Applying the Analytical Hierarchy Process to Identify the Challenges and Priorities of Reconstruction Projects in Iraq

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ABSTRACT

Reconstruction project management in the cities of Mosul, Anbar, and Tikrit, in Iraq still faces major obstacles that impede the comprehensive performance of these projects. It is thus necessary to improve the arising challenge estimation in the implementation of reconstruction projects and evaluate their components: time, cost, quality, and scope. This study used the Analytical Hierarchy Process (AHP) to prioritize major and minor criteria in the influential causes of challenges and formulate a mathematical model to help decision-makers estimate them. Using the Super Decisions software, the final results indicated that changes in scope reached 40.8%, which is the greatest difficulty, followed by changes in cost at 27.6%, changes in time at 13.5%, and changes in quality at 18.11%. The results of the essential subcriteria also indicated that underlying issues still exist in the Iraqi construction industry and that quick solutions are vital. Five mathematical equations were formulated to develop a model to estimate changes that introduce challenges in time, cost, quality, and scope and so to help decision-makers assess the level of these changes and identify challenges. This study recommended addressing these variables through realistic administrative and methodological strategies to consider changes, challenges, and available opportunities.

Keywords-challenges; AHP; reconstruction; cost overrun; time overrun

I. INTRODUCTION

Reconstruction is known as the process of returning building facilities to their natural state after war, planning errors, destruction for political motives, or after a natural disaster. Through this procedure, the damaged buildings are replaced or developed in a way that serves the country's economic growth. Reconstruction is an integrated concept that includes moving to a position of stability and peace. Reconstruction areas are divided into two main sections: physical and non-physical [1]. Reconstruction is associated with the architectural concepts of restoration (repairing existing building fabric) and preservation (preventing further decay), where the most comprehensive form is to create a destroyed buildingmreplica. Reconstruction is the act or process of photographing, by new construction, the form, features, and details of a non-existent site, landscape, building, structure, or object to replicate its appearance in a specific period and historic location [2]. It involves a process using the same materials and methods as closely as possible to the original ones or existing original components, particularly in buildings of cultural and historical importance, which then serve as objects of display and museums. However, in many cases, the rebuilding of a building to its original and typical form may not meet the requirements due to a lack of resources, such as a facade plans or document photos [1].

Reconstruction projects go through four stages, starting with monitoring the current situation and estimating losses. Then, executive plans and programs are developed, including identifying implementation mechanisms, participating parties, means of financing, and other details. Later, the implementation stage and project operation take place, followed by the maintenance stage and evaluation after operations. The first stage is considered the most important and dangerous, as shortcomings can ruin the whole process and threaten the whole project with failure [3]. The reconstruction process not only needs to assess economic needs by dealing with affected individuals or the facts on the ground but also needs to study political and social dimensions, which are crucial and are often overlooked. Before economies can be rebuilt or political institutions can be revitalized, societies must deal with these challenges [4]. There is no doubt that economic factors affect the results associated with reconstruction, which is evident in the three basic conditions that must be met for the process to be successful [5]:

- The availability of economic resources for reconstruction
- The presence or absence of a political process at national or regional level
- Economic structures, institutional legacy, and state relations.

Successful reconstruction is based on effective state-building as well as sustainable, balanced, and long-term economic recovery. If these factors are incomplete or missing, reconstruction can be disrupted, giving external actors greater scope to influence the course of this process to serve their agendas. Despite the availability of financial allocations and grants for the reconstruction of liberated cities, the Iraqi government needs help to fulfill its obligations and promises to complete the demolished homes, schools, hospitals, and infrastructure. However, it faces many different pressures and challenges that affect weak implementation, as represented in most local studies and scientific discussions, including the following [6]:

- External factors outside the institution's ability to influence, represented by the impact of security conditions, restrictions on oversight institution controls, the absence of necessary infrastructure to perform works, the delay in approving public budgets, inflexible laws and procedures, and the weakness of the rule of law due to the exceptional circumstances that the political process is going through.
- Internal factors specific to the institution producing services, represented by the weakness of implementing the requirements of good governance, such as transparency in decision-making, adopting competencies, and long-term planning. The weakness of good governance has been reflected in the lack of technical knowledge in project management (committees for opening and analyzing bids, department of the resident engineer, weak technical capabilities including laboratories and measuring devices), the absence of incentives for a sense of responsibility, and the centralization and complexity of administrative systems. These factors have led to delays and a lack of work mastery.
- Factors of weak integrated work between different institutions, represented by factors related to coordination between various state departments, including weak cooperation of state agencies on the issue of land allocation and in decisions to launch the disbursement of financial (Ministry of Planning) and government allocations (Ministry of Finance), and opening credits (Central Bank and Commercial Bank of Iraq).

Moving forward with the completion of some reconstruction projects in Iraq, the management aspect still needs to overcome the major obstacles that hinder the required performance of construction projects within the known determinants of success: time, cost, and specified quality. Extensive local studies are available to solve the most important obstacles and challenges in rebuilding liberated cities after disasters, but Iraq still faces great challenges for various reasons. Many facilities and infrastructures were partially or completely destroyed, leading to large-scale displacement waves that affected the construction sector and the Iraqi economy and caused social and environmental changes.

