Integrating FUCA, SRP, and OPARA Methods to Assess Faculty's Scientific Research Capacity

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ABSTRACT

Faculty's scientific research activities are not only a primary task besides teaching but also play a crucial role in knowledge development and enhancing education quality. Evaluating the scientific research capacity of the faculty in a department helps identify capabilities and promote a competitive spirit, thereby improving the effectiveness and reputation of the educational institution. This study evaluates the scientific research capacity of outstanding faculty members in a Vietnamese university department by integrating three methods: FUCA (Faire Un Choix Adéquat), SRP (Simple Ranking Process), and OPARA (Objective Pairwise Adjusted Ratio Analysis). The evaluation data are based on the number of Scopus-indexed scientific articles published in an academic year. Q1, Q2, Q3, and Q4 ranked articles are used as evaluation criteria for each faculty member. The weights of the criteria are calculated with the use of ROC (Rank Order Centroid) and RS (Rank Sum) weight methods. For both methods, two faculty members with outstanding scientific research achievements were identified.

Keywords-faculty ranking; MCDM; FUCA; SRP; OPARA

I. INTRODUCTION

Faculty members play an important role in nation-building and are considered the pillars of any education system. After recruitment, they must continuously develop themselves in many aspects [1]. Annual faculty evaluation is essential and must be conducted at all educational institutions to develop education and implement timely policies to improve the quality of the faculty [2-4]. Scientific research activities of the faculty are very important. This is not only a primary task besides teaching but also an opportunity to contribute to the development of human knowledge [5]. Evaluating the scientific research capacity of the faculty is necessary to ensure the quality of teaching and research. Comparing scientific research capacities helps to identify individuals with outstanding achievements, create conditions for the development of new projects, and promote a spirit of competition and mutual learning [6]. Comprehensive and objective evaluation of faculty's research capacity not only helps to identify excellent individuals but also promotes research activities and enhances the quality of training at higher education institutions [7].

To evaluate the scientific research capacity of the faculty, many factors need to be considered, such as the number of research projects undertaken, the number of recognized patents, the number of articles published in reputable journals, and scientific indices (H-index, i10-index, etc.). Among these, evaluating the number and quality of scientific articles is the most common method at higher education institutions. The number of articles shows the active contribution of the faculty to the scientific community. Meanwhile, the quality of the articles reflects the impact and value of the research. Publishing scientific articles and research results not only enhances personal reputation but also contributes to the reputation and quality of the educational institution. Articles published in high-impact journals often receive wide recognition, contributing to the prestige of both the faculty and the institution. The number of citations of the articles is also an important measure, showing the impact and dissemination of the research within the scientific community. This creates a rich and diverse knowledge resource, serving as a foundation for subsequent research and practical applications, bringing tangible benefits to society [8].

Assessing the scientific research capacity of faculty members within the same department over an academic year is crucial as it forms the basis for rewarding and promoting those with outstanding achievements. Faculty members with remarkable research capabilities are often prioritized for leading research groups, teaching important courses, and guiding students in scientific projects. They also receive funding support for research projects and focus more on research rather than administrative tasks. This evaluation promotes healthy competition among faculty members, enhancing the overall quality of teaching and research in the department, thereby boosting the reputation and prestige of the educational institution [11]. However, evaluating faculty and their scientific capacity is a challenging and sensitive task involving complex criteria that are both objective and subjective, creating a MCDM (Multi-Criteria Decision-Making) problem [10-14].

This study evaluates the scientific research capacity of faculty members in a department at a university in Vietnam

over an academic year. The tool for this task is the simultaneous use of three MCDM methods: FUCA, SRP, and OPARA.

