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Evaluation Of University Research Centers Performance Using Combined Multi-Criteria Decision-Making Model

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Abstract**:** Multi-Criteria Decision-Making (MCDM) focuses on reaching the best possible results in complex scenarios with conflicting criteria. The goal of this paper is to evaluate and rank the 26 research centres' outputs at a large public university using some MCDM techniques. While the current method of evaluating and ranking research centers in that university is based on weighting processes developed by a group of University experts, this paper incorporates Analytic Hierarchy Process (AHP), Stepwise Weight Assessment Ratio Analysis (SWARA), and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) among other MCDM techniques. The AHP was utilized to check for consistency across expert-determined criteria importance, followed by SWARA which was used to find the relative criteria weights. The TOPSIS methodology was then applied to rank research centers at that University as "alternatives". The Spearman's correlation coefficient between the present rank and the suggested rank from the integrated AHP-SWARA-TOPSIS model was calculated. Based on the obtained correlation coefficients from Spearman's technique, it is encouraging to use the proposed model as the number of centers increases.

Keywords: MCDM, AHP, SWARA, TOPSIS, Research Centers, Ranking Methods.

I. INTRODUCTION

MCDM is among the decision-making techniques that have gained popularity due to their wide range of applicability. MCDM offers powerful well-organized frameworks to analyze complex decision-making problems to reach rational and efficient decisions in numerous fields. The number of MCDM techniques is numerous. Some of the most common include Analytical Hierarchy Process (AHP), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), Analytic Network Process (ANP), VIekriterijumsko KOmpromisno Rangiranje (VIKOR), Weight Sum Model (WSM), Weight Product Model (WPM), Preference Ranking Organization METHod for Enrichment Evaluation (PROMETHEE), and Stepwise Weight Assessment Ratio Analysis (SWARA). Deciding which MCDM technique to deploy in any given situation is critical and depends on the availability and nature of the data collected [1]. For example, the use of highly qualitative data favors the deployment of the AHP method. On the other hand, when the available data is highly quantitative, TOPSIS and VIKOR are preferred. MCDM methodology had been extensively employed in education, business, industry and manufacturing sectors.

In higher education systems, research centers are one of the pillars of the system. The presence of research centers facilities in a country indicates that country's dedication to knowledge advancement for the benefit of society. These centers are always looking for new areas to work on, as well as innovative ways to bring interesting topics to the attention of academics and industry. One of the main responsibilities of research centers is to disseminate the findings of their connected researchers and to promote the centers' international reputations. The university under investigation in this study is a public university that features 26 research centers to support the university's scientific research infrastructure, as well as the continual expansion and improvement of scientific research activities and technology localization. Therefore, it is necessary to evaluate the centers' performance based on the volume of their outputs, which necessitates a study of a variety of criteria. Thus, the performance of research centers in the selected university to be evaluated using a combination of MCDM methodologies. The following is how the rest of the paper is organized: Section 2 examines current research in the field of education that used MCDM methodologies like as AHP, SWARA, and TOPSIS. Section 3 describes these strategies. Section 4 depicts the case study's precise numerical phases as well as the decision-making process's application methodologies. The findings of the study are presented in the final section.

II. MCDM APPLICATIONS IN THE EDUCATIONAL FIELD

MCDM techniques have been widely used in decision-making environments with conflicting objectives, diverse forms of data, multiple interests, and high uncertainties. There are many tools used in MCDM; this section reviews recent studies that used the Analytic Hierarchy Process (AHP), the Stepwise Weight Assessment Ratio Analysis (SWARA), and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). Researchers use the AHP in the education sector to assess student satisfaction in different academic-related programs.

Latief & Lefen [2], for instance, applied the AHP technique to evaluate levels of satisfaction of international students receiving Chinese Government Scholarships in Universities within Nanjing in China. Similarly, Gupta [3] used the AHP technique to assess students' perspectives on adopting Massive Open Online Courses (MOOCs) based on their resultant benefits, features, and social recognition.

Farid et al. [4] developed a hierarchical model of the challenges that higher education institutions in Pakistan face when combining information and communication technologies. In Farid et al. [4]'s study, a roadmap for implementing e-learning systems in developing countries was also provided in order to overcome challenges. The study concluded that there are 17 significant challenges which categorized into five dimensions: software, technical, institutional, personal, and cultural components. Lokare & Jadhav [5] employed AHP and TOPSIS for course selection that addressed student priorities. Lucas et al. [6] presented a framework for evaluationg workshops designed for teachers based on AHP. The evaluation model consisted of four main criteria. Şahin & Yurdugül [7] looked at studies in the field of education that used the AHP approach and gave the researchers' thoughts on using the method. The researchers illustrated the AHP approach with a sample application and then explained how the findings were interpreted. Using the SERVQUAL model, Milojević & Radosavljevic [8] investigated whether service quality influences student satisfaction. The researchers then used AHP and other statistical models to prioritize service quality improvements. Muhammad et al. [9] investigated the violating academic integrity factors within universities in Saudi Arabia. Their paper identified 12 major factors related to the e-learning environment, understanding of academic integrity, and e-learning guiding standards. They used AHP to assist in prioritizing these factors.

