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Using of the Two Tools Analytic Hierarchy Process (AHP) and Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) in Multi-Criteria Decision Making

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Abstract:

This study objective investigates to shed light on determine the priority through the use of modern styles in multi criteria decision making (MCDM), In order to reach a scientific and accurate decision based on modern technologies, The research sample is represented by project management Department in the Judicial Planning office dependent to the Ministry of Justice for the purpose of studying and evaluating projects for building judicial complexes that the institution wont to implement, selecting the best and most important for implementation, and arranging the other projects based on five criteria:(Community need, financial return, contractual position, security situation, executive position), For this purpose, the integration of two decision support methods was applied. The first method is the Analytical Hierarchy Technique (AHP), the second method is the technique for order performance by similarity to ideal solution (TOPSIS), The AHP method was used to determine the weights for the main criteria, and then those criteria were used as inputs to the TOPSIS method. The results of the study is that the two proposed methods were able to determine the priority of completing of projects for building judicial complexes and arrange them according to priority.

Keywords: Decision Making, Pairwise Comparisons, Normalized Matrix, Multi Criteria Decision Making (MCDM), Analytic Hierarchy Process (AHP), Technique for Order Performance by Similarity to Ideal Solution (TOPSIS).

1 .Introduction:

The development of technology in the world in many fields, especially in the use of operations research methods and the process of analyzing ideal decisions. The process of ideal diagnosis in public institutions suffers from an inability to choose the appropriate and ideal decision. Therefore, the process of multi-criteria decision analysis is considered the mainstay of the decision-making process regarding the issue or problem. This is done by identifying a set of criteria of varying importance and evaluating them by finding the best alternative from a

group of alternatives related to the decision problem. The study seeks to evaluate and determine the optimal project for building judicial complexes using quantitative and qualitative methods at the same time, represented by decision analysis techniques Multi-criteria Among the quantitative methods for decisions are the Analytic Hierarchy Method (AHP) and the Technique of Ranking Performance by Similarity to the Ideal Solution (TOPSIS), The use of operations research methods has generally expanded in the field of decision-making, as it helps us take all criteria into account, which may be contradictory. Therefore, the construction of judicial complexes in Iraq will be reclassified according to their importance, priority, and priority for implementation.

One of the basic tasks of the operations research specialty is to provide managers with a strong quantitative basis for making better decisions, as well as enhancing their ability to develop long-term plans and find the best solutions to the daily problems they face. The need for this specialization has increased, especially after the expansion of the size of institutions and the increase in complexity. The environment, as well as the rapid development in information technology, all of these things indicate that the use of traditional methods in managing organizations is not possible, so there are many quantitative methods and methods for making decisions. Decision-making involves selecting the best option among several possible alternatives. In most cases, the number of criteria used to evaluate these alternatives is extensive. These criteria often conflict, making it challenging to satisfy all of them simultaneously, and for this purpose, many (MCDM) methods have been proposed, including:the hierarchical analysis (AHP) method and Technique for Ordering Preference by Similarity to Ideal Solution) (TOPSIS). No decision can be made without reference to the decision-making process. Decision-making, as a complex psychological process, is a problem-solving procedure that aims to consider various aspects and determine the ideal outcome. Today, complex decision-making problems can be solved using mathematical equations, various statistical, mathematical, and economic theories, and computing devices that can automatically calculate and estimate solutions to decision problems.

We given the importance of (MCDM) several researchers have conducted different studies about techniques (AHP) and (TOPSIS), including:

In 2020 published research Paper by R. M. Zulqarnain, et all(Zulqarnain *et al.*, 2020) used the TOPSIS method for the selection of a car by using hypothetical data and examined that the civic is the best automotive car according to given parameters.

In 2021 published research Paper by Alaa A. N, and Fadhiela S.D,(N and S, 2021) aimed to provide a vision regarding the latest standards followed in choosing the best supplier Demonstrate how to apply the integration model between the Quality function deployment and fuzzy analytic hierarchy process (FAHP - QFD),and this research was applied in the "Arab Company for Antibiotics Industries (ACAI), the researcheres suggested several recommendations including: the necessity of adopting a multi-criteria scientific method in the process of selecting the supplier.

In 2022 by Caesarani G. and Dewi N.(Putri and Nusraningrum, 2022) published research Paper The aim of study was to identify the most important qualification criteria for selecting subcontractors in the construction supply chain, The criterion calculation was analyzed using the Analytical Hierarchy Process (AHP) to determine the weights of the criteria for selecting subcontractors and (TOPSIS) method was used to evaluate different subcontractors based on 22 sub-criteria indicators.

