesses an important and valuable experience in construction projects in Iraq. Considering the education level, 44% of the respondents have a doctorate, while 28% hold a master's and a bachelor's degree. Regarding the type of project and work sector, 63% of the constructed buildings are public structures, and 94% of the respondents are employed in the public sector. The roles of project manager, deputy manager, consultant, and supervising engineer are assigned to 41%, 9%, 34% and 16% of the participants, respectively. The respondents' specialization is primarily in civil engineering (94%), and the stage of the last project that they completed was most often the implementation phase (66%).
- The RII of skills was determined by a review of the theories, which answered the third and fourth research questions. The results indicated the presence of soft and technical skills that are essential for project managers. The importance of these skills was determined to be high, with a rating of 0.76 for soft skills and 0.74 for technical skills. Table VI shows the relative importance of soft and technical skills. It is evident that all project manager skills have high importance, with their RII varying by very small percentages (0.70–0.818). This finding supports the first research hypothesis. The soft skills, which include managing relationships between individuals, monitoring and controlling projects, and determining the time frame for project implementation, are ranked at the top of the list with equal importance (0.818). These skills are followed by team-building, delegation and decision-making skills, respectively, while coordination, communication, and risk management skills, come next. It is noteworthy that all project manager skills exhibit high relative importance, with only slight differences between them that do not clearly indicate a substantial variation in their relative importance.
- Skill Correlation: As displayed in Table VII, the relationship between soft and technical skills is indicative of the second research hypothesis and provides an answer to the fifth research question, which posits the existence of a relationship between soft and technical skills, as well as a relationship between skills within the same type. Table VIII presents the value of the correlation coefficient (r)[51] and Tables IX and X depict the correlation of soft skills with each other, where poor positive correlation and fair positive correlation prevail, thereby supporting the existence of a correlation (albeit weak or neutral) between soft skills. This finding aligns with the second research hypothesis and addresses the research gap [27], which demonstrated that most research neglects to consider the correlation between skills. Table X presents the correlation between technical skills skills mainly characterized by poor positive and fair positive correlation.

TABLE V. THE INFORMATION OF THE GENERAL QUESTIONNAIRE RESPONDENTS

Governorate (%)		**Specialization (%)**		**Years of experience (%)**		**Academic degree (%)**		**Project type (%)**		**Work sector (%)**		**Respondent role (%)**		**Project phase (%)**	
Salah al-Din	87	Civil	94	21 or more	28	PhD	44	Government buildings	63	Public	94	Project manager	41	Operation and maintenance	19
Kirkuk	10			16-20	16	Master	28	Roads and bridges	16			Deputy manager	9	Implementation	66
Baghdad	3	Mechanical	6	11-15	35	Bachelor	28	Water and sewage	13	Private	6	Consultant	34	Planning and design	15
				6-10	9			Residential complexes	8			Supervising engineer	16		
				1-5	12										

TABLE VI. RII OF PROJECT MANAGER SKILL

Code	**Project manager skills**	***RII***	**S.D**	**Rank**	**Direction**
S1	Coordination skill	0.776	0.71	5	H
S2	General knowledge of project management	0.776	0.75	5	H
S3	Communication skills	0.776	0.86	5	H
S4	Organizational skills	0.762	0.64	7	H
S5	Managing relationships between individuals	0.818	0.80	1	H
S6	Skill in dealing with others	0.718	0.63	13	H
S7	Conflict management / problem solving skill	0.768	0.76	6	H
S8	Define priorities	0.75	0.80	9	H
S9	Decision making	0.788	0.74	4	H
S10	Delegation	0.794	0.80	3	H
S11	Supervision	0.75	0.76	9	H
S12	Team building skill	0.8	0.76	2	H
S13	negotiation skills	0.75	0.68	9	H
S14	Feedback management	0.744	0.78	10	H
S15	Project monitoring and control skills	0.818	0.82	1	H
S16	Determine quality standards	0.738	0.72	11	H
S17	Data analysis and interpretation	0.768	0.69	6	H
S18	Determine the time frame for project implementation	0.818	0.74	1	H
S19	Determine the resources required to implement project activities	0.762	0.85	7	H
S20	Determine schedules of activities and tasks	0.744	0.75	10	H
S21	Adaptability(flexibility)	0.756	0.94	8	H
S22	Motivation skill	0.756	1.07	8	H
S	Soft Skills	0.76	H		
T1	Planning, strategic planning, and goal setting	0.768	0.81	6	H
T2	Legal experience	0.756	0.61	8	H
T3	Risk management skills	0.776	0.71	5	H
T4	Initiative and proactive	0.762	1.00	7	H
T5	Develop budget estimates necessary to complete projects	0.75	0.76	9	H
T6	Critical thinking	0.768	0.99	6	H
T7	Operation Management	0.718	0.76	13	H
T8	Political skills	0.75	0.62	9	H
T9	Innovation	0.726	0.55	12	H
T10	Oral and listening skills	0.70	0.72	14	H
T	Technical Skills	0.74	H		

TABLE VII. CORRELATION BETWEEN SOFT AND TECHNICAL SKILLS

Skills	***S***	***T***
S	1	
T	0.747**	1

** correlation is significant at the 0.01 level (2-tailed)

TABLE VIII. VALUE OF CORRELATION COEFFICIENT(R)

Correlation coefficient (R)	**Sign**	**Color**	**Interpreting**
1	+		Perfect positive correlation
	-		Perfect negative correlation
0.7-0.99	+		Good positive correlation
	-		Good negative correlation
0.5-0.69	+		Fair positive correlation
	-		Fair negative correlation
001-0.49	+		Poor positive correlation
	-		Poor negative correlation
0			No Correlation

- Top five skills according to the success factors: Table XI presents the number of repetitions obtained by each skill to ascertain the top five skills according to the primary success factor categories. In addition to identifying the total number of repetitions and arranging them in descending order (the final two columns), Table XI also highlights the top five skills irrespective of the success factor categories, which include coordination skills, supervision, general knowledge of project management, and skill in dealing with others and managing relationships between individuals, answering the sixth research question. The use of repetitions was crucial in determining the sequence of the top five most significant skills. The importance of each skill varied according to the specific success factor, as evidenced in Table XII, which presents the ranking of the top five skills according to each factor. The coordination skill is placed at the top of the five categories of success factors, while the skills related to the external environment, purchases, work environment, contractor, and project management are placed at the second and fourth positions, respectively, according to the success factors related to the project and client.