SWARA was used in a study to evaluate the preparation of higher education centers as well as universities for the successful deployment of an Enterprise Resource Planning (ERP) system [10]. The University of Mazandaran in Iran served as a case study to evaluate organizational capabilities to implement the ERP successfully. According to the study, the ERP establishment process, IT infrastructure, and cultural influence were all average while the organizational capability and influence were weak. The impact of organizational characteristics on the learning outcomes quality in primary schools was underlined by Epifanić et al. [11]. They ranked seven organizational elements affecting the quality of elementary education learning outcomes using Fuzzy SWARA. School management, school infrastructure, primary school kids' foreknowledge, instructors' abilities, curriculum substance, motivation of student, and the effectiveness process of teaching were among the elements (criteria).

Naveed et al. [12] used the SWARA technique to assess the factors influencing the successful implementation of web-based learning systems.

Tuslaela [13] developed criteria for scholarship recipients to be used on campus, in a school, or in any other social institution that offers financial aid. The developed criteria were economic conditions, academic grades, and other achievements. TOPSIS was applied to find the performance rating of each criterion. The results suggested that granting scholarships to students with academic achievement should take precedence. MEIRIZA & LESTARI [14] used the TOPSIS approach to help parents choose the best Integrated Islamic Elementary Schools (IIES) based on factors such as school fees, parking space, location, extracurricular, distance, facilities, entrance fee, and accreditation criteria.

In the education sector, many studies have used integrated MCDM techniques such as AHP-TOPSIS or AHP-SWARA. For instance, Yudatama & Sarno [15] authored a study based on the Balanced Scorecard (BSC) approach. The authors used four perspectives as criteria for the strategic decision-maker in higher education. The researchers used Fuzzy AHP to determine weighting criteria, and then Fuzzy TOPSIS was employed to identify the priority of perspectives in creating recommendations of strategic policy in higher education. The study found that the customer perspective rated higher than other perspectives, while the research and student affairs scores were also noteworthy scores compared with others. Both garnered attention in policymaking during strategic planning. Aly et al. [16] authored another study based on the BSC approach as a strategic tool to evaluate engineering faculty performance at Fayoum University in Egypt. The researchers used an integrated AHP-TOPSIS model to prioritize levels of all BSC perspectives (financial, learning and growth, internal processes, customers, and management commitments). To determine the relative importance of various perspectives, the researchers randomly collected data from 110 professors, assistant professors, lecturers, staff, researchers, graduates, and students using Likert scale questionnaires. The results derived from AHP-TOPSIS showed that management commitment was the most important perspective in the BSC approach, followed by the financial perspective and then by internal processes perspective. Rianto et al. [17] proposed a combined model using an AHP-TOPSIS method to select new university students. Thirty students comprised the sample. The selection criteria included, skills of English proficiency, psychological tests, skills of academic, attitude, and soft skills such as skills of communication, critical-thinking and problem-solving skills. Rainto et al. examined these criteria based on academic workplace needs. Analysis of the results showed that the most important criteria related to student selection were attitude followed by soft skills. Mohammed et al. [18] used the AHP-TOPSIS technique to evaluate e-Learning. The researchers selected five alternative e-learning approaches for implementation in a Malaysian public university. The authors used five evaluation criteria. The results of the AHP-TOPSIS assessment showed that “Strategic Readiness for e-Learning Implementation” was the most essential criterion from the respondents' perspective at a public university in Malaysia.

III. PROPOSED MCDM MODELS

There is growing interest in the education sector to apply MCDM techniques to evaluate complex problems, given that making the best decisions is an increasingly difficult task for policymakers. Studies have found no specific MCDM method to be superior to others. Therefore, the most appropriate MCDM method to deploy for a decision-making problem depends on how well a methodology fits the circumstance. The most important aspect to consider in choosing an approach is to consider the characteristics of the problem or scenario and choose the method that fits best. Based on the literature, this study aims to rank the research centers at one public university using combines suitable MCDM methods. The study used AHP, SWARA, and TOPSIS techniques. According to Moeinaddini et al. [19] and Hashemkhani Zolfani et al. [20], the advantages of using the three techniques in tandem are:

- Multiple criteria are handled easily
- Easily understandable and effective means to handle both qualitative and quantitative data
- Accommodates the handling of expert opinions regarding the relative weighting of criteria during the evaluation process
- Adaptable in coordinating and gathering data from experts
- Straightforward approach that encourages collaboration among experts
- Allows for addressing problem priorities based on an organization's policies
- Measures the relative performance of each alternative in a simple mathematical form and can be computed efficiently

Analytic Hierarchy Process (AHP)

The AHP technique is a mathematical problem-solving tool developed by Thomas L. Saaty**.** AHP can be utilized in a three-step hierarchical approach in the decision-making process. First, the decision maker defines the problem and the goals. The next is to determine the factors influencing the decision. Lastly, the decision-maker identifies the alternatives. When using the AHP technique, weights must be attached to the respective criteria to increase the probability of reaching the correct conclusion. Another importance of the AHP technique is that it provides checks and balances to ensure that decision-makers arrive at logically consistent solutions when comparing the relative significance of the solution by assigning weights to each possible solution. Due to its effectiveness, AHP has become one of the most used decision-making approaches in management science today. The AHP theory is illustrated by Thakkar [21] as follows:

Compare n elements C_1, …, C_n and consider the relative weight of C_i associated with C_j by a_{ij} and form a square matrix A=(a_{ij}) of n order with the following requirements: $a_{ij}=1/a_{ji}$, for $i\neq j$, and $a_{ij}=1$, for all $i=j$. The matrix established is called the reciprocal matrix. In AHP, a preference scale from 1 to 9 is used in the pairwise comparison matrix [22], as shown in Table 1.