In 2023 published research Paper by Hamed Taherdoost(Taherdoost and Madanchian, 2023), and Mitra Madanchian aimed to discuss the important concepts, applications, and types of MCDM methods, and how MCDMs are used in different fields as based one of the most common decision-making methods.

In 2023 published research Paper by Mitra Madanchian and Hamed Taherdoost (Madanchian and Taherdoost, 2023)aimed to discuss the contains step-by-step instructions for using the TOPSIS method, including determination of criteria weights, creation of a decision matrix, and calculation of TOPSIS values because a common technique for multi-criteria decision making (MCDM) is the TOPSIS technique (Technique for Order of Preference by Similar to Ideal Solution), which is commonly used in various application areas. The basis of the TOPSIS method is to find ideal and anti-ideal solutions, which are then used to determine the distance between the alternatives and the ideal solution.

2 .Material and Method

We will discuss the decision-making process in general and (MCDM) techniques in detail, which includes several criteria that were achieved in the data of the study sample and in the work policy of the Judicial Planning Office of the Ministry of Justice. We will also discuss how to apply the two techniques and choose the most important project by ccomplementarity the two methods of study.

2.1 Decision Concept

It is the result of a solution that was chosen after studying several available alternatives about a specific situation and , the verb “Decide” means arriving at a decision or conclusion regarding what one expects to do in the future later. (Gupta, P.K Hira, 2012)

2.1.2 Decision-Making Process Concept

The process of carefully selecting one alternative out of two or more available alternatives. In other words, it is the process of comparing different alternatives and choosing the best alternative to achieve a specific goal or set of goals.{Formatting Citation}

2.1.3 Differences Between Decision Taking and the Decision Making

There is an overlap in understanding between (decision-taking) and (decision-making) and researchers expect that the two pronunciation lead to one concept, but in fact each of them has special details, so the decision-taking process is considered one of the steps of decision-making, and decision-making is a dynamic process that contains Many activities in their different stages, starting from the planning and design stage and ending with the decision-making stage. Most researchers agreed to call this overall process decision-making.(Bin Al-Turki, 2009)

2.1.4 Types of Decision Situations

There are four types of environments under which decisions can be made, These differ according to degree of certainty. (Gupta, P.K Hira, 2012)

1. Decision making under condition of certainty.
2. Decision making under conditions of uncertainty.
3. Decision making under conditions of risk.
4. Decision under conflict

2.1.5 Steps of decision-making process

The scientific method should be adopted in formulating and making decisions, and in each of these steps it requires the participation of decision makers, stakeholders and experts, and the totality of opinions is taken into account and included in all stages of the decision-making process ,In order to reach distinct results with logic and objectivity and make the most appropriate choice. For all possible possibilities, the steps are: (Abood and Alashari, 2022)

- Defining the problem.
- Define criteria.
- Collecting the necessary data and information.
- Define alternatives
- Analyzing and evaluating alternatives.
- Tracking the implementation of the decision and evaluate the results.

2.1.6 Using Operation Research in Decision Making

The most of the problems of the current century are complex, and have diverse standards and multiple different goals, most of the problems related to the decision-making process, the increasing interest in this science has led to the emergence of a large number of methods that attempt to solve its problems as (MCDM) method.(Izadikhah, 2014)

2.1.7 Multi Criteria Decision Making (MCDM)

The method can be used to solve everyday problems in human life. However, if the problem is based on more important issues, the decision in these cases must be based on proper construction and explicit evaluation of all criteria using appropriate software and tools. In practice, MCDM is used to handle the construction, decision and planning steps when the domain has different criteria to achieve the best solution according to the decision maker's preferences. (Shahsavarani, Azad and Abadi, 2015)

2.2Analytical Hierarchy Process

Saaty (1980) developed a powerful and useful tool for managing the qualitative and quantitative multi-criteria elements involved in decision-making behavior.The model is called the Analytic Hierarchy Process (AHP) and is based on a hierarchical structure. (Saaty, 1980)

The process considers a range of options in the decision and can apply sensitivity analysis to subsequent criteria and benchmarks. In addition, it facilitates judgment and calculation through paired comparisons. Moreover, it emphasizes compatibility and incompatibility decisions, which is a bonus of multi-criteria decision making .(Lee, 2007)

The (AHP) is one of the most comprehensive systems for making decisions based on multiple criteria, as the method allows to formulate questions hierarchically and combine quantitative and qualitative criteria. The first step is to create a hierarchy of questions. In the second step, a nominal value is assigned to each level of the hierarchy and a matrix is created for pairwise comparison of judgments.(Taherdoost and Madanchian, 2023)

2.2.1 Steps The Hierarchical Analysis Process.

a. Step 1: Building the problem hierarchical.