II. LITERATURE REVIEW

An extensive literature review was conducted, which presents all delay factors in various reconstruction projects, focusing on Iraqi studies. The theoretical research also examined the applications of using the Analytical Hierarchy Process (AHP). It specifically explored its wide uses, and how to develop a creative tool to help the decision-maker make important decisions to identify challenges in reconstruction projects. Despite the clear difference in the environment and nature of reconstruction projects in Iraq, it was necessary to consult international studies. The most important factors regard the characteristics of customers, resources, economic and political conditions that Iraq suffers from, and managerial, organizational, and planning aspects. One of the main difficulties in reconstruction projects in Iraq is the weak coordination between the various competent authorities involved in the reconstruction process. In [7], an integrated information management system was presented through basic indicators (risk management, stakeholder management, and supply chain) by conducting a field study of critical success factors in reconstruction projects in Iraq.

Financial support is also an influential obstacle that causes the rationing of resources [8]. In [9], important criteria were tried to avoid delays and cost changes that occur in post-disaster reconstruction projects in Iraq, affecting the real duration and cost of the project versus the estimated time and cost. This study concluded that the most important factors are contractor failure, redesigns, continuous change orders, security, administrative corruption, and weather. In [10], it was shown that insufficient planning puts post-disaster reconstruction projects at risk. This study proposed an integrated approach to facilitate planning for procuring construction materials after a disaster. The collection of construction project sites using Differential Evolution (DE-K) models and the use of a matrix to prioritize a group of factors that affect the reliability of the route to reduce time can increase route reliability and reduce total resources.

In [11], the most important criteria in choosing a post-disaster project were quality, durability, accuracy, and customer satisfaction. This study also identified 21 sustainability criteria. According to [9], poor competition between contractors is the main challenge indicated by some local studies in Iraq. In [12], the interrelationship between different regions of expertise was investigated, showing that PDRP management is still in its initial stages. This study used descriptive exploratory research and qualitative data to determine cause-and-effect relationships and to identify factors that led to frequent scope changes, time and cost overruns, and low quality. The study concluded that stakeholder, risk, procurement, and communication management have a significant impact on project success. In [13], data on experience in post-disaster reconstruction projects were collected by International Non-Governmental Organizations (INGOs), showing that it is necessary to resolve some complex issues and to identify significant differences between problems and challenges at the different locations of reconstruction projects. This study proposed a method for building project strategies to avoid failure. The study in [14] aimed to establish resilience factors and a guiding framework to assist in their selection and strategic application that can contribute to improving the resilience of reconstruction projects. This study identified 24 resilience factors, divided into 5 criteria groups, in an attempt to develop a new conceptual framework to guide developers and practitioners in improving resilience in post-disaster reconstruction projects. In [15], damaged city areas demonstrated the need to strengthen their rebuilding capacity, requiring more experienced and efficient workers to supervise projects. This study attempted to analyze the problems associated with post-disaster housing reconstruction projects in India and provide potential solutions, concluding that institutional procedures, reconstruction techniques, project implementation, and stakeholder management contribute to effective implementation.

In [16], it was indicated that most of the cities affected by disasters were not suitable for resettlement due to various cultural factors. This study suggested resolving specific cultural issues that would accelerate resettlement to achieve successful results. In [17], it was proposed that education and guiding users in successful implementation can contribute to the solution of project problems. This study also proposed how industry practitioners can use the results to implement projects through the Lean technique.

There are different trends in calculating the real challenges in reconstruction projects without considering how to identify and address them or how to help or guide the decision-maker to know the extent of the challenges or evaluate them depending on the type of project. Discrimination between different reconstruction projects in terms of the availability of resources or continuous changes in time, cost, quality, and scope is of great importance. AHP has received increasing attention in the construction industry as a clear method of complex analysis and helps the decision-maker make sound decisions among the selected alternatives. Different studies have used AHP in many fields to support multidecision criteria and applications, as it is one of the most used processes for assessing priorities [18]. AHP is regarded a multi-criteria programming and decision-making technique in complex environments. It helps to consider many criteria, set priorities, and choose alternatives in various projects and studies [19]. AHP has been widely used in complex scenarios when human perceptions, judgments, and consequences have long-term implications [20]. In [21], 77 research papers on AHP applications were reviewed, showing that risk management and sustainable construction were the most common areas of AHP application in construction management. In [22], AHP helped stakeholders identify contractors using multiple criteria without relying on the lowest price. In [23], AHP was applied to evaluate the weight of risk factors, to develop risk model assessment in construction projects, and support decision-making. Based on the coupling of the evaluation index grading criteria, in [24], a comprehensive evaluation method was developed for roof stability grades by proposing a band-improved AHP weight assignment. In [25], AHP was used for the preliminary estimation of construction costs based on the minimum details of the project.

Previous studies that used AHP did not seek to derive mathematical relationships to facilitate the decision-maker. This study aims to facilitate decision-making in reconstruction projects, especially in the planning stage, to reach a final decision, identify challenges for projects, and evaluate them for different projects, especially since most decision-makers do not have sufficient information on how to use this analytical method or how to sort the final priorities. This study used data and results from [26] and AHP to develop mathematical equations to help the decision-maker determine the extent of the impact of the various types of challenges facing reconstruction projects in Iraq.

III. RESEARCH PROBLEMS AND OBJECTIVES

The main research problem is the continuing delays in rebuilding the liberated cities of Mosul, Anbar, and Tikrit. This issue results from the government's difficulty to make the necessary administrative arrangements to deal with these delays due to the conditions the construction environment is suffering from in Iraq. The most important ones were identified in [26]. These changes were within the determinants of cost, time, quality, and scope of work, without managing to know their proportions and determine the proportions of potential challenges. This study attempts to create a mathematical model with the help of AHP, which helps the decision-maker identify the proportions of challenges in various reconstruction projects and take advantage of the appropriate opportunity to address them. The main objective is to clarify the various changes in reconstruction projects and prepare a mathematical model that estimates the changes using several criteria. The final mathematical equations can help the decision-maker determine approximate changes in cost, time, quality, and scope of the project to initially prepare the required treatments, classify the projects based on the type of different changes, and determine the possibility of overcoming them. In addition, the developed models can help the Iraqi government prioritize the administrative challenges in reconstructing the liberated governorates.