Table 1. Saaty's pairwise comparison scale

Scale	Verbal judgment
1	Equally important
3	Weakly important
5	Strongly important
7	Very strongly important
9	Extremely important
2,4,6,8	Intermediate value between adjacent scales

The weights are considered consistent if they exhibit transitivity, that is $a_{ik}=a_{ij}a_{jk}$ for all i, j, and k. Based on the collected data of a_{ij}, the matrix can be generated. Then create a vector ω of order n so as to $A\omega = \lambda\omega$. The vector ω is called an eigenvector and λ is called an eigenvalue. Next, it requires evaluating the consistency of a matrix of order n.

In the AHP, Inconsistency is tolerated by its redundancy. comparisons may be re-examined if the consistency index doesn't reach a required level. The consistency index (CI) can be computed as follows

$CI = \frac{\lambda\text{max} - n}{n-1}$ where the λ_{max} is the maximum eigenvalue of the judgment matrix. Then, the CI is compared with the Ratio Index (RI). Forman obtained the Saaty scale for random matrices and utilized it to calculate RI. Thus, the equation $\frac{CI}{RI}$ is called the consistency ratio (CR) and for CR must be less than 0.1 to be accepted [23].

Stepwise Weight Assessment Ratio Analysis (SWARA)

SWARA is used to solve multi-criteria decision-making problems where respondents express their preferences about the importance of the criteria. The following steps demonstrate how to assign weights to criteria using SWARA [20]:

Step #1: Sort criteria in descending order based on their anticipated significance.

Step #2: Start with the second criterion.

Step #3: Calculate the coefficient K_j as follows:

$$k_j = \begin{cases} 1 & j = 1 \\ s_j + 1 & j > 1 \end{cases} \quad (1)$$

where S_j is the comparative importance for criterion j.

Step #4: Determine the recalculated weight q_j as follows:

$$q_j = \begin{cases} 1 & j = 1 \\ \frac{k_{j-1}}{k_j} & j > 1 \end{cases} \quad (2)$$

Step #5: The relative weights of the evaluation criteria are determined as follows:

$$w_j = \frac{q_j}{\sum_{k=1}^{n} q_k} \quad (3)$$

where W_j denotes the relative weight of criterion j.

Order of Preference by Similarity to Ideal Solution (TOPSIS)

The technique is an analytical multi-criteria decision-making approach that enables decision-makers to select the most preferred solution from a list of possible solutions. According to Uzun et al. [22], the most preferred solution is the one that is close to the positive desired and further to the negative (undesired) solutions. The positive solution is a combination of the best possible outcomes. In contrast, the negative solution, on the other hand, is a combination of the worst potential effects of each solution respectively. As per Uzun et al. [22], TOPSIS is commonly used in numerical datasets, especially those whose weighted significance is defined, and outcomes can be defined be computed by ranking each criterion by its corresponding weight. For instance, the TOPSIS technique can be used to evaluate different outcomes of different courses of action in our daily lives, such as selecting the best car based on a given number of parameters [25]. The following steps explain the TOPSIS technique [26]:

Step #1: Establish the normalized decision matrix:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}. \; i = 1, \dots, m \; ; \; j = 1, \dots, n \quad (4)$$

where: x_{ij} is the decision matrix, m is the number of alternatives, and n is the number of criteria

Step #2: Compute the normalized weights decision matrix:

$$V_{ij} = W_{ij} * r_{ij} \quad (5)$$

Step #3: identify the positive and negative ideals solution:

$$A^* = \{(max\, V_{ij} \mid j \in J), (min\, V_{ij} \mid j \in J')\} \quad (6)$$

$$A^- = \{(min\, V_{ij} \mid j \in J), (max\, V_{ij} \mid j \in J')\} \quad (7)$$

J = 1, 2, 3 …, n where J is associated with the benefit criteria.

J' = 1, 2, 3 …, n where J' is associated with the cost criteria.

Step #4: Calculate the separation measures for each alternative. The positive and negative ideals are the result of the following calculations, respectively:

$$S_i = \sqrt{\sum_{i=1}^{n}\left(V_{ij} - V_j^*\right)^2} \tag{8}$$

where i = 1, 2 ..., m

$$S_i^- = \sqrt{\sum_{i=1}^{n}\left(V_{ij} - V_j^-\right)^2} \tag{9}$$

where i = 1, 2 ..., m

Step #5: Calculate the relative closeness to the ideal solution.

$$C_i^* = \frac{S_i^-}{(S_i^* + S_i^-)},\ 0 \leq C_i^* \leq 1 \tag{10}$$

where, i = 1, 2 ..., m

Step #6: Rank the desired alternatives found or choose the highest one among them.

IV. CURRENT EVALUATION METHOD OF RESEARCH CENTERS IN THE SELECTED UNIVERSITY

The university under investigation currently hosts 26 research centers devoted to various scientific subjects. The goal of research centers was to construct and maintain scientific research infrastructure, ensure continual development and enhancement of scientific research activities, and encourage the domestic application of technology developed via research. General, health, and language and social sciences constitute the three broad disciplinary areas represented by the university centers. There are 19 centers for general researches, 4 centers for health researches, and 3 centers for language and social sciences researches.

Presently, the university evaluates the centers using the Delphi method, a popular method used to reach at a group decision by surveying a group of experts. Based on the Delphi method, the present evaluation process the university experts developed the current methodology over the years, using weighting factors derived from an integrated set of performance measures and indicators. In addition, experts at the university considered the influence coefficient of members' affiliation with respective centers, ignoring the strengths of an MCDM approach in this type of evaluation and performance measurement. In summary, this paper applied MCDM tools (AHP, SWARA, and TOPSIS) to evaluate and rank research centers based on legacy performance criteria.