MCDM methods have been applied in various fields, including education. Numerous studies in this field have utilized MCDM techniques to evaluate and rank different educational contents. Authors in [15] ranked three teaching modes using a combination of TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) and VIKOR (Vlsekriterijumska optimizacijaI KOmpromisno Resenje) methods [15]. Authors in [16] ranked teaching modes for undergraduate students in Malaysia during the Covid-19 period using a combination of AHP (Analytic Hierarchy Process) and VIKOR. Authors in [17] evaluated student learning outcomes with the TOPSIS method. Authors in [18, 19] assessed online training programs with the COPRAS (COmplex PRroportional ASsessment) method. Authors in [20] evaluated faculty recruitment processes using four methods: TOPSIS, SAW (Simple Additive Weighting), WASPAS (Weighted Aggregates Sum Product Assessment), and WSM (Weighted Sum Method). Authors in [21] ranked faculty based on their teaching performance utilizing AHP and ARAS (Additive Ratio Assessment). Authors in [22] ranked the performance of vocational teachers using a hybrid AHP and PROMETHE (Preference Ranking Organization Method for Enrichment Evaluation) model. Authors in [23] evaluated student assessment forms (gamification) using the AHP method. Authors in [24] ranked universities in Turkey using ANP (Analytic Network Process) combined with the PROMETHEE method. Authors in [25] ranked the top 10 universities in Vietnam using RAWEC (Ranking of Alternatives with Weights of Criterion), RAM (Root Assessment Method), and SRP methods. Authors in [26] ranked universities based on student perspectives using a combination of AHP and VIKOR. Authors in [27] selected scientific research supervisors using the COPRAS-G method. Authors in [28] chose individual learning strategies for university students using the BWM (Best-Worst Method) method. Authors in [29] compared educational development among the regions of Myanmar using the SAW method. Authors in [30] ranked teachers using the PROMETHEE method. Authors in [31] ranked recreational sports to encourage teachers' participation to improve their health and reduce work pressure using DEMATEL (DEcision MAking Trial and Evaluation Laboratory) and ANP.

FUCA, SRP, and OPARA are three MCDM methods that share the characteristic of not requiring data normalization when applied. Using these methods without normalizing the data ensures that the original information about the criteria is preserved [32]. The FUCA method uses natural and decimal numbers to rank alternatives internally, i.e., it ranks alternatives based on each criterion [33]. The SRP method only uses natural numbers for the internal ranking of the alternatives [34]. The OPARA method focuses on the original data, relying on the range of each criterion and the criterion linearity [32]. Besides the differences in how these methods are used, the research shows varying levels of application in the literature. Among the three methods, FUCA has been most widely used in various applications such as ranking types of CNC lathes [35], types of saws [36], types of plastic injection machines [37], materials used in electric discharge machining [38], metal turning methods [39], and financial efficiency of companies [40-42], ect. Meanwhile, only a few studies have applied the SRP method, such as ranking industrial tools [34], ranking types of materials [43, 44], and comparing the performance of energy companies [45]. Notably, the OPARA method has not been used in any studies as it was only introduced in June 2024. Another noteworthy point is that none of the FUCA, SRP, and OPARA methods have been used to rank faculty members in any published literature. Using the FUCA, SRP, and OPARA methods with the common feature of not requiring data normalization but with different implementation approaches and varying application frequencies aims to provide a comprehensive result and serve as a basis for determining whether these methods are suitable for faculty evaluation.

II. MATERIALS AND METHODS

To evaluate the scientific research capacity of faculty members in a department based on the scientific articles they publish in an academic year, it is first necessary to identify the faculty members to be evaluated and their scientific publication achievements. Assume we need to compare the scientific capacity of mmm faculty members, and the number of criteria for evaluation for each faculty member is nnn. Criteria that are larger-the-better are denoted as *BC*, and criteria that are smaller-the-better are denoted as *NC*. In this case, the scientific data for each faculty member selected are their articles indexed in Scopus at Q1, Q2, Q3, and Q4 levels, thus Q1, Q2, Q3, and Q4 are the four criteria, meaning nnn equals 4. We construct a decision matrix as in (1), where x_{ij} is the value of criterion j for alternative i, with $i = 1 \div m$, and $j = 1 \div n$. Let w_j be the weight of criterion j.

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \cdots & \cdots & \ddots & \cdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \quad (1)$$

After constructing the decision matrix, the sequence for ranking the candidates using the MCDM methods is as follows.

A. FUCA Method

To determine the ranking of alternatives using the FUCA method, we follow these steps [33]:

Step 1: Rank the alternatives for each criterion, denoting r_{ij} as the rank of alternative i for criterion j. Note that for the FUCA method, r_{ij} can be either a natural number or a decimal.

Step 2: Calculate the score for each alternative with:

$$S_i = \sum_{j=1}^{n} r_{ij} \cdot w_j \quad (2)$$

Step 3: The alternative with the smallest score is ranked first and so on.

B. SRP Method

To determine the ranking of the alternatives using the *SRP* method, we follow the following steps [34]:

Step 1: Rank the alternatives for each criterion. Note that for the R method, r_{ij} an only be chosen as natural numbers.

Step 2-3: Same with the steps 2-3 of the FUCA method.