The Figure (1) explain general hierarchy for any problem

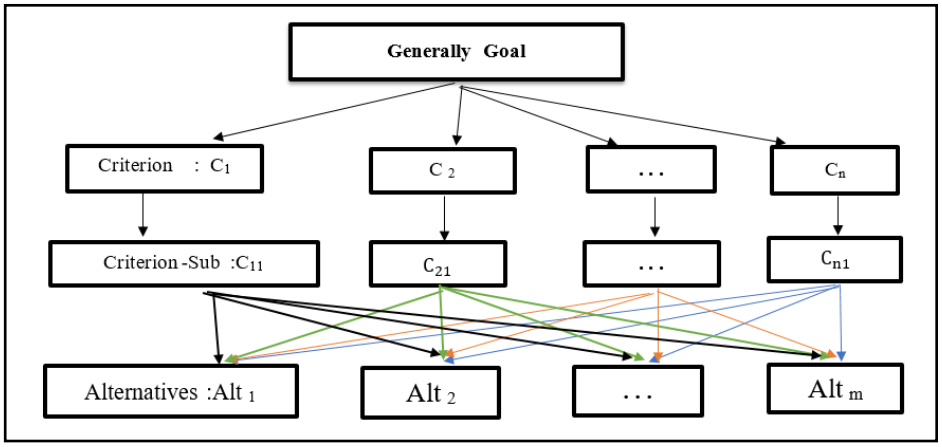

Figure (1) :"General hierarchy" Rai, N. B. *Strategic Decision Making : Applying the Analytic Hierarchy Process (Decision Engineering)*. (UK, 2022) (Rai, 2022).

b. Step 2: Pairwise Comparisons

The individual judgments of the experts are collected into one judgment that represents the entire group through calculating the geometric mean.

Table 1: Pair-wise comparison scale for (AHP) preferences (Saaty, 2004)

Intensity of importance	Definition
1	Equal importance
3	Moderate importance of one over another
5	Essential or strong importance
7	Very strong importance
9	Extreme importance
2,4,6,8	Intermediate values

c. Step 3: Deriving Priorities

The method of average normalized values was based, which is considered one of the easiest and oldest methods of calculating priorities, It can be explained in three steps:(Ishizaka and Lusti, 2006)

1. Sum the values in each column of the pairwise comparison matrix.

$$\begin{matrix} a_{11} + & a_{12} + & \cdots + & a_{1n} = \sum_{i=1}^{n} a_{1i} \\ a_{21} + & a_{22} + & \cdots + & a_{2n} = \sum_{i=1}^{n} a_{2i} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} + & a_{n2} + & \cdots + & a_{nn} = \sum_{i=1}^{n} a_{ij} \end{matrix} \quad (1)$$

2. Divide each column elements of the pairwise comparison matrix by its column sum, and the resulting matrix represents the normalization matrix.

$$\hat{a_{ij}} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} \qquad \textbf{(2)}$$

3. Calculate the average of the elements for each row of the normalization comparison matrix, and this average represents the relative priority of the elements that were compared among themselves.

$$w_i = \frac{\sum_{j=1}^{n} \hat{a_{ij}}}{n}, \quad i = 1,2,\ldots,n \qquad \textbf{(3)}$$

d. Step 4: Consistency (non-contradiction)

In general, experts require a certain limit of consistency that must be respected. By exceeding this limit, inconsistency between the provisions of the matrix becomes clear. As a result, these provisions must be reviewed and modified in order to obtain a stable matrix. Among the most important and most widespread of these methods is the method used by the founder of the hierarchical analtic hierarchy process (Franek and Kresta, 2014)

To test consistency, (Saaty) suggested calculating an indicator called the (consistency ratio). This indicator shows whether or not the matrix is consistent. The consistency rate can be estimated according to the following steps:(Almobarqaa and Alashari, 2018)

1- Calculating the maximum eigenvalue of the pairwise comparison matrix (λ_{max})