The second ranking is shared by five skills in addition to the coordination skill. These include communication skills, feedback management, skill in dealing with others, delegation, and general knowledge of project management. The third ranking is shared by six skills according to the categories of main success factors. In this ranking, the general knowledge of project management skills is repeated twice according to the success factors related to the client and project management. In addition to the skills in dealing with others, decision making, communication skills and managing relationships between individuals, the general knowledge of project management skill is also repeated according to the success factors related to the client and project management. The fourth ranking is shared by six skills, where the conflict management/problem-solving skill is repeated according to external environmental factors and

work environment, in addition to the skills in dealing with others, supervision, determining quality standards, coordination, and decision-making. The fifth ranking is shared by four skills according to the success factors: the organizational skill according to the external environment and client, the general knowledge of project management skill according to the success factors related to the project and procurement, the communication skill according to the success factors project-related to the work environment and project management, and the supervision skill according to the success factors related to the contractor. Table XIII demonstrates that thirteen skills occupy the top five positions according to the project success factors. This finding lends support to the third and fourth hypotheses, which assert that project manager skills possess a high and close importance, the determination of the priority order is difficult except by using accurate methods, and that the relative importance of project manager skills undergoes negligible change depending on the project success factors.

TABLE IX. SOFT SKILL CORRELATION

PEA	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	S21	S22
S1																						
S2	0.638¶**	1																				
S3	0.597¶**	0.362*	1																			
S4	0.525¶**	0.226	0.443*	1																		
S5	0.536**	0.397*	0.686**	0.330	1																	
S6	0.245	0.299	0.183	0.358¶*	-0.002	1																
S7	0.479**	0.563**	0.419*	0.248	0.305	0.253	1															
S8	0.385*	0.362¶*	0.498**	0.389*	0.515**	0.365*	0.555**	1														
S9	0.362*	0.399*	0.397*	0.279	0.196	0.614**	0.558**	0.432*	1													
S10	0.057	0.107	0.164	0.110	0.290	0.176	0.422*	0.527*	0.421*	1												
S11	0.419*	0.338	0.641**	0.264	0.372*	0.135	0.389*	0.159	0.401*	0.211	1											
S12	0.180	0.000	0.320	.116	0.093	0.253	0.278	0.079	0.215	0.369*	0.500**	1										
S13	0.259	-0.008	0.402*	0.062	0.257	-0.031	0.170	0.085	0.174	0.279	0.372*	0.480**	1									
S14	0.198	0.021	0.559**	0.241	0.324	0.031	0.041	-0.042	0.286	0.142	0.545**	0.368*	0.477**	1								
S15	0.320	-0.013	0.326	0.242	0.342	0.090	0.232	0.068	0.302	0.269	0.516**	0.438*	0.529**	0.654**	1							
S16	0.339	0.200	0.263	0.381*	0.278	0.087	0.454**	0.150	0.352*	0.097	0.293	0.337	0.235	0.256	0.459**	1						
S17	0.687**	0.522**	0.467**	0.272	0.482**	0.259	0.538**	0.362*	0.512**	0.102	0.430*	0.169	0.126	0.284	0.339	0.483**	1					
S18	0.201	0.131	0.554**	0.175	0.415*	0.144	0.143	0.089	0.107	0.136	0.459**	0.201	0.148	0.594**	0.380*	0.064	0.289	1				
S19	-0.007	0.044	0.234	-0.068	0.064	0.157	0.087	0.021	0.293	0.224	0.497**	0.584**	0.303	0.382*	0.332	0.083	0.101	0.067	1			
S20	0.372*	0.350*	0.485**	0.312	0.386*	0.199	0.409*	0.460**	0.336	0.495**	0.338	0.352*	0.254	0.368*	0.200	0.173	0.477**	0.331	0.153	1		
S21	0.491**	0.416*	0.506**	0.303	0.479**	0.377*	0.641**	0.623**	0.638**	0.608**	0.540**	0.371*	0.152	0.249	0.368*	0.232	0.629**	0.404*	0.283	0.661**	1	
S22	0.149	0.301	0.097	-0.041	0.118	0.102	0.079	0.085	0.148	0.488**	0.198	0.475**	0.204	0.160	0.156	0.005	0.049	0.071	0.412*	0.457**	0.364*	1

* correlation is significant at the 0.05 level (2-tailed)

** correlation is significant at the 0.01 level (2-tailed)

B. Experts Questionnaire Results

In the expert questionnaire, respondents were selected based on the criterion that the years of experience were not less than 15 years. MCDM, SWARA, and TOPSIS techniques were used to analyze the results and Table XIV presents the questionnaire sample, which included 14 experts, with 16 or more years of experience, 93% being from Salah al-Din and, having the same percentage of civil specialization. There are 71% Ph.D. degree holders and all of them work in the government sector, with the same percentage being project managers and the rest assistant managers. The last project phase in which 65% of the respondents were involved, is the planning and design phase, followed by the maintenance and operations phase with 21% respondents.

TABLE X. TECHNICAL SKILL CORRELATION

PEA	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
T1	1									
T2	0.388**	1								
T3	0.530**	0.459**	1							
T4	0.283	0.515**	0.606**	1						
T5	0.354*	0.365*	0.359*	0.318	1					
T6	0.332	0.264	0.295	0.460**	0.118	1				
T7	0.315	0.362*	0.445*	0.323	0.266	.344	1			
T8	0.369*	0.533**	0.513**	0.546**	0.272	.565**	.189	1		
T9	0.153	0.132	0.206	0.161	.076	.302	.164	.187	1	
T10	0.250	0.480**	0.381*	0.360*	.295	.159	.267	.289	.162	1

* correlation is significant at the 0.05 level (2-tailed)

** correlation is significant at the 0.01 level (2-tailed)

1) Results of the Stepwise Weight Assessment Ratio Analysis

A SWARA project success factor analysis revealed that the primary project success factors are associated with eight major categories: project manager, project, procurement, client, external environment, work environment, contractor, and project management. Table XV presents the outcomes of the stepwise weight assessment ratios of the project success factors. The project manager factor emerges as the primary success factor, thereby addressing the initial and secondary research questions and substantiating the first research hypothesis that the project manager is among the most significant factors. In the context of construction projects, the project manager is identified as a significant factor contributing to success. The analysis further delineates the relative importance of other factors, including project purchasing, contractor, work environment, project management, and client and external environment. The study's findings address the research question, underscoring the significance and impact of each factor on project success. It is noteworthy that the final weights exhibit a narrow margin of variation, ranging from 0.105 to 0.14, indicating the robustness of the statistical analysis and the reliability of the results.