IV. METHODOLOGY

After reviewing international and local literature on reconstruction projects and AHP applications, the high final factors leading to the fundamental challenges and opportunities in reconstruction projects in Iraq were used [26]. The former were based on the analysis of the interrelationship among different areas of expertise through cause-and-effect relationships that led to frequent changes in scope, time overruns, cost overruns, and low quality. AHP was used to determine the change priorities applying the Super Decisions software. Finally, mathematical equations were formulated.

A. Main Constraints and Related Factors

This study derived its data and aimed factors from [26], which highlighted the most important delay causes with the participation of the parties involved in the construction process and considered their impact on the scope, cost, time, and project quality. Iraq has all the entities, resources, and professional and scientific capacity required to implement reconstruction projects. However, the decision-maker can overcome them through a scientific decision based on research studies that support his decision. Figure 2 from [26] shows the main constraints and factors related to the changes and declares the hierarchy between them, while Table I represents the relative importance factors (RII) for the final results [26].

TABLE I. RELATIVE IMPORTANCE FACTORS (RII) [26]

No.	Scope Changes	Mean	RII%
1	Diversity and number of stakeholders	4.71	94
2	Lack of communication among projects	4.61	92
3	Difficulty in building consensus	4.30	86
4	Difficulty in identifying the needs of the affected population	4.02	80
No.	**Cost Overrun**	**Mean**	**RII%**
1	Unrealistic financial and cost estimate	4.74	95
2	Instability of local currency exchange rate	4.24	85
3	Political instability in the country	4.12	82
4	Difficulty in developing a cost plan	3.94	79
No.	**Time Overrun**	**Mean**	**RII%**
1	Unrealistic schedule	4.60	92
2	Legal and bureaucratic restrictions for tendering, acquisition, and construction	4.55	91
3	Difficulty in controlling activity duration	4.44	89
4	The urgency to meet essential needs	4.35	87
No.	**Low Quality**	**Mean**	**RII%**
1	Dependency on imported building materials and migrant/day labor/staffing from other countries	4.55	91
2	Dependency on local sellers	4.35	87
3	The relatively large size of the damaged area	3.82	76
4	Difficulty in controlling quality	3.63	73

B. Analytical Hierarchy Process (AHP)

AHP suggests that a problem can be hierarchically analyzed according to the required criteria so that it is easy to examine and compare the latter independently [26]. It allows the decision maker to evaluate the alternatives systematically and scientifically through pairwise comparisons for each of the selected criteria [27]. In general, the most important steps are:

- Define the problem, the criteria affecting it, and its suggested alternatives
- Make a binary comparison between the main criteria and the subcriteria by finding their weight relative to the goal
- Gather expert opinions by determining the relative importance, and choose the geometric mean for each comparison between two criteria
- Check the consistency ratio, which should be at most 10%
- Arrange the criteria using their weights

The following stages must be followed to complete the AHP [28].

1) Building the AHP Structure

In this stage, the objective and priorities are identified and an appropriate decision model is developed with concepts and terminology discussed and analyzed using AHP. The AHP model will decide which criteria will be used based on the statistical results. The main model consists of 3 levels (goal, clusters, nodes [29]), and the AHP structure consists of 4 clusters: scope change, time overrun, cost overrun, and low quality. Consequently, it sets up 4 nodes for all clusters, which contain the most important secondary criteria that obtained the most crucial index. These criteria are considered the most significant challenges faced and, in turn, are in line with the basic methodology objectivew [30], as shown in Figure 1.

2) Pairwise Comparison Matrix

After establishing the hierarchy, it is important to define the pairwise comparison, specify the comparison matrix, determine the priority vector (eigenvector), and analyze discrepancies. Criteria are evaluated in pairs to determine the relative weights between the subcriteria and the general goal. Evaluation begins with choosing the relative weight for all criteria sets [31]. Super Decisions software was used to obtain the priorities derived from the paired comparison matrices. The software calculates the eigenvector of priorities (the influence of each element on other elements) and the Consistency Ratio (CR) [32]. The Super Decisions software is structured as follows:

- It forms a hierarchical structure by analyzing the problem into clusters and nodes representing the axes and factors, respectively, as shown in Figure 1.
- After pairwise comparisons, the geometric mean of all answers is determined and entered into the program.
- The program creates the matrix, calculates the eigenvector of the priorities, and verifies the proportion of the consistency required for the success of the pairwise comparison, meaning that there is no contradiction in experts' opinions. The CR in all the pairwise comparison matrices was less than 0.1, which shows a reasonable constancy in the assessment matrix [33].

TABLE II. FUNDAMENTAL SCALE [27]

Intensity of importance	Definition
1	Equal importance
3	Moderate importance
5	Strong importance
7	Very strong importance
9	Extreme importance
2,4,6,8	Intermediate values

After completing these procedures, the following results are obtained:

- Pairwise comparisons between the four main axes and the main objective, as shown in Figure 2.
- Pairwise comparisons between the factors in these axes with the goal, as shown in Figures 3-6.
- Multiple criteria matrix, where the priorities that show the relationship between the factors were evaluated, calculated, and analyzed to determine their relative importance to the goal, as shown in Figure 7.
- Secondary criteria matrix, where the priorities show the relationship between the criteria for each factor separately.

