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FUZZY DEM-SAW: A NOVEL HYBRIDIZED MODEL OF FUZZY DEMATEL-SAW IN LECTURERS' PERFORMANCE EVALUATION BASED ON TEACHING, RESEARCH, SERVICE AND COMMERCIALIZATION (TRSC) CRITERIA FOR PROMOTION

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ASBTRACT

This study introduces an innovative hybridized model, Fuzzy DEM-SAW, designed to enhance the precision and efficacy of lecturers' performance evaluations for the purpose of promotion. This novel approach integrates two distinct methodologies, Fuzzy DEMATEL (Decision Making Trial and Evaluation Laboratory) and SAW (Simple Additive Weighting), presenting a comprehensive framework for the evaluation of lecturers based on the critical criteria of Teaching, Research, Service, and Commercialization (TRSC). The study's purpose is to rank lecturers for promotion. The Fuzzy DEMATEL technique is employed to derive weights, serving as a fundamental basis for subsequent ranking through the Fuzzy SAW process. The proposed model is applied to a case study, revealing significant findings pertaining to lecturers' performance evaluation. The outcomes disclose that Benone secured the foremost position with an Si value of 0.7, followed by Begu-Ellah at 0.583, and Bemane at 0.488. These results provide valuable insights for decision-makers involved in the promotion evaluation process. This research not only contributes to the advancement of hybridized fuzzy models but also holds practical implications for optimizing the assessment of lecturers in academic institutions, thereby contributing to the broader discourse on performance evaluation methodologies in academia.
Keywords: *Fuzzy DEMATEL, Fuzzy SAW, Lecturers, Performance Evaluation, Artificial Intelligence*

1. INTRODUCTION

This paper addresses the inherent inadequacies in the traditional methods employed for evaluating the performance of lecturers within higher education institutions. The challenge at hand revolves around the limitations of conventional evaluation frameworks, which often fall short in capturing correctly the quality aspect of performance which is fuzziness inherent and multifaceted nature of lecturers' roles[1]–[3]. The

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multifaceted criteria of Teaching, Research, Service, and Commercialization (TRSC). The evaluation of lecturers' performance holds immense significance for academic institutions, exerting a profound impact on their overall quality and effectiveness[2], [4], [5]. Through systematic assessments, institutions ensure the maintenance of rigorous academic standards, safeguarding the integrity and reputation of the educational experience they provide. [3] assert that to expedite the advancement of lecturers' academic positions, the implementation of a strategic management approach is essential. A good performance evaluation strategy by University management can play a pivotal role in enhancing teaching effectiveness, career progression, promotions, and tenure, motivating lecturers to continually strive for excellence and contributing to a positive institutional culture. Good performance evaluations could serve as a mechanism for attracting and retaining talented faculty, creating a dynamic, meritorious and accountable academic environment.

The TRSC framework encapsulates the essential facets of a lecturer's role, ensuring a comprehensive assessment that goes beyond traditional metrics. Evaluating Teaching performance ensures the maintenance of rigorous academic standards and the delivery of quality education, fostering continuous improvement in pedagogical approaches using assessment by students via lecturer evaluation at the end of semester[6]–[8]. Beyond the traditional metrics, it includes activities such as having evidence of problem-based learning, flipped classrooms, successful students mentored on academic and career progression and community outreach programs. The emphasis on Research within the TRSC criteria promotes scholarly contributions, advancing the institution's intellectual reputation and encouraging faculty engagement in meaningful research endeavors usually peer reviewed outlets or Journals and more precisely Scopus and Web of Science indexed outlets[7]–[9].Beyond the quantifiable count of publications in peer reviewed outlets, lecturers evaluation frameworks should include; evidence of interdisciplinary research, evidence of societal impact of the research finding such as; has your research finding caused or led to development of a software or device to solve societal problems, has your research finding birthed a business setup? Has your research finding cause an improvement in the life of people based on the final deliverables from your research? Recognition of Service contributions acknowledges the broader societal impact of academic institutions, motivating faculty to actively participate in institutional and community service. It includes evidence of leadership roles, evidence of giving talks, speak to the media on topical issues that fall within his/her academic area, participating to community events. Furthermore, the commercialization aspect underscores the importance of translating research into practical applications, fostering innovation and positioning institutions as contributors to economic development. It includes evidence of grant won for the university or the nation, evidence of a consultancy company and the industry partners consulted for, and any other activities that brings revenue to the University finally.