The SWARA of soft and technical skills is presented in Tables XVI and XVII, respectively. In this analysis, S1 is the most important soft skill in relation to all success factors except the external environment factor, and the external environment factor, in relation to which, the most important soft skill is S3. As for technical skills, T1 ranks first in relation to the work environment and project factors, T2 ranks first in relation to the purchases and external environment factors, and T9 ranks first in relation to each of the contractor, project, and client factors. The SWARA analysis demonstrates that the relative weight of the soft and technical skills varies according to each of the success factors. The results presented in Tables XVI and XVII address the seventh research question, which inquires about the relative priority of project manager skills according to each factor of construction project success.

TABLE XI. FREQUENCIES OF TOP FIVE SKILLS FOR EACH FACTOR IN THE SUCCESS OF CONSTRUCTION PROJECTS

Soft skill code	Success factors							Sum of repetition	Sum of repetition	% Ascending sort order
	EX	*PR*	*PU*	*WE*	*CL*	*CO*	*PM*			
S1	17	14	18	21	12	19	18	119	7.85	7.85
S11	9	10	12	8	13	15	15	82	5.41	13.26
S2	13	7	14	11	8	7	11	71	4.68	17.94
S6	11	7	10	9	12	13	7	69	4.55	22.49
S5	8	6	9	13	13	10	9	68	4.49	26.98
S3	11	4	10	14	9	12	5	65	4.29	31.27
S4	11	9	5	12	10	9	8	64	4.22	35.49
S9	10	15	8	7	11	8	5	64	4.22	39.71
S14	9	13	4	5	6	9	12	58	3.83	43.54
S10	5	7	8	8	13	7	8	56	3.69	47.23
S18	7	12	2	7	5	12	10	55	3.63	50.86
S7	9	9	6	6	4	12	8	54	3.56	54.42
S8	6	7	9	6	9	7	4	48	3.17	57.59
T10	4	3	16	2	3	2	18	48	3.17	60.75
T9	3	7	4	5	6	11	11	47	3.10	63.85
T4	4	10	13	4	10	3	2	46	3.03	66.89
S12	9	7	4	7	6	5	7	45	2.97	69.85
T6	8	7	3	4	6	9	8	45	2.97	72.82
T2	5	5	10	4	4	4	6	38	2.51	75.33
T3	5	3	5	5	6	8	5	37	2.44	77.77
S17	9	2	4	6	6	3	6	36	2.37	80.15
S20	4	4	3	10	7	3	4	35	2.31	82.45
T1	6	6	4	5	3	4	7	35	2.31	84.76
S22	3	5	3	5	7	2	5	30	1.98	86.74
T8	5	4	3	6	3	3	6	30	1.98	88.72
S13	3	6	4	6	4	4	2	29	1.91	90.63
T7	2	4	7	6	3	2	5	29	1.91	92.55
S15	8	2	3	5	3	3	3	27	1.78	94.33
T5	3	5	2	3	2	3	6	24	1.58	95.91
S21	5	3	3	2	4	2	4	23	1.52	97.43
S16	2	4	3	3	2	3	3	20	1.32	98.75
S19	2	3	3	2	4	3	2	19	1.25	100.00
								1516		

2) Results of the Preference Ranking of Skills according to Success Factors using Technique for Order of Preference by Similarity to Ideal Solution

The TOPSIS method is a comprehensive approach that considers the variation in the preference ranking of skills according to all project success factors, as opposed to evaluating each factor individually. This method calculates the preference ranking based on the combined effect of all success factors. To enhance the efficiency of the TOPSIS method, it was employed twice: initially to demonstrate the preference for soft skills and subsequently to show the preference for technical skills.

a) Technique for Order of Preference by Similarity to Ideal Solution Soft Skills Preference Order

Tables XVIII and XIX present the steps of the preference ranking technique by similarity to the ideal solution TOPSIS for soft skills, incorporating the effect of all success factors. As shown in Table XX, soft skills are prioritized in the following order: coordination skill S1 with a weight of 0.98, followed by the supervision skill S11 (0.552), general knowledge of project management skill S2 (0.473), the skill of dealing with others S6 (0.444), and S9 decision-making (0.440).

b) Technique for Order of Preference by Similarity to Ideal Solution Technical Skills Preference Order

Tables XXI and XXII illustrate the steps of the preference ranking technique by similarity to the ideal solution TOPSIS for technical skills, considering the effect of all success factors. Table XXIII presents the priority order of the technical skills, with legal expertise being the leading skill. T2, with a weight of 0.672, is followed by oral and listening skills T10 (0.369), planning, strategic planning, and goal setting T1 (0.359) and innovation skill T9 (0.306).

IV. CONCLUSIONS

The present study aimed to ascertain the relative importance of project manager skills in influencing project success. The study's findings indicated that project managers who possess a particular set of skills are considered key contributors to project success. A comprehensive review of the extant literature revealed eight primary factors that influence the success of construction projects, with factors related to the project manager exhibiting the highest relative importance according to the Stepwise Weight Assessment Ratio Analysis (SWARA) method (0.105-0.14). These factors include project manager, project, procurement, contractor, work environment, project management, and client. The present study examined the shortcoming previously indicated in [27], according to which there is a correlation between skills, and selecting the project manager based on the skills they possess is a multi-criteria problem according to the success factors.

TABLE XII. THE RANKING OF THE TOP FIVE SKILLS ACCORDING TO EACH CATEGORY OF THE MAIN SUCCESS FACTOR CATEGORIES

Rank	Success factors related to:						
	External environment	**The project**	**Purchases**	**Work environment**	**Client**	**Contractor**	**Project management**
1	Coordination skill	Define the priorities	Coordination skill	Coordination skill	Managing relationships Between individuals	Coordination skill	Coordination skill
2	Communication skills	Coordination skill	Feedback Management	Skill in dealing with others	Delegation	General knowledge of project management	Feedback management
3	Skill in dealing with others	Decision making	Communication skills	Managing relationships between individuals	General knowledge of project management	Organizational skills	General knowledge of project management
4	Conflict management / problem solving skill	Supervision	Determine quality standards	Conflict management / problem solving skill	Coordination skill	Skill in dealing with others	Decision making
5	Organizational skills	General knowledge of project management	General knowledge of project management	Communication skills	Organizational skills	Supervision	Communication skills

The study demonstrated a weak to medium correlation between soft skills ranging from 0.005 to 0.606, 0.076-0.606 between technical skills, and 0.707 between soft and technical skills. Authors in [14-15, 21-26] noted the significance of project managers' skill sets, identifying a group of skills that exert a substantial influence on the successful completion of construction projects within the constraints of time, cost, and quality. The study revealed that the Relative Importance Index (RII) of all soft and technical skills for the project manager is high, ranging from 0.7 to 0.818.