V. APPLICATION & RESULTS

The framework of the proposed integrated model to evaluate and rank the research centers consists of six steps, as shown in Figure 1. The first two steps included identifying the research centers (alternatives) and outlining their evaluation criteria. The remaining steps were unique to each proposed technique (AHP, SWARA, and TOPSIS). The following are the six steps in order:

Step #1: Identify the alternatives using the present classification of the 26 research centers.

Step #2: Identify the main decision criteria and their attributes. The performance of the 26 research centers can be judged using main evaluation criteria, which are then broken into sub-criteria. In this step, both the major and sub-criteria currently employed were considered.

The criteria were based on the outputs of the centres in terms of researches, publications, patents, community partnerships, support (finance and non-finance), and others.

Step #3: Construct the hierarchy for the proposed model as illustrated in figures 2-4. In AHP, it is suggested to start with identification of the overall goal [27].

Step #4: Check the consistency ratio. As indicated in the AHP approach, use Saaty's 1-9 scale to calculate the consistency ratio and examine the existing criteria importance process. When the index is less than 10%, deem the check successful. This check requires that the importance value in Table 2 be converted to Saaty’s scale. The following steps are required to determine consistency among the importance value of the criteria.

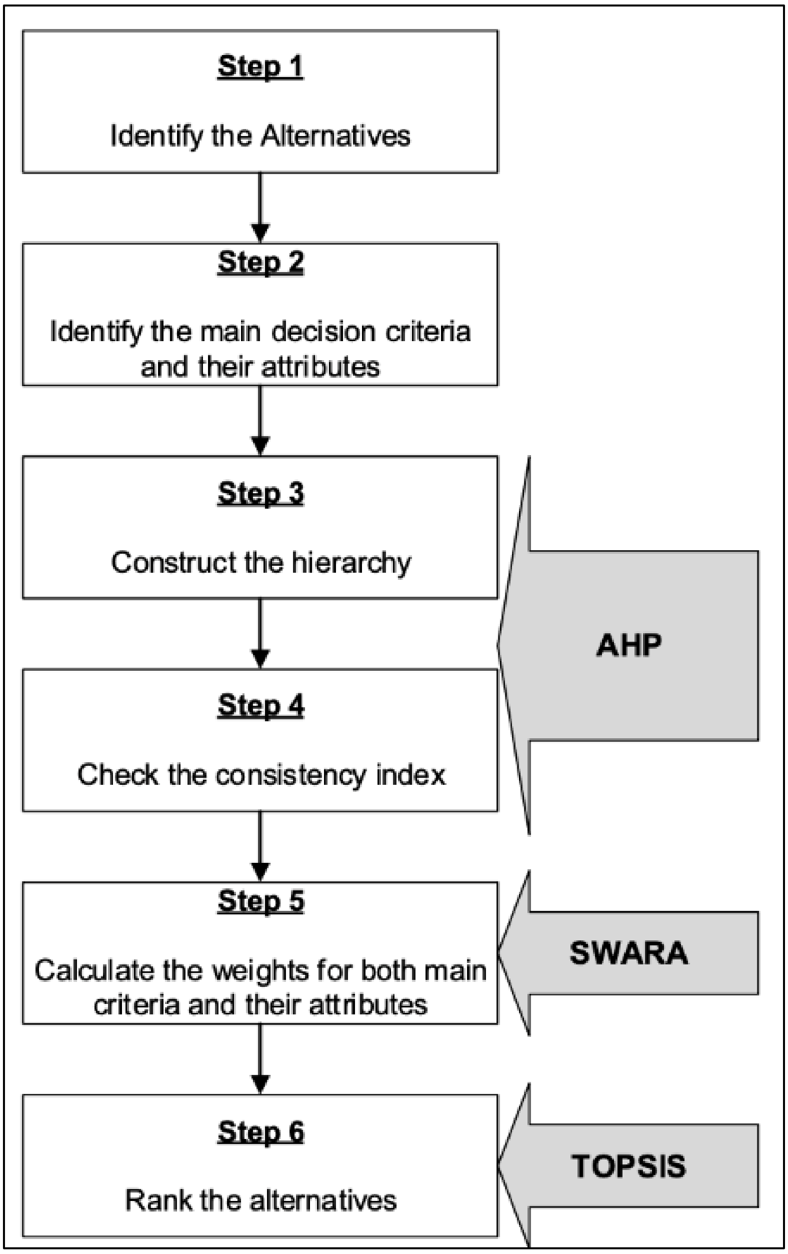

Figure 1. Proposed framework to rank research centers

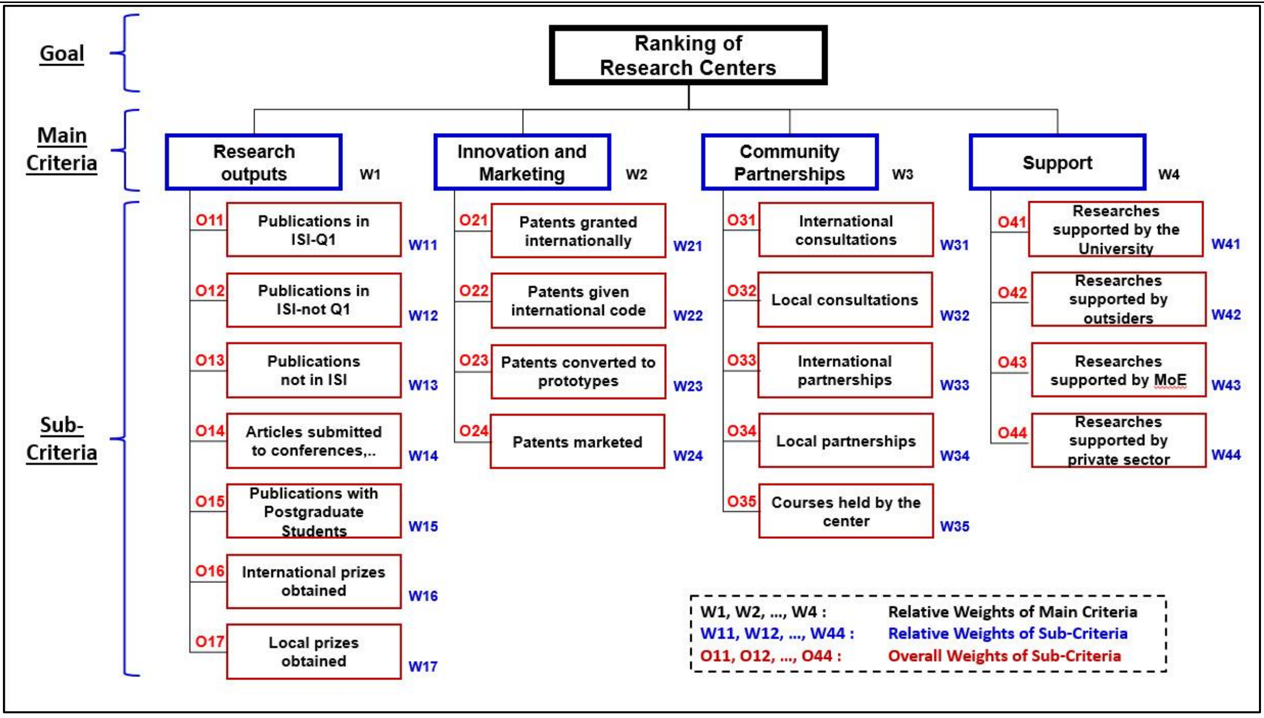

Figure 2. The distribution of relative weights over the General Research Centers' criteria

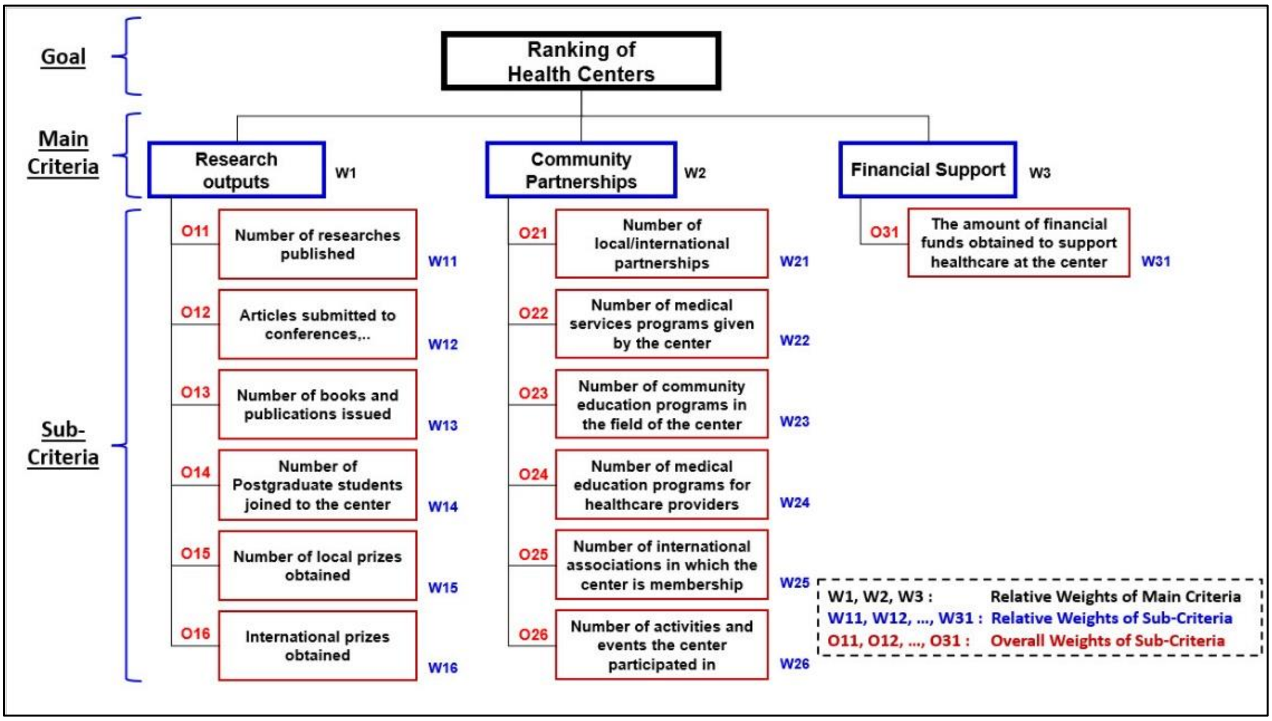

Figure 3. The distribution of relative weights over the Health Research Centers' criteria