To find(λ_{max}) the following steps are followed:

a. $$w_1 \begin{bmatrix} 1 \\ 1/a_{21} \\ \vdots \\ 1/a_{n1} \end{bmatrix} + w_2 \begin{bmatrix} a_{12} \\ 1 \\ \vdots \\ 1/a_{n2} \end{bmatrix} + \cdots + w_n \begin{bmatrix} a_{1n} \\ a_{2n} \\ \vdots \\ 1 \end{bmatrix} = \begin{bmatrix} \hat{w_1} \\ \hat{w_2} \\ \vdots \\ \hat{w_n} \end{bmatrix} \qquad \textbf{(4)}$$

b. $\frac{\hat{w_1}}{w_1} . \frac{\hat{w_2}}{w_2} . \ldots \frac{\hat{w_n}}{w_n}$ (**5**)

c. $$\boldsymbol{\lambda_{max} = \frac{\sum_{i=1}^{n} \frac{\hat{w_i}}{w_i}}{n}} \qquad \textbf{(6)}$$

2- The consistency index (CI) is calculated according to the following equation(Franek and Kresta, 2014)

$$\boldsymbol{CI = \frac{\lambda_{max} - n}{n-1}} \quad (7)$$

λ_{max}*:* maximum eigenvalue

n: number of criteria

If the result of the above equation is equal to zero, i.e. (CI = 0), this indicates that the matrix is completely consistent, and the possibility of consistency error increases when dealing with a large number of binary comparisons, so (Saaty) proposed another measure, which is the (consistency ratio) (CR).(Franek and Kresta, 2014)

3- Calculate the consistency rate(CR)

The consistency rate of the judgments is calculated according to the following formula:(Franek and Kresta, 2014)

$$CR = \frac{CI}{RI} \dots \quad (\mathbf{8})$$

CI: Consistency Index

RI: Random Consistency index

The table 2 shows the values of the random consistency index

Table 2: Values of the random Consistency Index(Xu, 2000)

N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0	0	0.52	0.89	1.12	1.26	1.36	1.41	1.46	1.49	1.52	1.54	1.56	1.58	1.59

4- Comparison between the calculated consistency rate and the calculated rate

(CR) is used to measure relative importance. If the consistency ratio is equal to (10%) or less, this leads to an acceptable level of consistency in personal estimates. However, if the consistency ratio exceeds (10%), this is an indicator that leads to Despite the lack of consistency, decision makers must re-evaluate their estimates in the binary comparison matrix until the percentage eventually reaches (10%) or less.(Saaty, 1987).

e. Step 5: Merage the priorities of criteria and the priorities of alternatives (decisions)

The general priority (preference) for each (alternative) will be obtained by summing (the product of multiplying the priority of the criteria by the priority of its alternative decisions), and then calculating the general priority to choose each alternative separately in order to obtain the final decision, and by arranging the priority values, it is obtained on the final arrangement of the hierarchical analysis of decision alternatives. (‘david-r.-anderson-dennis-j.-sweeney-thomas-a.-williams-jeffrey-d.-camm-james-james-j.-cochran-quantitative-methods-for-business-cengage-learning-2012’, no date)

2.3 The technique ordering preference by Similarity to Ideal Solution (TOPSIS) method

Hwang and Yoon developed this technique for solving MCDM called TOPSIS method (C. Hawng, 1981). As one of the other ways of (MCDM) Which depends on the weights resulting from the pairwise comparison matrix which using the analytic hierarchy process method(Roszkowska, 2011). To handle MCDM problems with numerous alternatives. The core concept of this technique proposed is that the selected alternative should have the smallest geometric distance to the positive ideal solution (PIS) and the largest geometric distance to the negative ideal solution (NIS).(Y. Bi, D. Lai, 2010)

The References also say that the TOPSIS technique is an effective tool that is applied to obtain solutions to MCDM problems.(Lakshmi Tulasi, 2017)

We can say combining the TOPSIS and AHP methods makes it possible to obtain the greatest decisions(Ishak, A., Parinduri, 2019)

2.3.1 Steps of the technique ordering preference by Similarity to Ideal Solution(TOPSIS)

The basic principle on which the technique is based is to choose the alternative with the shortest distance from the positive ideal solution and the And the farthest distance from the negative ideal solution: (Abood and Alashari, 2022)