TABLE XIII. TOP FIVE SKILLS ACCORDING TO THE PROJECT SUCCESS FACTORS

Skills	Type	Repetition	Ranking	Success factors related to:
Coordination skill	Soft	7	1	External environment, work environment, purchases, contractor, and project management
			2	The project
			4	Client
General knowledge of project management	Soft	5	2	Contractor
			3	Client, project management
			5	The project and purchases
Communication skills	Soft	4	2	External environment
			3	Purchases
			4	Work environment and project management
Skill in dealing with others	Soft	3	2	Work environment
			3	External environment
			4	Contractor
Conflict management / problem solving skill	Soft	2	3	External environment and work environment
Organizational skills	Soft	3	3	Contractor
			5	External environment and client
Decision making	Soft	2	3	The project
			4	project management
Feedback management	Technical	2	2	Purchases and project management
Supervision	Soft	2	4	The project
			5	Contractor
Managing relation-ships between individuals	Soft	2	1	Client
			3	Work environment
Define the priorities	Soft	1	1	The project
Delegation	Soft	1	2	Client
Determine quality standards	Soft	1	3	Purchases

TABLE XIV. EXPERTS QUESTIONNAIRE SAMPLE

Governorate (%)		Specialization (%)		Years of experience (%)		Academic degree (%)		Project Type (%)		Work Sector (%)		Respondent Role (%)		Project Phase (%)	
Salah al-Din	93	Civil	93	21 or more	64	PhD	71	Government buildings	86	Governmental	100	Project Manager	71	Operation and maintenance	21
Baghdad	7	Mechanical	7	16-20 years	36	Master	22	Residential complexes	7	Private	0	Deputy Manager	29	Implementation	14
						Bachelor	7	Water and sewage	7					Planning and design	65

TABLE XV. SWARA OF THE PROJECT SUCCESS FACTORS

Code	Global score	Rank	Comparative importance of average value (S_j)	Coefficient (K_j)	Re-calculated weight (Q_j)	Weight (W_j)
MS	Project manager	59		1.000	1.000	0.140
PR	The project	57	0.021	1.021	0.979	0.137
PU	Purchases	56	0.005	1.026	0.954	0.134
CO	Contractor	56	0.007	1.033	0.924	0.130
WE	Work environment	54	0.012	1.045	0.884	0.124
PM	Project management	54	0.003	1.048	0.844	0.118
CL	Client	53	0.013	1.061	0.795	0.112
EX	External environment	53	0.002	1.063	0.748	0.105
					7.129	

The study further found that project managers' priorities vary according to project success factors, and no single skill occupies a fixed order among the top five most important skills, which corresponds to the eighth research question. The study examined the variation in the sequence of priorities for project manager skills as a multi-decision problem using Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), which revealed the order of preference for skills according to the impact of all success factors. The results indicated that the preference order for soft skills was: coordination skill (0.98), supervision (0.552), and general knowledge of project management (0.473). The preference order for technical skills was: legal expertise (0.67), oral and listening skills (0.369), planning, strategic planning, goal setting (0.359), and innovation (0.306). The study proposes the following:

- The cultivation of the project manager's competencies in construction projects should be prioritized as a significant factor contributing to the success of the project.
- When selecting a project manager, the specific competencies and their respective quantities should be given due consideration.
- The research findings offer a framework for decision-makers in the selection of a project manager and the identification of the most crucial competencies.

TABLE XVI. SWARA OF SOFT SKILLS

Soft Skills	External environment		The project		Purchases		Work environment		Client		Contractor		Project management	
Code	Weight (Wj)	Rank	Weight (Wj)	Rank	Weight (Wj)	Rank	Weight (Wj)	Rank	Weight (Wj)	Rank	Weight (Wj)	Rank	Weight (Wj)	Rank
S1	0.057	2	0.064	1	0.062	1	0.068	1	0.056	1	0.061	1	0.063	1
S2	0.055	3	0.045	8	0.053	3	0.045	7	0.050	6	0.055	2	0.049	3
S3	0.058	1	0.038	16	0.055	2	0.055	2	0.041	10	0.055	2	0.041	10
S4	0.051	5	0.045	8	0.047	5	0.054	3	0.046	8	0.049	5	0.047	5
S5	0.053	4	0.044	9	0.047	5	0.050	4	0.048	7	0.049	6	0.049	4
S6	0.053	4	0.047	7	0.045	6	0.046	6	0.055	2	0.051	3	0.049	4
S7	0.049	6	0.048	6	0.044	9	0.043	11	0.039	12	0.050	4	0.045	6
S8	0.041	11	0.041	12	0.051	4	0.039	15	0.053	4	0.043	10	0.040	12
S9	0.042	10	0.063	2	0.044	9	0.044	9	0.050	6	0.049	6	0.045	7
S10	0.040	13	0.041	13	0.045	7	0.044	8	0.052	5	0.039	14	0.044	8
S11	0.043	9	0.056	4	0.062	1	0.046	5	0.054	3	0.047	7	0.056	2
S12	0.043	9	0.049	5	0.040	12	0.046	5	0.040	11	0.046	8	0.045	7
S13	0.041	12	0.039	15	0.045	8	0.046	6	0.046	8	0.042	11	0.040	13
S14	0.041	12	0.057	3	0.042	10	0.043	11	0.042	9	0.046	8	0.049	3
S15	0.041	11	0.039	15	0.040	11	0.042	12	0.039	12	0.043	10	0.041	11
S16	0.039	14	0.040	14	0.040	11	0.043	11	0.039	13	0.041	12	0.040	12
S17	0.047	7	0.039	15	0.040	12	0.040	14	0.040	11	0.040	13	0.041	10
S18	0.046	8	0.043	10	0.040	12	0.045	7	0.042	9	0.047	6	0.049	3
S19	0.039	14	0.042	11	0.040	11	0.040	14	0.039	12	0.040	13	0.040	13
S20	0.041	11	0.039	15	0.040	12	0.043	10	0.046	8	0.040	13	0.042	8
S21	0.040	13	0.039	15	0.040	12	0.041	13	0.042	9	0.040	13	0.042	8
S22	0.039	14	0.040	14	0.040	12	0.044	9	0.041	10	0.040	13	0.041	10