These priorities were evaluated, calculated, and analyzed to determine their relative importance to the goal, as shown in Figure 8 for the first axis as a general model.

- The 4 main axes were the final priorities of all the criteria.

The responses of 23 experts, determined on a scale of 1 to 9 as shown in Table II to allow the measurement of the strength of the judgments [25], were examined.

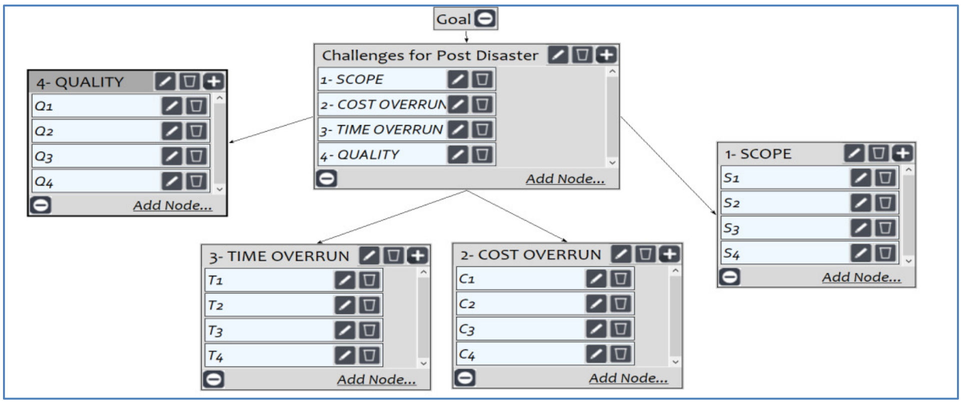

Fig. 1. Snapshot of the AHP model (main window).

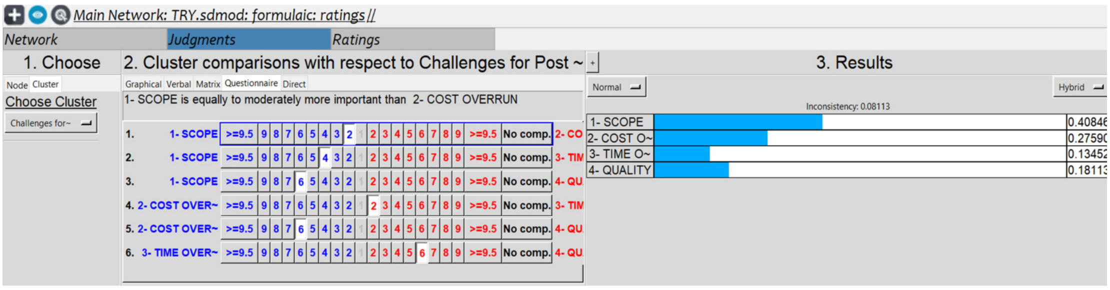

Fig. 2. Pairwise comparisons between the four main axes and resulting priorities.

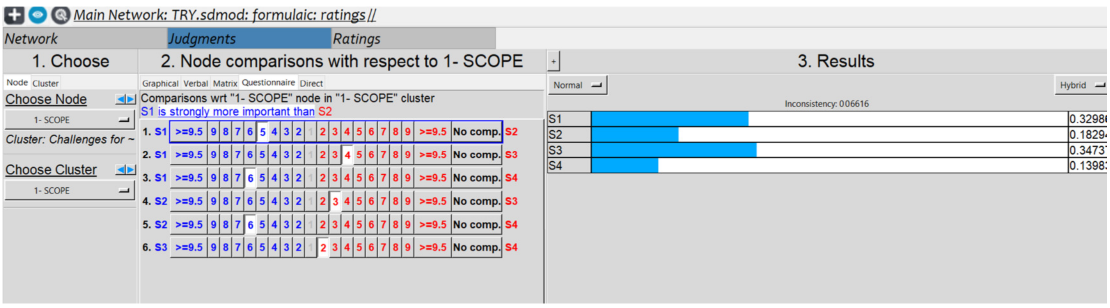

Fig. 3. Pairwise comparisons between the factors of change in scope and resulting priorities.

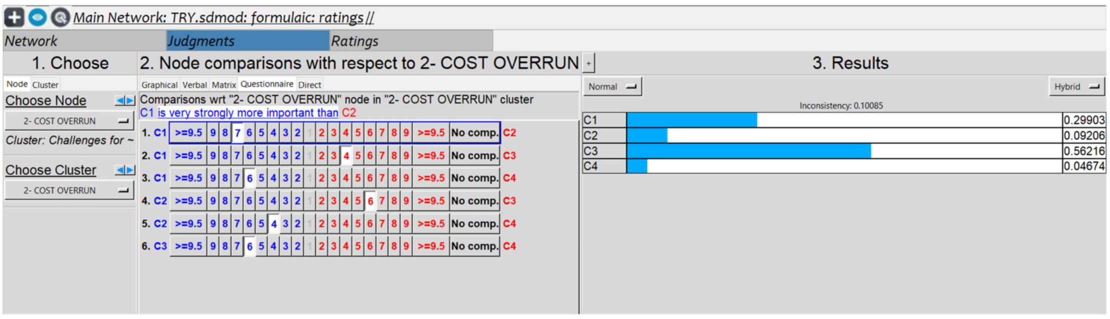

Fig. 4. Pairwise comparisons between the factors of cost overrun and resulting priorities.