Diverse models have been employed in the evaluation of lecturer performance[1]–[3], [5], [6], [10]–[16], each characterized by its unique methodological approach, accompanied by inherent strengths and limitations. The traditional quantitative metrics, such as student evaluations and publication count, numerical benchmarks among others facilitating straightforward assessment[6], [7]. However, these metrics may oversimplify the multifaceted nature of a lecturer's contributions, potentially neglecting qualitative dimensions and fuzziness. For instance, [10] focused on the performance appraisal process and its compliance among lecturers at Koforidua Polytechnic, examining its effects on lecturer productivity. Data was collected from both staff and students using a stratified sampling technique. [10] found that the performance appraisal process at Koforidua Polytechnic is strongly associated with well-established policies that adhere to established standards. Also, [16]investigated the impact of performance appraisal on teacher effectiveness in basic public schools in the Kwahu East district of Ghana. [16] study's results indicated that enhancing performance appraisal is crucial for enhancing teachers' effectiveness, thereby leading to improved student outcomes and overall school success. [11] investigated students' perspectives on lecturer evaluations at the University of Cape Coast using qualitative research approach. [11] Further analysis revealed that assessments in the university, as perceived by the students, did not reflect the activities of the world of work.

However, none of the above studies propose Artificial Intelligence techniques to model the

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fuzziness inherent in performance evaluation processes since human beings are involved.
Models that centered on peer review mechanisms offer a qualitative lens, capturing nuanced aspects of teaching, research, service and commercialization through the lens of colleagues[17]–[21]. Despite the richness of qualitative insights, peer reviews can be subject to subjectivity and biases inherent in the evaluative process. This requires an Artificial Intelligence (AI) approach that can model the subjectivity and biases inherent in the process. To address this, researchers have proposed some Fuzzy Systems- a branch of AI integrated with other robust techniques to eliminate the fuzziness inherent in the process. Several studies have explored the use of Single Fuzzy SAW in addressing different problem applications. [22] applied Fuzzy Simple Additive Weighting (FSAW) method in group decision-making for managing capital investment expenditures related to the acquisition of cars intended for rental to the public. [22]used only Fuzzy SAW which is too simple to appropriate capital investment expenditures. They did not establish the interrelation among the criteria they based on to perform the ranking. the [23] used fuzzy SAW for students selections.[23] did not model the fuzziness in the selection process. [24]applied Fuzzy SAW in disease mapping which was able to choose the best alternative disease.[24] dis not establish the correlation among criteria which is very important. Also, the Single Fuzzy SAW method is too simple to be used for both weighting and ranking. [25]applied Fuzzy Logic in the selection process of Brilliant but Needy Students with the aim to model the subjectivity, incompleteness, ambiguity, biases in short for all the fuzziness inherent in the evaluation process. [25] study did not consider any of the Multi-Criteria Decision-Making Method in their Study. See other studies that used Fuzzy and other techniques to model fuzziness by the authors but with different Fuzzy Multi-Criteria Decision Making Methods with focus on service selection and ranking[26]–[30].For studies that integrate Fuzzy SAW, and SAW with other methods on different application areas see [31]–[35].Notwithstanding the diversity in existing approaches, a common limitation is the struggle to comprehensively address all facets of the Teaching, Research, Service, and Commercialization (TRSC) criteria while modeling the fuzziness inherent as well as establishing the relationship among criteria before the ranking. The current evaluation methodologies for lecturer promotion predominantly focus on easily quantifiable criteria such as publication counts, teaching evaluations, and service activities ignoring commercialization. While these metrics offer valuable insights into a lecturer's productivity and impact, they often fall short in capturing the qualitative aspects of their contributions. Quality, which inherently contains subjective elements, remains challenging to quantify using traditional approaches. As a result, there is a growing recognition of the need for evaluation methodologies that can account for both quantitative metrics and subjective quality assessments in a balanced and integrated manner.
Thus, there arises a discernible need for more sophisticated and integrative evaluation methodologies that can capture all criteria and also properly quantify the quality aspect (Subjectivity) in the evaluation process for evaluation lecturers for promotion. The ultimate aim of this study is to present a novel model called Fuzzy DEM-SAW that is Fuzzy DEMATEL-SAW model for assessing three (3) lecturers on the TRSC criteria for the purpose of ranking them for promotion from Senior Lecturer to Associate Professor. Novelties;

1. The study presents a combination of Fuzzy Logic- a branch of Artificial Intelligence with a combination of two Multi-Criteria Decision-Making Makings a branch of operations research namely; DEMATEL and SAW. This integrated approach will appropriately address the multifaceted criteria of Lecturers Promotions handling uncertainty whiles ranking the Lecturers based on the TRSC criteria.
2. The Fuzzy DEMATEL approach delivered the task of establishing and unraveling the complex interdependencies among the TRSC criteria as well as assigning weights to the criteria.
3. The Fuzzy SAW simply ranking the three (3) lecturers based on the TRSC criteria using the weights from the Fuzzy DEMATEL technique.