TABLE XVII. SWARA OFTECHNICAL SKILLS

Technical Skills	**External environment**		**The project**		**Purchases**		**Work environment**		**Client**		**Contractor**		**Project management**	
Code	Weight (*Wj*)	Rank	Weight (*Wj*)	Rank	Weight (*Wj*)	Rank	Weight (*Wj*)	Rank	Weight (*Wj*)	Rank	Weight (*Wj*)	Rank	Weight (*Wj*)	Rank
T1	0.104	2	0.107	1	0.096	4	0.110	1	0.097	5	0.105	2	0.104	2
T2	0.106	1	0.097	5	0.139	1	0.097	5	0.097	5	0.099	3	0.097	4
T3	0.102	3	0.095	6	0.091	5	0.103	2	0.101	3	0.099	3	0.104	2
T4	0.104	2	0.103	2	0.096	4	0.096	6	0.103	2	0.097	4	0.097	4
T5	0.102	3	0.101	3	0.091	5	0.098	4	0.097	5	0.099	3	0.104	2
T6	0.104	2	0.103	2	0.091	5	0.100	3	0.099	4	0.099	3	0.095	5
T7	0.092	6	0.095	6	0.102	3	0.100	3	0.099	4	0.097	4	0.101	3
T8	0.094	5	0.095	6	0.091	5	0.103	2	0.097	5	0.097	4	0.095	5
T9	0.098	4	0.101	3	0.091	5	0.103	2	0.108	1	0.111	1	0.106	1
T10	0.094	5	0.099	4	0.112	2	0.098	4	0.099	4	0.097	4	0.095	5

TABLE XVIII. TOPSIS SOFT SKILLS DECISION MATRIX

Success factors	**External environment**	**The project**	**Purchases**	**Work environment**	**Client**	**contractor**	**Project management**
Soft Skills	EX	PR	PU	WE	CL	CO	PM
Wight	0.140	0.146	0.145	0.143	0.140	0.144	0.142
S1	0.057	0.064	0.062	0.068	0.056	0.061	0.063
S2	0.055	0.045	0.053	0.045	0.050	0.055	0.049
S3	0.058	0.038	0.055	0.055	0.041	0.055	0.041
S4	0.051	0.045	0.047	0.054	0.046	0.049	0.047
S5	0.053	0.044	0.047	0.050	0.048	0.049	0.049
S6	0.053	0.047	0.045	0.046	0.055	0.051	0.049
S7	0.049	0.048	0.044	0.043	0.039	0.050	0.045
S8	0.041	0.041	0.051	0.039	0.053	0.043	0.040
S9	0.042	0.063	0.044	0.044	0.050	0.049	0.045
S10	0.040	0.041	0.045	0.044	0.052	0.039	0.044
S11	0.043	0.056	0.062	0.046	0.054	0.047	0.056
S12	0.043	0.049	0.040	0.046	0.040	0.046	0.045
S13	0.041	0.039	0.045	0.046	0.046	0.042	0.040
S14	0.041	0.057	0.042	0.043	0.042	0.046	0.049
S15	0.041	0.039	0.040	0.042	0.039	0.043	0.041
S16	0.039	0.040	0.040	0.043	0.039	0.041	0.040
S17	0.047	0.039	0.040	0.040	0.040	0.040	0.041
S18	0.046	0.043	0.040	0.045	0.042	0.047	0.049
S19	0.039	0.042	0.040	0.040	0.039	0.040	0.040
S20	0.041	0.039	0.040	0.043	0.046	0.040	0.042
S21	0.040	0.039	0.040	0.041	0.042	0.040	0.042
S22	0.039	0.040	0.040	0.044	0.041	0.040	0.041

TABLE XIX. BEST (HIGHEST V+ VALUE) AND WORST IDEAL (WORST V- VALUE) VALUE CALCULATIONS FOR SOFT SKILLS

	EX	**PR**	**PU**	**WE**	**CL**	**CO**	**PM**
S1	0.0079	0.0094	0.0090	0.0097	0.0078	0.0087	0.0089
S2	0.0076	0.0065	0.0077	0.0065	0.0070	0.0079	0.0070
S3	0.0081	0.0056	0.0080	0.0078	0.0057	0.0079	0.0059
S4	0.0072	0.0065	0.0069	0.0077	0.0064	0.0071	0.0067
S5	0.0075	0.0064	0.0069	0.0071	0.0067	0.0070	0.0069
S6	0.0075	0.0069	0.0066	0.0066	0.0077	0.0073	0.0069
S7	0.0068	0.0071	0.0063	0.0061	0.0055	0.0072	0.0064
S8	0.0058	0.0060	0.0074	0.0056	0.0074	0.0061	0.0057
S9	0.0059	0.0092	0.0063	0.0063	0.0070	0.0070	0.0063
S10	0.0056	0.0059	0.0065	0.0064	0.0072	0.0057	0.0062
S11	0.0060	0.0082	0.0090	0.0066	0.0075	0.0067	0.0080
S12	0.0060	0.0072	0.0057	0.0066	0.0056	0.0066	0.0063
S13	0.0057	0.0057	0.0065	0.0066	0.0064	0.0061	0.0056
S14	0.0057	0.0084	0.0061	0.0061	0.0059	0.0066	0.0070
S15	0.0058	0.0057	0.0059	0.0060	0.0055	0.0061	0.0058
S16	0.0055	0.0058	0.0059	0.0061	0.0054	0.0059	0.0057
S17	0.0065	0.0057	0.0057	0.0057	0.0056	0.0057	0.0059
S18	0.0064	0.0063	0.0057	0.0065	0.0059	0.0068	0.0070
S19	0.0055	0.0062	0.0059	0.0057	0.0055	0.0058	0.0056
S20	0.0058	0.0057	0.0057	0.0062	0.0064	0.0057	0.0060
S21	0.0056	0.0057	0.0057	0.0058	0.0059	0.0057	0.0060

S22	0.0055	0.0058	0.0057	0.0063	0.0057	0.0057	0.0059
V+	0.0081	0.0094	0.0090	0.0097	0.0078	0.0087	0.0089
V-	0.0055	0.0056	0.0057	0.0078	0.0054	0.0057	0.0056