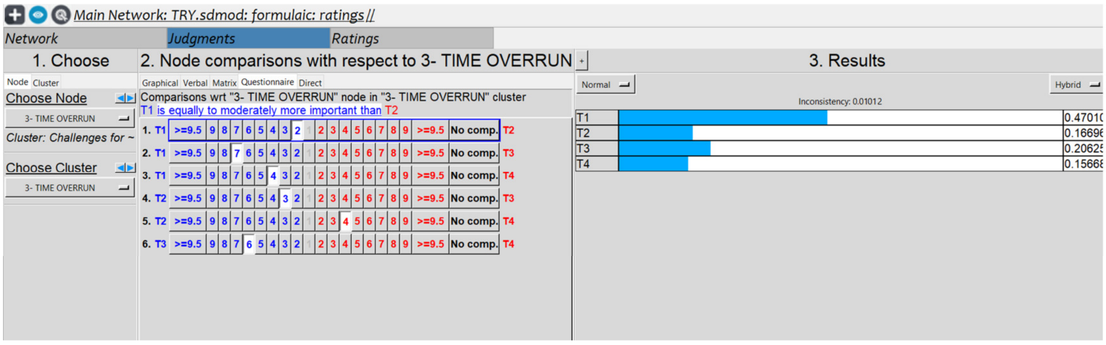

Fig. 5. Pairwise comparisons between the factors of time overrun and resulting priorities.

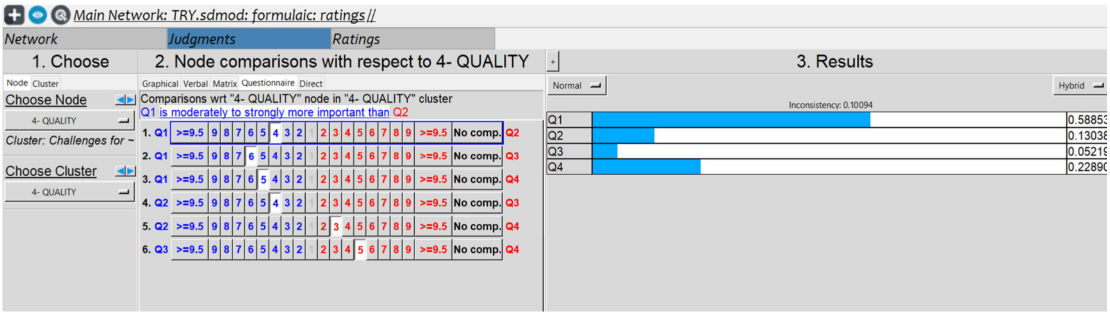

Fig. 6. Pairwise comparisons between the factors of low quality and resulting priorities.

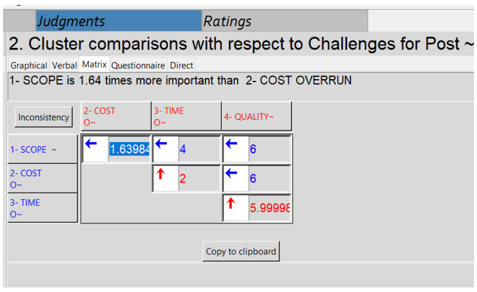

Fig. 7. Multiple criteria matrix.

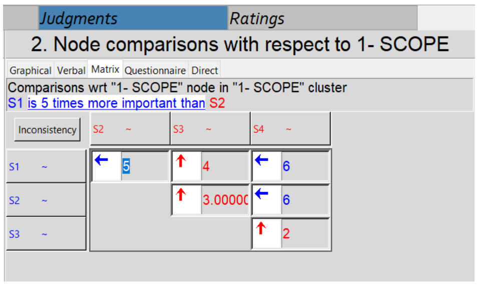

Fig. 8. Secondary criteria matrix.

V. RESULTS AND DISCUSSION

Table III shows the results obtained. When comparing the results for the priorities of management challenges faced by the Iraqi government for the post-disaster reconstruction of the liberated provinces, they depend first on the project's scope changes with an importance of 40.86%. This was followed by the cost overrun factor at 27.60% and the low quality of the project was 18.11%. Finally, the time-overrun factor remained the last in impact, as its importance was 13.45%. The difficulty in building consensus was the main reason that affected the scope changes at 34.7%, followed by diversity and several stakeholders at 33%, lack of communication between projects at 18.3%, and finally the difficulty in identifying the needs of the affected population at 14%.

The results for the cost overrun priorities depend first on the political instability in the country at 56.2%, and then on unrealistic financial and cost estimate reasons at 29%. The instability of the local currency exchange rate was 9.2%, and the difficulty in developing a cost plan reason remained the last at 4.7%. Importing building materials and using migrant workers from other countries without improving the skills of local workers is the main reason for the low quality at 58.9%, followed by the difficulty in controlling quality at 22.9%, the dependence on local sellers at 13%, and the relatively large size of the damaged area at 5.2%. Time overruns were the last major challenge affecting the management of post-disaster reconstruction of Iraqi provinces. This depends mainly on the unrealistic schedule (40%), followed by the difficulty of controlling activity duration (20.6%). However, the legal and bureaucratic restrictions for tendering, acquisition, and construction reached 16.7%. Finally, the urgency to meet essential needs has the least impact at 15.7%.

The AHP results were used to formulate mathematical equations that can help stakeholders or decision-makers make decisions about the value of different variables in the project. Equations (1-5) were presented to some experts who had previously been elected to conduct AHP. The experts showed how easy it is to use these equations, applied them to some projects, and confirmed their credibility.