C. OPARA Method

To determine the ranking of the alternatives using the OPARA method, we follow the following steps [32]:

Step 1: Determine the Range-based Pairwise Adjusted Ratio (RPAR) between alternative k and alternative l using (3):

$$RPAR_{kl} = \sum_{j\in BC} w_j \cdot \left(\frac{x_{kj}}{x_{lj}}\right)^{p_j} + \sum_{j\in NC} w_j \cdot \left(\frac{x_{lj}}{x_{kj}}\right)^{p_j} \quad (3)$$

where $k, l \in \{1, 2, \dots, n\}$ and p_j is the adjustment coefficient in RPAR, calculated by:

$$\rho_j = \begin{cases} \frac{(\alpha-1)\max(x_{ij})+\min(x_{ij})}{\alpha\cdot\max(x_{ij})} & \text{if } \frac{\max(x_{ij})-\min(x_{ij})}{\max(x_{ij})+\min(x_{ij})} > \beta \\ 1 & \text{otherwise} \end{cases} \quad (4)$$

where α and β are chosen to be 5 and 0.8, respectively [32].

Step 2: Determine the linearity-based pairwise adjusted ratio (*LPAR*) between alternative k and alternative l using (5):

$$LPAR_{kl} = \sum_{j\in BC} w_j \cdot \left(\frac{x_{kj}}{x_{lj}}\right)^{\tau_j} + \sum_{j\in NC} w_j \cdot \left(\frac{x_{lj}}{x_{kj}}\right)^{\tau_j} \quad (5)$$

where $k, l \in \{1, 2, \dots, n\}$. The value of τ_j is user-defined. When a criterion is linear, τ_j is 1. To increase LPAR, one must choose τ_j greater than 1 and vice versa.

Step 3: Calculate the aggregated pairwise adjusted ratios ($APAR_{kl}$) with:

$$APAR_{kl} = \omega \cdot RPAR_{kl} + (1-\omega) LPAR_{kl} \quad (6)$$

where $\omega \in [0,1]$ and is usually chosen as 0.5.

Step 4: Calculate the scores of the alternatives using (7):

$$S_i = \frac{1}{n}\left(\sum_{l=1}^{n}\left(\frac{APAR_{il}}{\sum_{k=1}^{n} APAR_{kl}}\right)\right) \quad (7)$$

Step 5: The alternative with the highest score is ranked first and so on.

The flowchart illustrating the sequence of applying FUCA, SRP, and OPARA methods is presented in Figure 1.

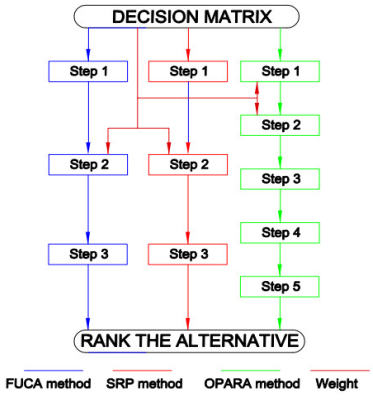

Fig. 1. Block diagram of the considered methods. The steps are defined above.

D. Weighting Methods Used

In this study, two different methods were used to calculate the weights for the criteria: the ROC method and the RS method. Both methods are simple yet effective and are particularly suitable for determining which criteria should be prioritized over the others [46]. Therefore, they are deemed appropriate for calculating the weights of the criteria in this study, given that publishing a Q1-ranked paper should clearly be prioritized over Q2, Q3, or Q4-ranked papers. The formulas to calculate the weights of the criteria using the ROC and RS methods are presented in (8) and (9) [4], where k is the priority level of criterion j.

$$w_j = \frac{1}{n}\sum_{k=i}^{n}\frac{1}{k} \quad (8)$$

$$w_j = \frac{2\,(n+1-k)}{n(n+1)} \quad (9)$$

III. RESULTS AND DISCUSSION

Table I summarizes the scientific papers published in one year by five faculty members in a department at a university in Vietnam. These five faculty members are denoted as candidates A1, A2, A3, A4, and A5. The data in the Q1, Q2, Q3, and Q4 columns correspond to the number of papers each candidate has published that are indexed in Scopus at the Q1, Q2, Q3, and Q4 levels, respectively. We observe that candidate A1 has the highest number of Q1 papers (3 papers) compared to the other candidates. Candidate A3 has the most Q2 and Q4 papers. Candidate A2 has the highest number of Q3 papers.