TABLE XX. SI+, SI-, AND THE SOFT SKILL PERFORMANCE SCORE CI

Code	Si+	Si-	Ci	Ranking
S1	0.000159	0.007795	0.980021	1
S2	0.005049	0.004531	0.472971	3
S3	0.005785	0.004138	0.417038	6
S4	0.005182	0.003084	0.373076	8
S5	0.005332	0.0034	0.389353	7
S6	0.005278	0.00422	0.444317	4
S7	0.006393	0.003215	0.334632	10
S8	0.007242	0.003445	0.322351	11
S9	0.005806	0.004573	0.440564	5
S10	0.007253	0.002544	0.259671	14
S11	0.004452	0.005489	0.552144	2
S12	0.006684	0.002394	0.263728	13
S13	0.007457	0.001829	0.196934	19
S14	0.006327	0.003744	0.371787	9
S15	0.008009	0.001915	0.192953	20
S16	0.008174	0.00175	0.176363	21
S17	0.008091	0.002352	0.225181	15
S18	0.006678	0.002573	0.278136	12
S19	0.008219	0.002157	0.207897	16
S20	0.007843	0.001989	0.202305	17
S21	0.008198	0.002067	0.201393	18
S22	0.008043	0.001607	0.166518	22

TABLE XXI. TOPSIS TECHNICAL SKILLS DECISION MATRIX

Technical Skills	External environment	The project	Purchases	Work Environment	Client	Contractor	Project management
Code	EX	PR	PU	WE	CL	CO	PM
Wight	0.140	0.146	0.145	0.143	0.140	0.144	0.142
T1	0.104	0.107	0.096	0.110	0.097	0.105	0.104
T2	0.106	0.097	0.139	0.097	0.097	0.099	0.097
T3	0.102	0.095	0.091	0.103	0.101	0.099	0.104
T4	0.104	0.103	0.096	0.096	0.103	0.097	0.097
T5	0.102	0.101	0.091	0.098	0.097	0.099	0.104
T6	0.104	0.103	0.091	0.100	0.099	0.099	0.095
T7	0.092	0.095	0.102	0.100	0.099	0.097	0.101
T8	0.094	0.095	0.091	0.103	0.097	0.097	0.095
T9	0.098	0.101	0.091	0.103	0.108	0.111	0.106
T10	0.094	0.099	0.112	0.098	0.099	0.097	0.095

TABLE XXII. CALCULATION OF THE BEST IDEAL VALUE (HIGHEST V+ VALUE) AND THE WORST IDEAL VALUE (WORST V- VALUE) FOR TECHNICAL SKILLS

Code	EX	PR	PU	WE	CL	CO	PM
T1	0.0145	0.0157	0.0140	0.0158	0.0136	0.0151	0.0148
T2	0.0148	0.0142	0.0202	0.0138	0.0136	0.0142	0.0138
T3	0.0143	0.0139	0.0132	0.0147	0.0142	0.0142	0.0148
T4	0.0145	0.0151	0.0140	0.0138	0.0145	0.0140	0.0138
T5	0.0143	0.0148	0.0132	0.0140	0.0136	0.0142	0.0148
T6	0.0145	0.0151	0.0132	0.0142	0.0139	0.0142	0.0136
T7	0.0129	0.0139	0.0148	0.0142	0.0139	0.0140	0.0144
T8	0.0132	0.0139	0.0132	0.0147	0.0136	0.0140	0.0136
T9	0.0137	0.0148	0.0132	0.0147	0.0151	0.0160	0.0150
T10	0.0132	0.0145	0.0163	0.0140	0.0139	0.0140	0.0136
V+	0.0148	0.0157	0.0202	0.0158	0.0151	0.0160	0.0150
V-	0.0129	0.0139	0.0132	0.0138	0.0136	0.0140	0.0136

TABLE XXIII. SI+, SI-, AND THE TECHNICAL SKILL PERFORMANCE SCORE CI

Code	Si+	Si-	Ci	Ranking
T1	0.006455	0.003616	0.359055	3
T2	0.003559	0.00728	0.671667	1
T3	0.007595	0.00213	0.218997	7
T4	0.007004	0.002303	0.247485	5
T5	0.007647	0.00205	0.211365	9
T6	0.007651	0.002073	0.213223	8
T7	0.006607	0.001907	0.22396	6
T8	0.008015	0.00095	0.105936	10
T9	0.007243	0.003199	0.306325	4
T10	0.005456	0.003192	0.369073	2

REFERENCES

[1] O. D. Awolusi, "Economic Growth and Socioeconomic Sustainability in BRICS Countries: A Vector Error Correction Modeling Approach,"

Journal of Economics and Behavioral Studies, vol. 13, no. 3(J), pp. 1–23, Jul. 2021, https://doi.org/10.22610/jebs.v13i3(J).3122.

[2] M.-Y. Cheng, M.-T. Cao, and A. Y. Jaya Mendrofa, "Dynamic feature selection for accurately predicting construction productivity using symbiotic organisms search-optimized least square support vector machine," *Journal of Building Engineering*, vol. 35, Mar. 2021, Art. no. 101973, https://doi.org/10.1016/j.jobe.2020.101973.

[3] A. M. Alklkali, "Analyzing Delay Factors in Iraqi Construction Projects: An ANP Approach with Najaf Governorate as a Case Study," *Engineering, Technology & Applied Science Research*, vol. 14, no. 6, pp. 17844–17847, Dec. 2024, https://doi.org/10.48084/etasr.8536.

[4] N. B. Siraj and A. R. Fayek, "Risk Identification and Common Risks in Construction: Literature Review and Content Analysis," *Journal of Construction Engineering and Management*, vol. 145, no. 9, Sep. 2019, Art. no. 03119004, https://doi.org/10.1061/(ASCE)CO.1943-7862.0001685.

[5] M. Dessalegn, "Assessment of Critical Success Factors in Construction Projects Performance in South West Ethiopia," *Civil and Environmental Research*, vol. 13, no. 6, 2021, Art. no. 1.

[6] A. Nassar and A. Elbisy, "Evaluation of Factors Leading to Time Delays and Cost Overruns in Marine Construction Projects," *Engineering, Technology & Applied Science Research*, vol. 14, no. 5, pp. 16095–16102, Oct. 2024, https://doi.org/10.48084/etasr.8116.

[7] P. Girish, H. S. Jayatheertha, V. Kumar, and V. A. Hosur, "Skills and competencies perceived of an effective construction project manager," *International Research Journal of Engineering and Technology (IRJET)*, vol. 06, no. 12, pp. 820–825, Dec. 2019.

[8] I. Y. Wuni, G. Q. Shen, and R. Osei-Kyei, "Quantitative evaluation and ranking of the critical success factors for modular integrated construction projects," *International Journal of Construction Management*, vol. 22, no. 11, pp. 2108–2120, Aug. 2022, https://doi.org/10.1080/15623599.2020.1766190.