TABLE III. RANKING OF THE MODEL ELEMENTS

Cluster	Normalized by Cluster	Nodes	Normalized by Nodes	Limiting
Scope	0.408458	S1= Diversity and number of stakeholders	0.32987	0.118048
		S2= lack of communication among projects	0.18294	0.066234
		S3= Difficulty to build consensus	0.34737	0.342449
		S4= Difficulty in identifying the needs of the affected population	0.13983	0.035859
Cost	0.275898	C1= Unrealistic financial and cost estimate	0.29904	0.024636
		C2= Instability of local currency exchange rate	0.09206	0.009942
		C3= Political instability in the country	0.56216	0.056837
		C4= Difficulty in developing a cost plan	0.04674	0.013616
Time	0.134516	T1= Unrealistic schedule	0.47011	0.131564
		T2= Legal and bureaucratic restriction for tendering, acquisition, and construction	0.16697	0.058752
		T3= Difficulty to control activity duration	0.20625	0.019725
		T4= Urgency to meet essential needs	0.15668	0.039829
Quality	0.181129	Q1= Dependency on imported building material and migrant/day labor/staffing from other countries	0.58853	0.042536
		Q2= Dependency on local sellers	0.13038	0.021171
		Q3= Relatively large size of the damaged area	0.05219	0.011863
		Q4= Difficulty to control quality	0.2289	0.00694

VI. MATHEMATICAL MODEL

After obtaining the priorities for the main constraints and their subfactors, they were arranged in a mathematical function to facilitate the decision-makers' ability to obtain the percentage of change occurring in the four variables for any project. The mathematical relationship was formed based on the results shown in Table III as follows:

$$SC = 0.3299 S1 + 0.1829 S2 + 0.3474\, S3 + 0.1398\, S4 \quad (1)$$

where SC is the scope change, $S1$ is the diversity and number of stakeholders, $S2$ is the lack of communication between projects, $S3$ is the difficulty in building consensus, and $S4$ is the difficulty in identifying the needs.

$$CC = 0.299\, C1 + 0.0921\, C2 + 0.5622\, C3 + 0.0467\, C4 \quad (2)$$

where $C1$ is the unrealistic financial and cost estimate, $C2$ is the instability of the local currency exchange rate, $C3$ is the political instability in the country, and $C4$ is the difficulty in developing a cost plan.

$$TC = 0.4701\, T1 + 0.1670\, T2 + 0.2063 T3 + 0.1567\, T4 \quad (3)$$

where TC is the time change, $T1$ is the unrealistic schedule, $T2$ is the legal and bureaucratic restrictions, $T3$ is the difficulty in controlling activity duration, and $T4$ is the urgency to meet essential needs.

$$QC = 0.5885\, Q1 + 0.1304\, Q2 + 0.0522\, Q3 + 0.2289\, Q4 \quad (4)$$

where QC is the quality change, $Q1$ is the dependency on imported building materials and migrant/day labor/staffing from other countries, $Q2$ is the dependency on local sellers, $Q3$ is the large size of the damaged area, and $Q4$ is the difficulty in controlling quality. Finally,

$$RC = 0.4085 SC + 0.2759 CC + 0.1345 TC + 0.1811 QC \quad (5)$$

The total challenges of the reconstruction project are calculated through (5) after calculating the values of the four changes (time, cost, quality, and scope) to arrive at an approximate value of the number of challenges of the reconstruction project. Mathematical equations make it easier for the stakeholder or decision-maker to decide the value of different variables in the project. Equations (1-5) were presented to some experts who had previously been elected to carry out the AHP. The experts showed the ease of using these equations, which were initially applied to some projects and confirmed the credibility of the results. The final value can help the decision maker evaluate the challenges of different reconstruction projects. It can also help to compare various projects and choose the appropriate one that achieves the least challenges required to work on it within the specified strategies.

VII. CONCLUSIONS

Using AHP and deducing the main changes in assessing the challenges, the decision maker can make a decisive decision on the change types of and potential challenges in reconstruction projects. They and can additionally choose the appropriate project within the available resources under the current strategic policy. This study illustrates more accurate results than previous studies because the reconstruction projects in Iraq did not rely on scientific methods to evaluate the proportion of challenges or the ability to make a qualitative comparison to choose the appropriate project within the available resources under the current strategic policy. The results showed that the priority of the changes witnessed by reconstruction projects in Iraq are the challenges of changes in the scope of the project. These challenges play a decisive role in reconstruction projects, followed by changes in cost due to poor realistic financial estimates and the reasons for the instability of the local currency exchange rate. This occurs owing to political and perhaps economic reasons emerging from the conflict in adopting sound economic thought that is applied globally. Regarding the scope of quality, its impact appears clear as an important challenge that must be addressed, especially after controlling imported building materials and migrant labor from other countries without oversight, since the size of the affected areas in Iraq is very large and requires many resources. The time frame remains the last variable that has not received the necessary attention in all Iraqi projects, particularly after the difficulty in controlling project implementation durations for many reasons, perhaps the most prominent being the legal and bureaucratic restrictions, with suspicions of administrative corruption, lack of professional experience, and weak construction oversight work. This leads to many changes, causing delays in reconstruction projects.

VIII. RECOMMENDATIONS

AHP was performed using Super Decisions software to determine the necessary priorities for all challenge factors in post-disaster projects and identify alternatives among the main constraints and project changes. Its direct impact on final decision-making plays a role in estimating the percentage of changes in cost, time, quality, and scope in reconstruction projects in Iraq due to the continuing delay in the return of displaced Iraqis. The study recommended the need to address these changes through realistic administrative and methodological strategies, to consider changes and available opportunities, like encouraging national industry, relying on and training local skills, resolving political reality, and providing services. The main recommendations include finding an appropriate method to secure companies operating in Iraq, adopting various computer programs from the design to the project monitoring, adapting cost and time analysis during all project stages, adhering to technical specifications and assessing quality. They also entail encouraging training workers to improve their skills, set clear time and cost schedules for evaluation and assessment, define the tasks and duties of the stockholders concerned with the reconstruction projects, and audit and control all various professional and managerial levels.