2. THEORETICAL FOUNDATION

2.1 Fuzzy DEMATEL

2.1.1 Fuzzy direct- relation matrix

$$z = \begin{bmatrix} 0 & \cdots & \tilde{z}_{n1} \\ \vdots & \ddots & \vdots \\ \tilde{z}_{1n} & \cdots & 0 \end{bmatrix} \quad (1)$$

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This matrix is square with dimensions nxn where each entry is denoted by z_{ij} *where* i represents the row and j represents the column. The diagonal entries (from top-left to bottom-right) are all zero. Off-diagonal entries (not on the main diagonal) are denoted by $\tilde{z}_{ij}$, i and j are interchangeable, meaning $\tilde{z}_{ij} = \tilde{z}_{ij}$

2.1.2 Step 2: Normalize the fuzzy direct-relation matrix

$$\tilde{x}_{ij} = \frac{\tilde{z}_{ij}}{r} = \left(\frac{l_{ij}}{r}, \frac{m_{ij}}{r}, \frac{u_{ij}}{r}\right) \qquad (2)$$

where

$$r = \max_{i,j}\left\{\max_i \sum_{j=1}^{n} u_{ij}, \max_j \sum_{i=1}^{n} u_{ij}\right\} \qquad i,j \in \{1,2,3,\dots,n\} \qquad (3)$$

2.1.3 **fuzzy total-relation matrix**

$$\tilde{T} = \lim_{k\to+\infty}(\tilde{x}^1 \oplus \tilde{x}^2 \oplus \dots \oplus \tilde{x}^k) \qquad (4)$$

$$\tilde{t}_{ij} = (l''_{ij}, m''_{ij}, u''_{ij})$$

$$[l''_{ij}] = x_l \times (I - x_l)^{-1}$$

$$[m''_{ij}] = x_m \times (I - x_m)^{-1}$$

$$[u''_{ij}] = x_u \times (I - x_u)^{-1}$$

2.1.4 **Defuzzify into crisp values**

$$l_{ij}^n = \frac{(l_{ij}^t - \min l_{ij}^t)}{\Delta_{min}^{max}} \qquad (5)$$

Code	Linguistic terms	L	M	U
1	Very Low (VL)	0	0	0.2
2	Low(L)	0	0.2	0.4
3	Medium(M)	0.2	0.4	0.6
4	High(H)	0.4	0.6	0.8
5	Very High (VH)	0.6	0.8	1
6	Excellent(E)	0.8	1	1

$$m_{ij}^n = \frac{(m_{ij}^t - min\, l_{ij}^t)}{\Delta_{min}^{max}} \qquad (6)$$

$$u_{ij}^n = \frac{(u_{ij}^t - min\, l_{ij}^t)}{\Delta_{min}^{max}} \qquad (7)$$

Hence,

$$\Delta_{min}^{max} = \max u_{ij}^t - \min l_{ij}^t \qquad (8)$$

Lower and Upper Bounds computations

$$l_{ij}^s = m_{ij}^n \Big/ (1 + m_{ij}^n - l_{ij}^n) \qquad (9)$$

$$u_{ij}^s = u_{ij}^n \Big/ (1 + u_{ij}^n - l_{ij}^n) \qquad (10)$$

$$x_{ij} = \frac{[l_{ij}^s(1 - l_{ij}^s) + u_{ij}^s \times u_{ij}^s]}{[1 - l_{ij}^s + u_{ij}^s]} \qquad (12)$$

2.1.5 Step 5: set the threshold value

Therefore, designate the threshold value as β.

2.1.6 Step 6: Final output and create a causal relation diagram

$$D = \sum_{j=1}^{n} T_{ij} \qquad (13)$$

$$R = \sum_{i=1}^{n} T_{ij} \qquad (14)$$

$$W_j = [(D+R)^2 + (D-R)^2]^{\frac{1}{2}} \qquad (15)$$

2.2 Fuzzy SAW

Table 1 provides a structured representation of the criteria, their types, and respective weights, which are essential components for evaluating alternatives and making informed decisions in a decision-making model.

2.2.1 Table 1: Create a decision matrix

	Name	Type	Weight
1	C1	+	$(C_1w_1, C_1w_1, C_1w_1,)$
2	C2	+	(C_2w_2, C_2w_2, C_2w_2)
3	C3	+	(C_3w_3, C_3w_3, C_3w_3)
4	C4	+	(C_4w_4, C_4w_4, C_4w_4)

Table 2 outlines linguistic terms along with their corresponding membership functions for fuzzification in a fuzzy logic system.