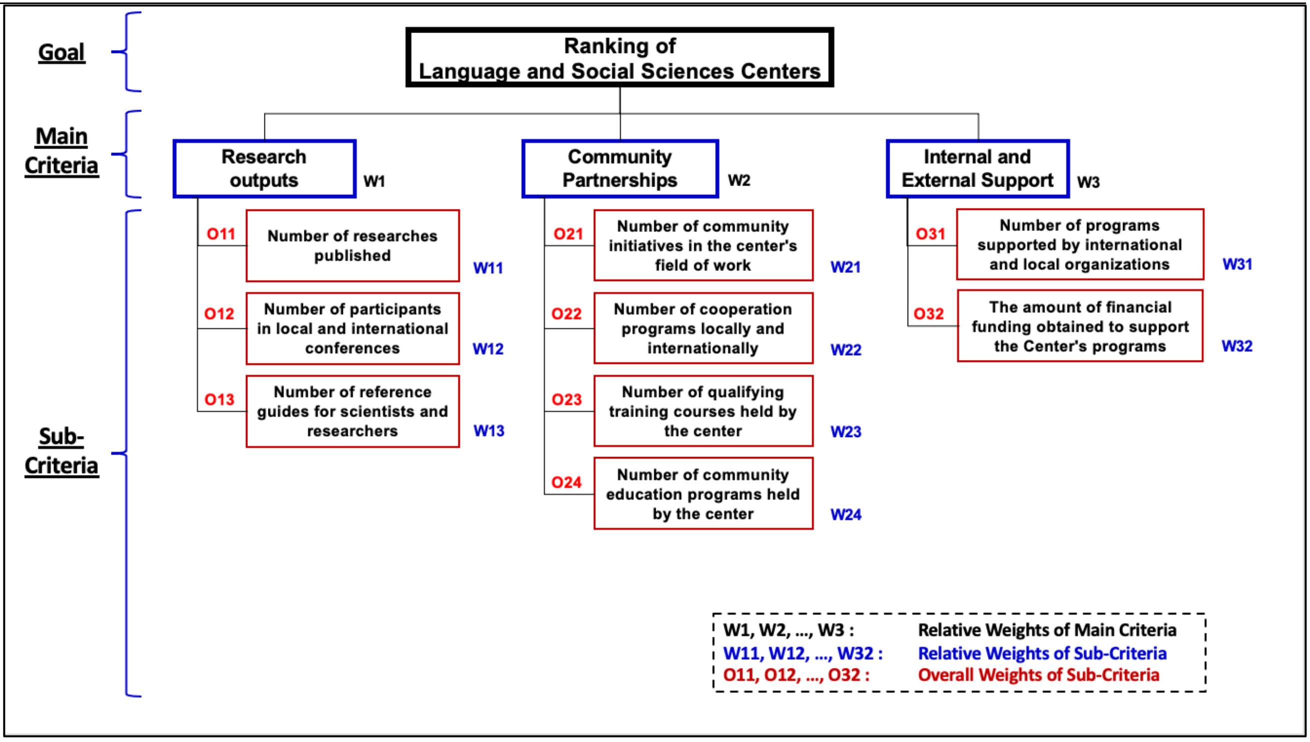

Figure 4. The distribution of relative weights over the Language and Social Science Research Centers' criteria

Step 4a: Consider a list from n criteria and sort them in descending order. After that, find the relative importance between the two criteria in the list by applying steps 4a to 4c.

Step 4b: Select the criterion's weight C_i from the list and distribute its value equally over the nine-scale of Saaty. The original value of C_i will be at scale 1, and then it will decrease equally by a value δ_i until it reaches value 1 at scale 9. The δ_i and the distribution line of C_i over Saaty's scale will take the following forms: $\delta_i=(C_i-1)/8$.

Saaty's Scale	Equal (weak)		Moderately		Strongly		Very Strongly		Extremely
	1	2	3	4	5	6	7	8	9
Distribution of C_i	C_i	$C_i-\delta_i$	$C_i-2\delta_i$	$C_i-3\delta_i$	$C_i-4\delta_i$	$C_i-5\delta_i$	$C_i-6\delta_i$	$C_i-7\delta_i$	1

Step 4c: Apply a pairwise comparison between the weights C_i and C_{i+1} by finding the nearest value to C_{i+1} in the distribution line of C_i and select the corresponding Saaty scale (S_{i+1}). This step defines the relative importance between C_i and C_{i+1}. The relative importance between C_i and itself is 1 (i.e., $S_i=1$). Repeat this step until all pairwise comparisons between C_i and the remaining criteria in the list are utilized.

Step 4d: Select the next criterion (C_{i+1}) in the list and repeat the previous two steps (4b and 4c) until a pairwise comparison between the two criteria in the list is compared to each other. Then, go to step 4e.

Step 4e: Construct the pairwise comparison matrix and calculate the Consistency Ratio (CR) between the criteria weights under investigation.

For example, check the consistency ratio among the four main criteria weights (C_1=30%, C_2=30%, C_3=20%, and C_4=20%) presented in Table 2 for the general research centers group. To find the relative importance between C_1 and C_2, the δ_1 = (30-1)/8 = 3.625. The distribution line takes the following form:

Saaty's Scale	Equal (weak)		Moderately		Strongly		Very Strongly		Extremely
	1	2	3	4	5	6	7	8	9

Distribution of C_i	30	26.375	22.75	19.125	15.5	11.875	8.25	4.625	1

The nearest value of C_2=30 in the distribution line of C_1 is 30, with a corresponding Saaty scale equal to 1. The result indicates that both weights are equally important in Saaty's definition. To determine the relative importance between the two weights, C_1=30 and C_3=20, the nearest value to 20 is 19.125, corresponding to scale 4. This result indicates that C_1 is moderately more important than C_3. Repeating this methodology, the pairwise comparison matrix of these four main criteria, as given in Table 3, resulted in a consistency ratio of 0%.