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REFERENCES

[1] A. M. H. Al-Samarrai, "Post-War Reconstruction, Study of the Impact of Non-Urban Dimensions on Reconstruction," MSc Thesis, University of Cairo, Egypt, 2012.

[2] R. E. Looney, "Reconstruction and Peacebuilding Under Extreme Adversity: The Problem of Pervasive Corruption in Iraq," *International Peacekeeping*, vol. 15, no. 3, pp. 424–440, Jun. 2008, https://doi.org/10.1080/13533310802059032.

[3] H. B. Bakr and A. M. Al-Suwaidani, "Policies for Reconstructing Cities After Conflicts and Wars," *Journal of Al-Azhar University Engineering Sector*, vol. 12, no. 44, pp. 1183–1197, Jul. 2017, https://doi.org/10.21608/auej.2017.19196.

[4] D. O'Driscoll and D. van Zoonen, "Governing Nineveh After the Islamic State: A Solution for All Components," *MERI Policy Papers*, vol. 3, no. 2, Oct. 2016, [Online]. Available: https://research.manchester.ac.uk/en/publications/governing-nineveh-after-the-islamic-state-a-solution-for-all-comp.

[5] N. Gcabashe, "Feminist advocacy in the agenda for implementing Post-Conflict Reconstruction and Development initiatives in Monrovia, Liberia," *Agenda*, vol. 36, no. 3, pp. 90–100, Jul. 2022, https://doi.org/10.1080/10130950.2022.2120408.

[6] K. F. Al-Basri, M. Al-Sebahi, "The Political Economy of Iraq: Will Oil Burn Out Democracy?," Italian Institute for Political Studies (ISPI), Analysis 198, Sep. 2013.

[7] S. T. Al-Qaicy and H. K. Breesam, "An Analytical Study to Evaluate Iraqi Construction Sector Readiness to Manage Post-Disaster Reconstruction," *Journal of Physics: Conference Series*, vol. 1804, no. 1, Oct. 2021, Art. no. 012014, https://doi.org/10.1088/1742-6596/1804/1/012014.

[8] A. Sulaiman, S. Hajismail, and B. Caliskan, "Optimizing Post-Conflict Building Reconstruction in Iraq: A Multi- Criteria Decision-Making Approach in Public Projects," presented at the International Conference on Advances and Innovations in Engineering, Oct. 2023.

[9] R. A. Waheeb and B. S. Andersen, "Causes of Problems in Post-Disaster Emergency Re-Construction Projects—Iraq as a Case Study," *Public Works Management & Policy*, vol. 27, no. 1, pp. 61–97, Jan. 2022, https://doi.org/10.1177/1087724X21990034.

[10] Z. Gharib, M. Yazdani, A. Bozorgi-Amiri, R. Tavakkoli-Moghaddam, and M. J. Taghipourian, "Developing an integrated model for planning the delivery of construction materials to post-disaster reconstruction projects," *Journal of Computational Design and Engineering*, vol. 9, no. 3, pp. 1135–1156, Jun. 2022, https://doi.org/10.1093/jcde/qwac042.

[11] Z. Mohammadnazari, M. Mousapour Mamoudan, M. Alipour-Vaezi, A. Aghsami, F. Jolai, and M. Yazdani, "Prioritizing Post-Disaster Reconstruction Projects Using an Integrated Multi-Criteria Decision-Making Approach: A Case Study," *Buildings*, vol. 12, no. 2, Feb. 2022, Art. no. 136, https://doi.org/10.3390/buildings12020136.

[12] O. Alsaadi and E. Acar, "Challenges of Post-Disaster Reconstruction Projects: An Empirical Investigation According to Project Management Knowledge Areas," *American Journal of Management*, vol. 21, no. 4, Sep. 2021, [Online]. Available: https://articlearchives.co/index.php/AJM/article/view/1567.

[13] D. Ismail, T. A. Majid, and R. Roosli, "Analysis of Variance of the Effects of a Project's Location on Key Issues and Challenges in Post-Disaster Reconstruction Projects," *Economies*, vol. 5, no. 4, Dec. 2017, Art. no. 46, https://doi.org/10.3390/economies5040046.

[14] S. H. Charles, A. Y. Chang-Richards, and T. W. Yiu, "A systematic review of factors affecting post-disaster reconstruction projects resilience," *International Journal of Disaster Resilience in the Built Environment*, vol. 13, no. 1, pp. 113–132, Jan. 2021, https://doi.org/10.1108/IJDRBE-10-2020-0109.

[15] R. Sanchaniya, N. Somrajan, and I. Geipele, "Problems and Possible Solutions of Post-Disaster Housing Reconstruction Projects in India," *Baltic Journal of Real Estate Economics and Construction Management*, vol. 11, no. 1, pp. 37–47, Jan. 2023, https://doi.org/10.2478/bjreecm-2023-0004.

[16] S. D. Siriwardhana, U. Kulatunga, A. Samaraweera, and V. G. Shanika, "Cultural issues of community resettlement in Post-Disaster Reconstruction projects in Sri Lanka," *International Journal of Disaster Risk Reduction*, vol. 53, Feb. 2021, Art. no. 102017, https://doi.org/10.1016/j.ijdrr.2020.102017.