1. Create a decision matrix and determine the weight of the criteria.

Assuming a multi-criteria decision problem, with n criteria and m alternatives, the decision matrix is as follows:

$$X = \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_m \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_n \end{array} \\ \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \end{array} \qquad \textbf{(9)}$$

2. Calculate the standard decision matrix.

In order to calculate the standard decision matrix, must be calculated standard values , and standard values are calculated according to the following equation:

$$\mathbf{r_{ij}} = \frac{\mathbf{x_{ij}}}{\sqrt{\sum_{i=1}^{m} \mathbf{x_{ij}^2}}} \qquad \textbf{(10)} \quad , \quad \mathbf{i=\{1,2\ldots m\}} \quad , \mathbf{j=\{1,2,\ldots n\}}$$

Thus, the standard decision matrix is as shown below

$$\boldsymbol{R} = \begin{bmatrix} \boldsymbol{r_{11}} & \boldsymbol{r_{12}} & \cdots & \boldsymbol{r_{1n}} \\ \boldsymbol{r_{21}} & \boldsymbol{r_{22}} & \cdots & \boldsymbol{r_{2n}} \\ \vdots & \vdots & \ddots & \vdots \\ \boldsymbol{r_{m1}} & \boldsymbol{r_{m2}} & \cdots & \boldsymbol{r_{mn}} \end{bmatrix} \qquad \textbf{(11)}$$

3. Calculate the standard weighted decision matrix.

The standard weighted decision matrix is calculated by multiplying the standard decision matrix with the weights linked by the criteria, where the values of the weighted standard decision matrix are calculated according to the following equation

$$V_{ij} = w_j r_{ij} \qquad \textbf{(12)} \quad , \quad i=\{1,2,\ldots m\} \quad , \quad j=\{1,2,\ldots n\}$$

The sum of the weights of the criteria equals one . $\sum_{j=1}^{n} w_j = 1$.

4. Determine the positive ideal solution and the negative ideal solution.

The ideal positive and negative solution is determined according to the two equations below:

$$A^+ = (v_1^+, v_2^+, \ldots, v_n^+) = \left[\left(max_i^{vij} \mid j \in J\right), \left(min_i^{vij} \mid j \in J'\right)\right] \qquad \textbf{(13)}$$

$$A^- = (v_1^-, v_2^-, \ldots, v_n^-) = \left[\left(min_i^{vij} \mid j \in J\right), \left(max_i^{vij} \mid j \in J'\right)\right] \qquad \textbf{(14)}$$

5. Calculating deviation measures from the positive ideal solution and the negative ideal solution.

The distance between the positive ideal point and each alternative may be calculated using the following equation:

$$D_i^+ = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^+\right)^2} \qquad \textbf{(15)} \quad , \quad i=\{1,2,\ldots m\}$$

Also the distance between the negative ideal point and each alternative may be calculated from the following equation

$$D_i^- = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^-\right)^2} \qquad \textbf{(16)} \quad , \quad i=\{1,2,\ldots m\}$$

6. Calculate the relative proximities of the optimal solution.

The relative approximation to the optimal solution is calculated according to the following equation:

$$H_i^* = \frac{D_i^-}{D_i^- + D_i^+} \qquad \textbf{(17)} \qquad , \ 0 \le H_i^* \le 1, \ i = 1,2, \dots , m.$$

7. Arrange by favorability.

The arrangement is done according to favorability, or in other words, choosing the alternative nearer to 1,maybe to arrange the set of alternatives according to preference in a renunciative order of the values of "H_i^*"and larger index values indicate better performance of the alternatives. (Lee, 2007)

3. Results and Discussion

In this important part, projects are identified according to importance and the projects are as follows:

Project (1): Building the judicial complex in the governorate of Baghdad.

Project (2): Building the judicial complex in the governorate of Karbala.

Project (3): Building the judicial complex in the governorate of Samawah.

Project (4): Building the judicial complex in the governorate of Diyala.

Project (5): Building the judicial complex in the governorate of Diwaniyah.

Project (6): Building the judicial complex in the governorate of Babylon.