Table 2. Criteria and their corresponding importance value for research centers by the university experts

General Research Centers					
Main Criteria	Importance Value	Consistency Ratio (Proposed approach)	Sub-Criteria	Importance Value	Consistency Ratio (Proposed approach)
C_1	30%	0%	C_{11}	8%	16%
			C_{12}	5%	
			C_{13}	2%	
			C_{14}	2%	
			C_{15}	3%	
			C_{16}	7%	
			C_{17}	3%	
C_2	30%		C_{21}	10%	0%
			C_{22}	5%	
			C_{22}	5%	
			C_{23}	10%	
C_3	20%		C_{31}	5%	4%
			C_{32}	4%	
			C_{33}	5%	
			C_{34}	3%	
			C_{35}	3%	
C_4	20%		C_{41}	4%	4%
			C_{42}	5%	
			C_{43}	5%	
			C_{44}	6%	
Health Research Centers					
C_1	40%	0%	C_{11}	10%	6%
			C_{12}	5%	
			C_{13}	5%	
			C_{14}	5%	
			C_{15}	7%	
			C_{16}	8%	
C_2	40%		C_{21}	10%	7%
			C_{22}	8%	
			C_{23}	6%	
			C_{24}	6%	
			C_{25}	5%	
			C_{26}	5%	
C_3	20%		C_{31}	20%	N/A
Language and Social Sciences Research Centers					
C_1	40%	0%	C_{11}	20%	0%
			C_{12}	10%	
			C_{13}	10%	
C_2	40%		C_{21}	10%	0%
			C_{22}	10%	
			C_{23}	10%	
			C_{31}	10%	
C_3	20%		C_{32}	10%	0%
			C_{33}	10%	

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Table 3. Pairwise comparison matrix of main Criteria for general research centers group

Saaty's Scale	S1	S2	S3	S4
S1	1	1	4	4
S2	1	1	4	4
S3	1/4	1/4	1/4	1
S4	1/4	1	1	1
CR = 0%				

Table 2 shows that all consistency ratios were between 0% and 4%, except one, which was 16%. According to Goepel [28], a higher CR can still be accepted and it depends on the nature of the project.

Step #5: Calculate the weights for the main criteria and their attributes using SWARA. Here, the relative weights of the research centers' evaluation will be calculated using the following steps:

Step 5a: The criteria weights, as determined by the university experts, are sorted in descending order.

Step 5b: Starting from the second criterion, calculate the value of the importance of C_{i+1} on the relative comparison with C_i using the SWARA's equations 1, 2, and 3.

Step 5c: Calculate coefficient K_i using the ratios from the previous step.

Step 5d: Recalculate the weights (q_i) and calculate the relative weights of each criterion (W_i).

Step 5e: Follow the above four steps for all main criteria and sub-criteria for the three groups of research centers. Once all criteria are taken into consideration, proceed to the next step 5f.

Step 5f: Turn back the sorting of all criteria and calculate the overall weight of each sub-criterion (j) associated to the main criterion (i) by the following formula:

$$O_{ij} = W_i * W_{ij}\ , \quad i = 1, \dots n\ \ , j = 1, \dots m$$

Where:

- W_i : The relative weight of main criterion (i)
- W_{ij} : The relative weight of sub-criterion (j) corresponding to main criterion (i)
- O_{ij} : The overall weight of sub-criterion (j) associated to main criterion (i)
- n : Number of main criteria in each set of research centers
- m : Number of sub-criteria related to each main criterion

The overall weights for the main criteria and sub-criteria for all research centers are presented in Table 4 using the AHP-SWARA technique.

Step #6: Rank the alternatives. This last step in the proposed model uses the TOPSIS method, illustrated in equations from 4 to 10, to achieve the final ranking results. Table 5 presents the decision matrix for the health research centers group while Table 6 presents the final ranking of research centers using the TOPSIS technique and weights derived from the AHP-SWARA technique. There is no change in the rankings of the language and social sciences research centers group. There was a minor change for the health research centers group and a more substantial change for the general research centers group.

Table 4. The interval and overall weights of for the criteria of the three research centers' group.