[17] B. A. I. Eranga, K. Ranadew, A. P. Rathnasinghe, and P. A. D. Rajini, "Lean iceberg model for post disaster reconstruction projects," in *Proceedings of The 10th World Construction Symposium*, 2022, pp. 625–636, https://doi.org/10.31705/WCS.2022.50.

[18] Y. X. Liao, E. R. Loures, O. C. Junior, and H. Panetto, "A Novel Approach for Ontological Representation of Analytic Hierarchy Process," *Advanced Materials Research*, vol. 988, pp. 675–682, 2014, https://doi.org/10.4028/www.scientific.net/AMR.988.675.

[19] T. L. Saaty, "Decision making with the analytic hierarchy process," *International Journal of Services Sciences*, vol. 1, no. 1, pp. 83–98, Jan. 2008, https://doi.org/10.1504/IJSSCI.2008.017590.

[20] T. L. Saaty and L. G. Vargas, "Measuring Dependence Between Activities: Input–Output Application to the Sudan," in *Models, Methods, Concepts & Applications of the Analytic Hierarchy Process*, T. L. Saaty and L. G. Vargas, Eds. Boston, MA, USA: Springer US, 2012, pp. 107–113.

[21] A. Darko, A. P. C. Chan, E. E. Ameyaw, E. K. Owusu, E. Pärn, and D. J. Edwards, "Review of application of analytic hierarchy process (AHP) in construction," *International Journal of Construction Management*, vol.

19, no. 5, pp. 436–452, Sep. 2019, https://doi.org/10.1080/15623599.2018.1452098.

[22] S. Belekar, S. Jamadar, J. Manjarekar, R. Singh, and A. Kazi, "Application of Analytical Hierarchy Process (AHP) in Construction Works," *International Journal of Engineering Research*, vol. 9, no. 3, 2021.

[23] H. A. E. Khalek, R. F. Aziz, and H. Kamel, "International Construction Projects' Risk Cost Estimation: Fuzzy Logic and AHP in Application (Real Case Studies)," *Journal of Buildings and Sustainability*, vol. 2, no. 2, 2017.

[24] Q. Chen, B. Zou, Z. Tao, M. He, and B. Hu, "Construction and Application of an Intelligent Roof Stability Evaluation System for the Roof-Cutting Non-Pillar Mining Method," *Sustainability*, vol. 15, no. 3, Jan. 2023, Art. no. 2670, https://doi.org/10.3390/su15032670.

[25] A. M. R. Mahjoob, M. R. Wali, and H. A. Atyah, "Exploring the Factors Affecting the Elemental Cost Estimation with Relationship Analysis Using AHP," *Journal of Engineering*, vol. 22, no. 8, pp. 1–13, Aug. 2016, https://doi.org/10.31026/j.eng.2016.08.13.

[26] M. R. Altaie, M. M. Dishar, and I. F. Muhsin, "Fundamental Challenges and Management Opportunities in Post Disaster Reconstruction Project," *Civil Engineering Journal*, vol. 9, no. 9, pp. 2161–2174, Sep. 2023, https://doi.org/10.28991/CEJ-2023-09-09-05.

[27] O. Nesterenko, "Ontology and Analytic Hierarchy Process in the Information and Analytical Systems," in *Lecture Notes in Computational Intelligence and Decision Making*, Zalizniy Port, Ukraine, 2021, pp. 302–314, https://doi.org/10.1007/978-3-030-54215-3_19.

[28] M. L. Dvoretskyi, T. O. Savchuk, M. T. Fisun, and S. V. Dvoretska, "Using the Analytic Hierarchy Process with Fuzzy Logic Elements to Optimize the Database Structure," *Radio Electronics, Computer Science, Control*, no. 2, pp. 101–101, Jun. 2022, https://doi.org/10.15588/1607-3274-2022-2-10.

[29] O. M. Olabanji and K. Mpofu, "Appraisal of conceptual designs: Coalescing fuzzy analytic hierarchy process (F-AHP) and fuzzy grey relational analysis (F-GRA)," *Results in Engineering*, vol. 9, Mar. 2021, Art. no. 100194, https://doi.org/10.1016/j.rineng.2020.100194.

[30] F. T. Benaissa and B. Khalfallah, "Industrial Activity Land Suitability Assessment Using Delphi and AHP to Control Land Consumption¨: The Case Study of Bordj Bouarreridj, Algeria," *Engineering, Technology & Applied Science Research*, vol. 11, no. 5, pp. 7738–7744, Oct. 2021, https://doi.org/10.48084/etasr.4362.

[31] R. A. Deshmukh and R. Hiremath, "Decision Making with Analytical Hierarchy Process for Selection of Furnace for Foundry Industry," *International Journal of Mechanical and Production Engineering Research and Development*, vol. 8, no. 4, pp. 189–196, 2018, https://doi.org/10.24247/ijmperdaug201821.

[32] R. Alshehri, N. Aljojo, A. Alshutayri, A. Alrashedi, A. Alghoson, and A. Zainol, "The Efficacy of the Strategy Planning Process Criteria based on the Fuzzy Analytical Hierarchy Process," *Engineering, Technology & Applied Science Research*, vol. 13, no. 4, pp. 11235–11241, Aug. 2023, https://doi.org/10.48084/etasr.6034.

[33] T. N. Le, H. M. V. Nguyen, T. A. Nguyen, T. T. Phung, and B. D. Phan, "Optimization of Load Ranking and Load Shedding in a Power System Using the Improved AHP Algorithm," *Engineering, Technology & Applied Science Research*, vol. 12, no. 3, pp. 8512–8519, Jun. 2022, https://doi.org/10.48084/etasr.4862.