[9] A. Fariala and O. D. Awolusi, "An assessment of Key Success Factors for Construction Projects in the Democratic Republic of Congo," *Information Management and Business Review*, vol. 13, no. 2, pp. 16–34, 2021.

[10] M. H. Zahoor and M. Ali, "Assessment of Critical Success Factors for Building Projects through the Literature," *Engineering Proceedings*, vol. 53, no. 1, 2023, Art. no. 45, https://doi.org/10.3390/IOCBD2023-15988.

[11] N. Faris Ali and M. A. Mansor, "An integrated framework for measuring construction project performance success," *AIP Conference Proceedings*, vol. 2591, no. 1, Mar. 2023, Art. no. 030058, https://doi.org/10.1063/5.0123472.

[12] K. Ahsan, M. Ho, and S. Khan, "Recruiting Project Managers: A Comparative Analysis of Competencies and Recruitment Signals from Job Advertisements,"*Project Management Journal*, vol. 44, no. 5, pp. 36–54, Oct. 2013, https://doi.org/10.1002/pmj.21366.

[13] M. Elmezain, W. H. W. Baduruzzaman, and M. A. Khoiry, "The Impact of Project Manager's Skills and Age on Project Success," *Brazilian Journal of Operations & Production Management*, vol. 18, no. 4, pp. 1–16, Jun. 2021, https://doi.org/10.14488/BJOPM.2021.017.

[14] D. Borges B., C. Soares A. P., M. Najjar, B. B. F. da Costa, V. W. Y. Tam, and A. N. Haddad, "Project success and critical success factors of construction projects from the perspective of a multicultural team: a case study in Guyana," *International Journal of Construction Management*, pp. 1–15, https://doi.org/10.1080/15623599.2024.2397626.

[15] M. Gunduz and A. M. A. Yahya, "Analysis of project success factors in construction industry," *Technological and Economic Development of Economy*, vol. 24, no. 1, pp. 67–80, Jan. 2018, https://doi.org/10.3846/20294913.2015.1074129.

[16] Y. A. Alragabah and M. Ahmed, "Impact assessment of critical success factors (CSFs) in public construction projects of Saudi Arabia," *Frontiers in Engineering and Built Environment*, vol. 4, no. 3, pp. 184–195, May 2024, https://doi.org/10.1108/FEBE-10-2023-0048.

[17] M. Singh and S. K. Sharma, "Critical Success Factors in Construction Projects," *International Journal of Recent Technology and Engineering (IJRTE)*, vol. 8, no. 5, pp. 1799–1804, Jan. 2020, https://doi.org/10.35940/ijrte.E6408.018520.

[18] A. Amoah, J. Berbegal-Mirabent, and F. Marimon, "Making the Management of a Project Successful: Case of Construction Projects in Developing Countries," *Journal of Construction Engineering and Management*, vol. 147, no. 12, Dec. 2021, Art. no. 04021166, https://doi.org/10.1061/(ASCE)CO.1943-7862.0002196.

[19] L. F. da Silva, P. S. G. de Oliveira, G. Grander, R. Penha, and F. S. Bizarrias, "Soft skills fuzzy TOPSIS ranked multi-criteria to select project manager," *International Journal of Information and Decision Sciences*, vol. 16, no. 1, pp. 19–45, 2024.

[20] V. Kumar, A. Pandey, and R. Singh, "Project success and critical success factors of construction projects: project practitioners' perspectives," *Organization, Technology and Management in Construction: an International Journal*, vol. 15, no. 1, pp. 1–22, May 2023, https://doi.org/10.2478/otmcj-2023-0001.

[21] B.-G. Hwang and W. J. Ng, "Project management knowledge and skills for green construction: Overcoming challenges," *International Journal of Project Management*, vol. 31, no. 2, pp. 272–284, Feb. 2013, https://doi.org/10.1016/j.ijproman.2012.05.004.

[22] R. Y. Sunindijo, "Project manager skills for improving project performance," *International Journal of Business Performance Management*, vol. 16, no. 1, pp. 67–83, 2015.

[23] M. N. Wahedy and A. Faqiri, "Proposed Competencies Required for Construction Project Managers in Afghanistan," *International Journal of Advanced Academic Studies*, vol. 3, no. 1, pp. 192–203, 2021, https://doi.org/10.33545/27068919.2021.v3.i1c.485.

[24] F. Alshammari, K. Yahya, and Z. Binti Haron, "Project Manager's Skills for improving the performance of complex projects in Kuwait Construction Industry: A Review," *IOP Conference Series: Materials Science and Engineering*, vol. 713, no. 1, Jan. 2020, Art. no. 012041, https://doi.org/10.1088/1757-899X/713/1/012041.

[25] E. Nejatyan, H. Sarvari, S. A. Hosseini, and H. Javanshir, "Deploying Value Engineering Strategies for Ameliorating Construction Project Management Performance: A Delphi-SWARA Study Approach," *Buildings*, vol. 14, no. 8, Aug. 2024, Art. no. 2291, https://doi.org/10.3390/buildings14082291.

[26] S. Moradi, K. Kähkönen, and K. Aaltonen, "Project Managers' Competencies in Collaborative Construction Projects," *Buildings*, vol. 10, no. 3, Mar. 2020, Art. no. 50, https://doi.org/10.3390/buildings10030050.

[27] A. Afshari, "Review on Construction Project Manager Selection Criteria and Methods," in *8th International Symposium Engineering Management and competitiveness*, Zrenjanin, Serbia, 2018, pp. 22–23.

[28] A. H. Awil and A. Ondara, "Analysis of Project Management Skills and Performance of Real Estate Construction Projects in Mogadishu, Somalia," *International Journal of Science and Research*, vol. 11, no. 6, pp. 144–151, Jun. 2022, https://doi.org/10.21275/SR22530154500.

[29] A. Amoah and F. Marimon, "Project Managers as Knowledge Workers: Competencies for Effective Project Management in Developing Countries," *Administrative Sciences*, vol. 11, no. 4, Dec. 2021, Art. no. 131, https://doi.org/10.3390/admsci11040131.

[30] M. Tahir, "The effect of project manager's soft skills on success of project in the construction industry," *International Journal of Applied Research in Social Sciences*, vol. 1, no. 5, 2019, https://doi.org/10.51594/ijarss.v1i5.44.

[31] L. Kisamo and S. O. Mokaya, "Project Management Skills and Performance of Construction Projects In Tanzania; A Case Of Selected Construction Firms In Mwanza," *International Journal of Social Science and Humanities Research*, vol. 7, no. 2, pp. 363–370, Jun. 2019.