	General Research Centers				Health Research Centers				Linguistic and Social Sciences Research Centers			
Criteria	**Symbol**	**Interval Weight**	**Overall Weight**		**Symbol**	**Interval Weight**	**Overall Weight**		**Symbol**	**Interval Weight**	**Overall Weight**	
			Symbol	**Value**			**Symbol**	**Value**			**Symbol**	**Value**
Main Criteria	W1	0.262			W1	0.353			W1	0.353		
	W2	0.262			W2	0.353			W2	0.353		
	W3	0.238			W3	0.294			W3	0.294		
	W4	0.238										
Sub Criteria	W11	0.161	O11	0.042	W11	0.181	O11	0.064	W11	0.385	O11	0.136
	W12	0.146	O12	0.038	W12	0.160	O12	0.056	W12	0.308	O12	0.109
	W13	0.132	O13	0.035	W13	0.160	O13	0.056	W13	0.308	O13	0.109
	W14	0.132	O14	0.035	W14	0.160	O14	0.056	W21	0.250	O21	0.088
	W15	0.137	O15	0.036	W15	0.168	O15	0.059	W22	0.250	O22	0.088
	W16	0.156	O16	0.041	W16	0.172	O16	0.061	W23	0.250	O23	0.088
	W17	0.137	O17	0.036	W21	0.181	O21	0.064	W24	0.250	O24	0.088
	W21	0.269	O21	0.071	W22	0.172	O22	0.061	W31	0.500	O31	0.147
	W22	0.231	O22	0.060	W23	0.164	O23	0.058	W32	0.500	O32	0.147
	W23	0.231	O23	0.060	W24	0.164	O24	0.058				
	W24	0.269	O24	0.071	W25	0.160	O25	0.056				
	W31	0.210	O31	0.050	W26	0.160	O26	0.056				
	W32	0.200	O32	0.048	W31	1.000	O31	0.294				
	W33	0.210	O33	0.050								
	W34	0.190	O34	0.045								
	W35	0.190	O35	0.045								
	W41	0.238	O41	0.057								
	W42	0.250	O42	0.059								
	W43	0.250	O43	0.059								
	W44	0.262	O44	0.062								

Spearman's rank correlation is employed to check the correlation between the present method with the proposed method. The correlation coefficient between the two arrangements was calculated using the following formula:

$$\rho = 1 - \frac{6\sum d_i^2}{n(n^2-1)}$$

Where:

- ρ : Spearman's rank correlation coefficient
- d_i : Difference between the two ranks of each observation
- n : Number of observations

For example, the correlation coefficient (ρ) between the ranks obtained from the proposed and current technique for the general research centers group was 62.6%, as portrayed in Table 7. Repeating Spearman's approach for the other two research centers' groups, the correction coefficients obtained were 80% for the health research centers group and 100% for the social research centers group.

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Table 5. The decision matrix for language and social sciences research centers

	Overall Criteria Weight	O_{11} 0.136 Max.	O_{12} 0.109 Max.	O_{13} 0.109 Max.	O_{21} 0.088 Max.	O_{22} 0.088 Max.	O_{23} 0.088 Max.	O_{24} 0.088 Max.	O_{31} 0.147 Max.	O_{32} 0.147 Max.
Centers' Outputs	A1	7	19	1	0	6	5	3	1	1000000
	A2	14	5	0	2	2	8	4	0	0
	A3	0	0	6	0	0	0	2	0	0

Table 6. The proposed rank for research centers

General Research Centers				Health Research Centers				Language and Social sciences Research Centers			
Current Method		Proposed Method		Current Method		Proposed Method		Current Method		Proposed Method	
Research Center	Overall Weight	Research Center	Relative closeness	Research Center	Overall Weight	Research Center	Relative closeness	Research Center	Overall Weight	Research Center	Relative closeness
A1	0.710	A1	0.568	A1	0.880	A1	0.861	A1	0.630	A1	0.645
A2	0.580	A2	0.443	A2	0.690	A2	0.409	A2	0.580	A2	0.410
A3	0.415	A6	0.425	A3	0.370	A4	0.304	A3	0.140	A3	0.263
A4	0.380	A7	0.368	A4	0.280	A3	0.140				
A5	0.365	A13	0.366								
A6	0.345	A8	0.360								
A7	0.350	A4	0.356								
A8	0.250	A3	0.334								
A9	0.220	A5	0.334								
A10	0.205	A18	0.300								
A11	0.190	A10	0.292								
A12	0.190	A17	0.289								
A13	0.155	A16	0.282								
A14	0.130	A19	0.280								
A15	0.105	A12	0.276								
A16	0.110	A14	0.274								
A17	0.100	A15	0.273								
A18	0.050	A11	0.267								
A19	0.000	A9	0.263								

Table 7. The correlation coefficient calculations between two ranks for research centers

Research Centers	Current Rank (X_i)	Proposed Rank (Y_i)	$d_i = X_i - Y_i$	$(d_i)^2$
A1	1	1	0	0
A2	2	2	0	0
A3	3	6	-3	9
A4	4	7	-3	9
A5	5	13	-8	64
A6	6	8	-2	4
A7	7	4	3	9
A8	8	3	5	25
A9	9	5	4	16
A10	10	18	-8	64
A11	11	10	1	1
A12	12	17	-5	25
A13	13	16	-3	9
A14	14	19	-5	25

A15	15	12	3	9
A16	16	14	2	4
A17	17	15	2	4
A18	18	11	7	49
A19	19	9	10	100
			å(d$_i$)^2 =	426
			r =	62.6%

VI. CONCLUSION & RECOMMENDATION

This paper proposed a new combined Multi-Criteria Decision-Making (MCDM) technique to evaluate and rank research centers at universities. While various MCDM techniques are available, this paper used a technique combining Stepwise Weight Assessment Ratio Analysis (SWARA), Analytic Hierarchy Process (AHP), and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). The SWARA and AHP methods were used to evaluate the weight of each criterion noted in this paper. Precisely, this paper used an AHP-SWARA to check the consistency of an existing evaluation that was used by the Delphi method and the combined technique was not discussed in the literature. Then, the TOPSIS method used the outcome weights to obtain the final results of ranking the alternatives (research centers). This paper explained the different applications of MCDM to assist decision-makers in determining the performance of university research centers. The proposed model examined the centers based on their relative proximity to the ideal solution. Spearman’s technique was employed to check the correlation between the current method with the proposed method. Based on the obtained correlation coefficients from Spearman’s technique, it is encouraging to use the proposed model as the number of centers increases.

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