3.1 The result for (AHP) method

A . Pairwise Compression between Criteria

Table 3: Result of (Pairwise Compression between Criteria)

Criteria Chosen	Community needing	Financial return	Contractual position	The security situation	Executive position
Community needing	1	3.00	5.00	1.00	3.00
Financial return	0.33	1	2.00	0.33	0.50
Contractual position	0.20	0.50	1	0.33	0.50
The security situation	1.00	3.00	3.00	1	3.00
Executive position	0.33	2.00	2.00	0.33	1

Table 4: Result of (Priority for Criteria)

	Criteria	Priority	Rank
1	**Community needing**	35.2%	1
2	**Financial return**	10.8%	4
3	**Contractual position**	7.4%	5
4	**The security situation**	32.3%	2
5	**Executive position**	14.3%	3

Number of comparisons=10,Consistency Ratio CR = 2.5%, Principal Eigen value = 5.111

B. **Pairwise comparisons between projects within with selection criteria:**

1. **Pairwise comparison between projects within the community needing criterion**

Table5: (Pairwise comparison between projects within the community needing criterion)

Projects	Project ١	Project ٢	Project ٣	Project ٤	Project ٥	Project ٦
Project 1	1	2.00	0.50	3.00	4.00	3.00
Project 2	0.50	1	1.00	3.00	3.00	2.00
Project 3	2.00	1.00	1	4.00	3.00	5.00
Project 4	0.33	0.33	0.25	1	0.33	1.00
Project 5	0.25	0.33	0.33	3.00	1	2.00
Project 6	0.33	0.50	0.20	1.00	0.50	1

Table 6: Result Priority of (Projects within the community needing criterion)

	Projects	Priority	Rank
1	**project 1**	25.7%	2
2	**project 2**	20.2%	3
3	**project 3**	30.5%	1
4	**project 4**	6.3%	6
5	**project 5**	10.5%	4
6	**project 6**	6.8%	5

Number of comparisons = 15, Consistency Ratio CR = 5.0%, Principal eigen value = 6.316

2. **Pairwise comparison between projects within the financial return criterion**

Table 7: Result of (Pairwise comparison between projects within the financial return criterion)

Projects	Project ١	Project ٢	Project ٣	Project ٤	Project ٥	Project ٦
Project 1	1	2.00	3.00	5.00	6.00	4.00
Project 2	0.50	1	2.00	5.00	3.00	2.00
Project 3	0.33	0.50	1	3.00	2.00	3.00
Project 4	0.20	0.20	0.33	1	0.33	1.00
Project 5	0.17	0.33	0.50	3.00	1	2.00
Project 6	0.25	0.50	0.33	1.00	0.50	1

Table 8: Result Priority of (Projects within the financial return criterion)

	Projects	Priority	Rank
1	**project 1**	39.3%	1
2	**project 2**	23.0%	2
3	**project 3**	15.5%	3
4	**project 4**	5.3%	6
5	**project 5**	9.9%	4
6	**project 6**	7.0%	5

Number of comparisons = 15, Consistency Ratio CR = 4.0% ,Principal eigen value = 6.251

3.Pairwise comparison between projects within the contractual position criterion

Table 9: Result of (Pairwise comparison between projects within the contractual position criterion)

Projects	Project ١	Project ٢	Project ٣	Project ٤	Project ٥	Project ٦
Project 1	1	1.00	0.50	1.00	1.00	3.00
Project 2	1.00	1	2.00	1.00	4.00	5.00
Project 3	2.00	0.50	1	2.00	3.00	4.00
Project 4	1.00	1.00	0.50	1	2.00	3.00
Project 5	1.00	0.25	0.33	0.50	1	4.00
Project 6	0.33	0.20	0.25	0.33	0.25	1

Table 10: Result Priority of (Projects within the contractual position criterion)

	Projects	Priority	Rank
1	**project 1**	15.3%	4
2	**project 2**	27.7%	1
3	**project 3**	24.4%	2
4	**project 4**	17.1%	3
5	**project 5**	10.8%	5
6	**project 6**	4.7%	6

Number of comparisons = 15, Consistency Ratio CR = 5.4%, Principal eigen value = 6.337

4. Pairwise comparison between projects within the security situation criterion

Table 11: Result of (Pairwise comparison between projects within the security situation criterion

Projects	Project ١	Project ٢	Project ٣	Project ٤	Project ٥	Project ٦
Project 1	1	5.00	1.00	5.00	3.00	6.00
Project 2	0.20	1	0.33	0.50	0.50	2.00
Project 3	1.00	3.00	1	5.00	4.00	8.00
Project 4	0.20	2.00	0.20	1	2.00	3.00
Project 5	0.33	2.00	0.25	0.50	1	4.00
Project 6	0.17	0.50	0.12	0.33	0.25	1

Table 12: Result Priority of (Projects within the security situation criterion)