[32] N. Gudienė, A. Banaitis, N. Banaitienė, and J. Lopes, "Development of a Conceptual Critical Success Factors Model for Construction Projects: A Case of Lithuania," *Procedia Engineering*, vol. 57, pp. 392–397, Jan. 2013, https://doi.org/10.1016/j.proeng.2013.04.051.

[33] V. C. M. Amora and J. B. P. Juanzon, "A Framework of Critical Success Factors and Success Criteria for Structural Works of a Mixed-Use Building Construction Project," *Civil Engineering and Architecture*, vol. 10, no. 1, pp. 267–279, Jan. 2022, https://doi.org/10.13189/cea.2022.100123.

[34] H. K. Al-Ageeli and A. S. J. A. Alzobaee, "Critical Success Factors in Construction Projects (Governmental Projects as a Case Study)," *Journal of Engineering*, vol. 22, no. 3, pp. 129–147, Mar. 2016, https://doi.org/10.31026/j.eng.2016.03.09.

[35] N. Iram, B. Khan, and A. W. Sherani, "Critical Factors Influencing the Project Success : An Analysis of Projects in Manufacturing and Construction in Pakistan," *Oman Chapter of Arabian Journal of Business and Management Review*, vol. 6, no. 2, pp. 20–24, Sep. 2016, https://doi.org/10.12816/0033272.

[36] J. Olopade and B. Franz, "Success factors for cross-functional teams in the construction industry: A literature review," in *16th Engineering Project Organization Conference*, Brijuni, Croatia, Jun. 2018, pp. 512–529.

[37] M. A. Mansor and S. R. Mohammed, "Maysoon Abdullah Mansor & Dr.Sawsan Rasheed Mohammed:Developing Sustainable Urban Planning Indicators Framework for Iraqi Cities by Using Content Analysis and Delphi Method," *International Journal of Modern Sciences and Engineering Technology (IJMSET)*, vol. 2, no. 3, pp. 46–56, Jan. 2015.

[38] H. Sarvari, A. B. Baghbaderani, D. W. M. Chan, and M. Beer, "Determining the significant contributing factors to the occurrence of human errors in the urban construction projects: A Delphi-SWARA study approach," *Technological Forecasting and Social Change*, vol. 205, Aug. 2024, Art. no. 123512, https://doi.org/10.1016/j.techfore.2024.123512.

[39] D. Stanujkić *et al.*, "A New Grey Approach for Using SWARA and PIPRECIA Methods in a Group Decision-Making Environment," *Mathematics*, vol. 9, no. 13, Jan. 2021, Art. no. 1554, https://doi.org/10.3390/math9131554.

[40] R. A. Majeed and H. K. Breesam, "Application of SWARA Technique to Find Criteria Weights for Selecting Landfill Site in Baghdad Governorate," *IOP Conference Series: Materials Science and Engineering*, vol. 1090, no. 1, Mar. 2021, Art. no. 012045, https://doi.org/10.1088/1757-899X/1090/1/012045.

[41] Z. Mou, C. Scheutz, and P. Kjeldsen, "Evaluation and application of site-specific data to revise the first-order decay model for estimating landfill gas generation and emissions at Danish landfills," *Journal of the Air & Waste Management Association*, vol. 65, no. 6, pp. 686–698, Jun. 2015, https://doi.org/10.1080/10962247.2015.1008653.

[42] A. ElMarkaby, A. Sanad, A. Elyamany, and E. Yehia, "Multi-criteria decision support system for bridge construction system selection utilizing value engineering and TOPSIS," *Innovative Infrastructure Solutions*, vol. 8, no. 11, Oct. 2023, Art. no. 295, https://doi.org/10.1007/s41062-023-01267-7.

[43] K. Fahimi, A. Jafari Shahrestani, A. R. Zamaninejad, and F. Kaboli, "Proposing a performance assessment model for the tehran municipality using TOPSIS and AHP," *Journal of Applied Research on Industrial Engineering*, vol. 11, no. 2, pp. 298–317, Jun. 2024, https://doi.org/10.22105/jarie.2024.407131.1554.

[44] E. Roszkowska, "Multi-criteria Decision Making Models by Applying the Topsis Method to Crisp and Interval Data," *Multiple Criteria Decision Making/University of Economics in Katowice*, vol. 6, no. 1, pp. 200–230, 2011.

[45] C.-C. Hung and L.-H. Chen, "A fuzzy TOPSIS decision making model with entropy weight under A fuzzy TOPSIS decision making model with entropy weight under intuitionistic fuzzy environment," in *Proceedings of the International MultiConference of Engineers and Computer Scientists*, Hong Kong, China, Mar. 2009.

[46] J. Jia, M. Ibrahim, M. Hadi, W. Orabi, and Y. Xiao, "Multi-Criteria Evaluation Framework in Selection of Accelerated Bridge Construction (ABC) Method," *Sustainability*, vol. 10, no. 11, Nov. 2018, Art. no. 4059, https://doi.org/10.3390/su10114059.

[47] M. Keshavarz-Ghorabaee, M. Amiri, E. K. Zavadskas, Z. Turskis, and J. Antucheviciene, "Ranking of Bridge Design Alternatives: A TOPSIS-FADR Method," *The Baltic Journal of Road and Bridge Engineering*, vol. 13, no. 3, pp. 209–237, Sep. 2018, https://doi.org/10.7250/bjrbe.2018-13.413.

[48] R. M. Zulqarnain, M. Saeed, N. Ahmad, F. Dayan, and B. Ahmad, "Application of TOPSIS Method for Decision Making," *International Journal of Scientific Research in Mathematical and Statistical Sciences*, vol. 7, no. 2, pp. 76–81, Apr. 2020.

[49] M. N. Ahmed, G. K. Aswed, and H. A. Mohammed, "Decision-Making for Project Delivery System in Construction Projects Based on SWARA-TOPSIS Methods," *Tikrit Journal of Engineering Sciences*, vol. 31, no. 1, pp. 306–313, Mar. 2024, https://doi.org/10.25130/tjes.31.1.25.

[50] N. Ahmad, F. A. Alias, M. Hamat, and S. A. Mohamed, "Reliability Analysis: Application of Cronbach's Alpha in Research Instruments," *Pioneering the Future: Delving Into E-Learning's Landscape*, pp. 114–119, 2024.

[51] W. Alshami, "Critical factors contribute to construction project success: Study of success factors in relation to the project size," M.S. thesis, Joint Study Program of Metropolia UAS and HTW Berlin, 2018.