Thus, the question arises: which candidate has the best research capability among the five candidates based on the collected data? Clearly, this question cannot be answered merely by observing the data in Table I because the number of papers varies. Additionally, many opinions suggest that publishing a Q1-ranked paper is significantly more difficult than publishing a Q2, Q3, or Q4-ranked paper. This implies that the weights assigned to each type of ranked paper will also differ. Therefore, to assess the research capabilities of the faculty members, it is necessary to calculate the weights for the ranks of the papers and then use the FUCA, SRP, and OPARA ranking methods to rank the candidates. The weights for the criteria (different Scopus-indexed papers) were calculated using (8) and (9) and are shown in Table II. The ranking results of the candidates using FUCA, SRP, and OPARA methods are illustrated in Figures 2 and 3.

TABLE I. PUBLISHED PAPERS BY EACH FACULTY MEMBER (SOURCE: AUTHOR)

Candidate	Q1	Q2	Q3	Q4
A1	3	4	1	1
A2	1	3	9	1
A3	1	6	4	2
A4	2	5	5	1
A5	1	3	6	1

TABLE II. CRITERIA WEIGHTS

Method	Q1	Q2	Q3	Q4
ROC	0.5208	0.2708	0.1458	0.0625
RS	0.4	0.3	0.2	0.1

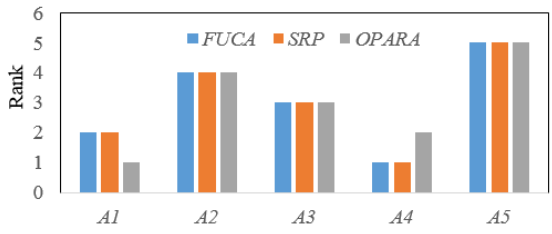

Fig. 2. Candidate ranking when the weights are calculated with the ROC method.

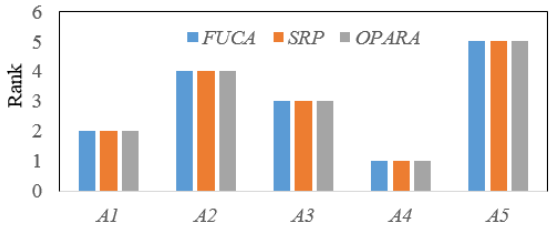

Fig. 3. Candidate ranking when the weights are calculated with the RS method.

It is easily noticeable that using the ROC method to calculate the criteria weights results in rankings entirely consistent with those of the FUCA and SRP methods. Although absolute consistency in the rankings of the candidates is not achieved, all three methods indicate that candidate A5 is ranked 5th, candidate A2 is ranked 4th, and candidate A3 is ranked 3rd. The FUCA and SRP methods ranked A4 1st and A1 2nd, while the OPARA method ranked A1 as 1st and A4 as 2nd. These findings suggest that A1 and A4 are identified as the two most outstanding candidates among the five surveyed.

When the RS method was used to calculate the weights for the criteria, the rankings of the candidates are entirely consistent with all three methods. Accordingly, the candidates are ranked as follows: A4 > A1 > A3 > A2 > A5. The determination that A2 ranks 4th, A3 ranks 3rd, and A5 ranks 5th is also completely consistent with the case where the criteria weights were calculated using the ROC method. Moreover, in this case, we also observe that A1 and A4 are identified as the two candidates with the most outstanding performance among the five surveyed.

In summary, regardless of whether the criteria weights were calculated with the ROC or RS methods, A1 and A4 are consistently identified as the candidates with the most outstanding research performance among those surveyed. This finding can help managers, such as department heads, make important decisions regarding teaching assignments. Outstanding faculty members like A1 and A4 can be prioritized for research tasks, mentoring research students, and receiving more financial support to maximize their potential. Conversely, faculty members with lower performance, like A5, may need additional support to improve their research quality.

The results also demonstrate that despite differences in implementation and the number of studies referenced by the three methods, they are all reliable for evaluating and classifying the research capabilities of faculty members. Particularly through this study, a newly introduced method like OPARA has shown that it is very suitable for ranking faculty members and is expected to be applied in many other fields in the future.

IV. CONCLUSIONS

- Among the five surveyed faculty members, A1 and A4 are the two candidates with outstanding scientific achievements. These individuals should be afforded certain policies to further enhance their research accomplishments. Conversely, A5 needs support to improve his research capabilities.
- The rankings of the candidates using the three considered methods (FUCA, SRP, and OPARA) show a very high degree of similarity. This gives us confidence in the results obtained. Moreover, through this study, it is shown that a very new method like OPARA is completely reliable when used to rank alternatives in various fields.
- To achieve a more comprehensive evaluation of the research capabilities of faculty members, other factors of each candidate, such as the H-index, i10-index, number of citations, IF of the papers, scientific reputation, number of patents, etc., should be considered. These are also tasks to be undertaken in the near future.

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