	Projects	Priority	Rank
1	**project 1**	33.7%	2
2	**project 2**	6.9%	5
3	**project 3**	34.3%	1
4	**project 4**	11.2%	3
5	**project 5**	10.2%	4
6	**project 6**	3.7%	6

Number of comparisons = 15, Consistency Ratio CR = 4.4%, Principal eigen value = 6.276

5. Pairwise comparison between projects within the executive position criterion

Table 13: Result of (Pairwise comparison between projects within the executive position criterion)

Projects	Project ١	Project ٢	Project ٣	Project ٤	Project ٥	Project ٦
Project 1	1	0.50	0.33	0.50	2.00	1.00
Project 2	2.00	1	0.50	1.00	4.00	2.00
Project 3	3.00	2.00	1	2.00	6.00	4.00
Project 4	2.00	1.00	0.50	1	3.00	4.00
Project 5	0.50	0.25	0.17	0.33	1	1.00
Project 6	1.00	0.50	0.25	0.25	1.00	1

Table 14: Result Priority of (Projects within the executive position criterion)

	Projects	Priority	Rank
1	**project 1**	10.2%	4
2	**project 2**	19.5%	3
3	**project 3**	35.3%	1
4	**project 4**	21.1%	2
5	**project 5**	6.0%	6
6	**project 6**	7.9%	5

Number of comparisons = 15, Consistency Ratio CR = 1.4% ,Principal eigen value = 6.088

C. **Decision Matrix**:

A decision matrix is created, the columns of which represent the selection (Criteria) and the rows of which represent the decision alternatives (Alternative), and all data contained in the table are from the results of the questionnaires of the Judicial Planning Department.

Table 15: Result of (Pairwise comparison)

Total weights	C 1	C 2	C 3	C 4	C 5
Project 1	0.257	0.393	0.153	0.337	0.102
Project 2	0.202	0.23	0.277	0.069	0.195
Project 3	0.305	0.155	0.244	0.343	0.353
Project 4	0.063	0.053	0.171	0.112	0.211
Project 5	0.105	0.099	0.108	0.102	0.06
Project 6	0.068	0.07	0.047	0.037	0.079
∑	**1**	**1**	**1**	**1**	**1**

D. Calculate preference for project

The result of multiplying the decision matrix with the weights of the criteria

Total weights	C 1	C 2	C 3	C 4	C 5
Project 1	25.70%	39.30%	15.30%	33.70%	10.20%
Project 2	20.20%	23.00%	27.70%	6.90%	19.50%
Project 3	30.50%	15.50%	24.40%	34.30%	35.30%
Project 4	6.30%	5.30%	17.10%	11.20%	21.10%
Project 5	10.50%	9.90%	10.80%	10.20%	6.00%
Project 6	6.80%	7.00%	4.70%	3.70%	7.90%
∑	**100%**	**100%**	**100%**	**100%**	**100%**

✖

Criteria weights
35.20%
10.80%
7.40%
32.30%
14.30%
∑=١00%

=

Decision	The Best
Project 1	24.73%
Project 2	19.98%
Project 3	27.30%
Project 4	12.52%
Project 5	8.71%
Project 6	6.76%
∑	100%

E. The rank of the projects

Project (3) with periorty : 27.30%
Project (1) with periorty : 24.73%
Project (2) with periorty : 19.98%
Project (4) with periorty : 12.52%
Project (5) with periorty : 8.71%
Project (6) with periorty : 6.76%

Note:The sum of the all periorties equell 100%.

3.2 The result for (TOPSIS) Method

1.Normalized decision matrix

$$\begin{bmatrix} 0.25 & 0.07 & 0.02 & 0.18 & 0.03 \\ 0.19 & 0.04 & 0.04 & 0.04 & 0.05 \\ 0.29 & 0.03 & 0.03 & 0.18 & 0.09 \\ 0.06 & 0.01 & 0.02 & 0.06 & 0.05 \\ 0.10 & 0.02 & 0.02 & 0.05 & 0.02 \\ 0.07 & 0.01 & 0.01 & 0.02 & 0.02 \end{bmatrix}$$

2. **Best answer vector: [0.29 0.07 0.04 0.18 0.09]**
3. **Choices distance from best vector: [0.08 0.18 0.04 0.27 0.25 0.30]**
4. **Worst answer vector: [0.06 0.01 0.01 0.02 0.02]**
5. **Choices distance from worst vector: [0.25 0.15 0.30 0.06 0.05 0.01]**
6. **Closeness vector of each choices: [0.76 0.44 0.87 0.18 0.18 0.02]**
7. **Then the result for rank of this technique is:**

Project (3) with score : 0.87

Project (1) with score : 0.76

Project (2) with score : 0.44

Project (4) with score : 0.18

Project (5) with score : 0.18

Project (6) with score : 0.02

We can now Discussion the result in this study showed that the main criterion that received the highest importance based on perwise decision matrix is the extent of societal need, with a percentage of (35.2%), followed by the security situation criterion with a percentage of (32.3%), followed by the executive position criterion with a percentage of (14.3%). The financial return criterion is (10.8%), and finally the contractual position criterion is (7.4%), and demonstrated that the third alternative (Project 3), represented by building the Judicial Complex in Samawah Governorate, is the most important alternative to complete and which was diagnosed within the targeted criteria by experts in the Judicial Planning Department, followed by the first alternative in second place (Project 1) represented by building the Judicial Complex in Baghdad Governorate, and then the second alternative: building the judicial complex in Karbala Governorate (Project 2) came in third place, while in the fourth place came (Project 4), represented by building the judicial complex in Diyala Governorate, followed by (Project 5) building the judicial complex in Diwaniyah Governorate ranked fifth, and finally (Project 6) the construction of the Judicial Complex in Babylon Governorate ranked sixth.

4. Conclusion

- The success of using the (AHP) and (TOPSIS) in evaluating the construction of judicial complexes, by conducting pairwise comparisons between these projects according to the main criteria.
- The use of a combined method between the(AHP) and (TOPSIS) method gives a clear seeing and a strong choice for decision makers.
- Using quantitative methods in institutions to reach the best decisions in (MCDM), because using a clear and frank scientific method in any institution leads to reduces reliance solely on personal experience.
- Adopting modern quantitative methods in decision-making in government institutions, to solve all complex problems, to help specialists in the decision-making process and support it with a scientific approach. Therefore, the research recommends using quantitative methods in the case of multiple criteria to reach the best decisions.
- The necessity of using the combined method (AHP) and (TOPSIS) to obtain accurate decisions, Researchers in future studies can use more multi-criteria decision-making methods (MCDM) that are not used in research, such as (Goal Programming, ELECTRE, PROMETHE, MOORA, VIKOR, WPM, WSM) and applied to many decision problems in the areas of control, project planning, etc., in order to enhance decision makers with the accuracy of their decisions.

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إستعمال الأداتين عملية التحليل الهرمي (AHP) وتقنية ترتيب الأداء بالتشابه مع الحل المثالي (TOPSIS) في اتخاذ قرار متعدد المعايير (MCDM)

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المستخلص:

تهدف هذه الدراسة إلى تسليط الضوء على تحديد الأولوية في اتخاذ قرار متعدد المعايير (MCDM) من أجل الوصول الى قرار علمي ودقيق بالاعتماد على اساليب حديثة، وتمثلت عينة البحث بقسم إدارة المشاريع في دائرة التخطيط العدلي التابعة إلى وزارة العدل لغرض دراسة وتقييم مشاريع بناء المجمعات العدلية التي تروم المؤسسة تنفيذها واختيار الأهم بالإكمال والتنفيذ وترتيب المشاريع الاخرى بناءً على خمسة معايير وهي (الاحتياج المجتمعي ، العائد المالي ، الموقف التعاقدي ، الوضع الأمني ،الموقف التنفيذي) ولغرض ذلك تم تطبيق تكامل أسلوبين لدعم القرار، الأسلوب الأول هو تقنية التحليل الهرمي (AHP) والأسلوب الثاني تقنية ترتيب الأداء بالتشابه مع الحل المثالي (TOPSIS) وتم استعمال (AHP) لتحديد أوزان المعايير الرئيسية ومن ثم تم استعمال تلك الأوزان كمدخلات لطريقة (TOPSIS)،إن أهم ما توصلت اليه نتائج الدراسة أن الطريقتين المقترحتين تمكنتا من تحديد أولوية إنجاز مشاريع بناء المجمعات العدلية وترتيبها حسب الأولوية.

الكلمات الدالة: صنع القرار، مصفوفة المقارنة الزوجية، المصفوفة المعدلة، اتخاذ القرار متعدد المعايير، عملية التحليل الهرمي، تقنية ترتيب الأداء بالتشابه مع الحل المثالي.