Table 2: Fuzzy Linguistic Scale based on Triangular Fuzzy Numbers

2.2.3 Step 2- Normalizing the fuzzy decision matrix

$$\tilde{R} = [\tilde{r}_{ij}]_{m\times n} \qquad (15)$$

$$i = 1,2,\dots,m \quad j = 1,2,\dots,n$$

m: number of alternatives n: number of criteria

$$\tilde{r}_{ij} = \left(\frac{a_{ij}}{c_j^*}, \frac{b_{ij}}{c_j^*}, \frac{c_{ij}}{c_j^*}\right) \qquad (16)$$

In this formula, c is the maximum value of a for criterion j among all alternatives. The following equation expresses this concept:

$$c_j^* = max_i c_{ij} \qquad (17)$$

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- If the criteria are negative:

$$\tilde{r}_{ij} = \left(\frac{a_j^{\circ}}{c_{ij}}, \frac{a_j^{\circ}}{b_{ij}}, \frac{a_j^{\circ}}{a_{ij}}\right) \quad (18)$$

In this formula, a is the minimum value of a for criterion j among all alternatives. The following equation expresses this concept:

$$a_j^{\circ} = min_i a_{ij} \quad (19)$$

2.2.4 step 3- create weighted normalized fuzzy decision matrix

$$\tilde{V} = [\tilde{V}_{ij}]_{m\times n} \quad (20)$$

$$i = 1,2, \ldots, m \quad j = 1,2, \ldots., n$$

$$\tilde{V}_{ij} = \tilde{r}_{ij} \otimes \widetilde{w}_j \quad (21)$$

2.2.5 step 4- Rank order the alternatives

$$\tilde{F}_i = \sum_{j=1}^{n} V_{ij}^{k} \quad (22)$$

$$k \in \{a, b, c\}$$

If the fuzzy number obtained from the previous step is assumed as $\tilde{V}_{ij} = (a, b, c)$.

The fuzzy scores of each alternative are defuzzified based on the following relationship:

$$F = \frac{(a + 2b + c)}{K} \quad (23)$$

If the total fuzzy score is assumed to be $\tilde{F}_{ij} = (a, b, c)$.

3.0 CASE APPLICATION.

The case study in this paper describes performance evaluation regarding the promotion of University Lecturers with the purpose of them proffering solutions to the plethora of problems in their respective fields. Universities spend a lot on visiting professors from other Universities and adjunct faculties from using Internally Generated Fund.There is the need to home-grow some senior lecturers into Professors to alleviate the cost. Five experts (E1,E2,E3,E4 and E5 from the University Appointment and Promotion committee were asked to evaluate three alternatives (University Lecturers) who have applied for promotion from Senior Lecturer to Associate Professor: Benone, Bemane, and Begu-Ella denoted as L1, L2, and L3, selecting the aforementioned alternatives, decision-makers considered the following four criteria: Teaching Effectiveness(C1), Research(C2), Service (C4) and finally Commercialization(C4). To solve this case based on the theoretical foundation in section 2, and dataset from the five expert rating using the authors' modified version of Online Output software, the Results in Tables are Figures are presented in the Results and Discussions. Tables 3,4,5,6,7,9,10 11, and 13 give numerical values from the mathematical formula given in the theoretical found, can be found at the appendix of this paper.

4. RESULTS AND DISCUSSION

Table 8: The Fuzzy DEMATEL Final Output AndWeight Computation Based D+R, D-R Values

	R	D	D+R	D-R	(D-R)^2	(D-R)^2	Weights
Teaching	3.436	2.687	6.123	0.749	37.49113	0.561001	0.415811
Research	2.702	3.337	6.039	0.635	36.46952	0.403225	0.298868
Service	2.656	3.148	5.803	0.492	33.67481	0.242064	0.179416
Commercialization	3.192	2.814	6.006	0.378	36.07204	0.142884	0.105905
						1.349174	1

In Table 8 and Figure 1, the (D + R) delineates the significance of each factor within the overall system, capturing both the impact of a specific factor (denoted as factor i) on the entire system and the reciprocal influence of other factors on it[27]. In the context of importance, Teaching holds the top position, while Research, Commercialization, and Service follow in subsequent ranks. In this investigation, Research and Service are conceptualized as causal variables, influencing other factors, whereas Teaching and Commercialization are viewed as effects, being influenced by other elements. Conversely, the (D-R) illustrates the extent of a factor's influence on the entire system; a positive value of D-R signifies a factor acting as a causal variable, exerting influence on other elements, while a negative value indicates an effect, representing the factor being influenced[26]. Similar to the horizontal vector, Teaching is ranked as the most crucial factor, with Research, Commercialization, and Service succeeding in importance. In this study, Research and Service are identified as causal variables, shaping the

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dynamics of the system, whereas Teaching and Commercialization are recognized as effects, being shaped by the influence of other factors. This study is similar to [27] which also classified criteria(QoS factors) into cause and effect groups based on the D+R and D-R values. However, this study is different in terms of focus from[27]

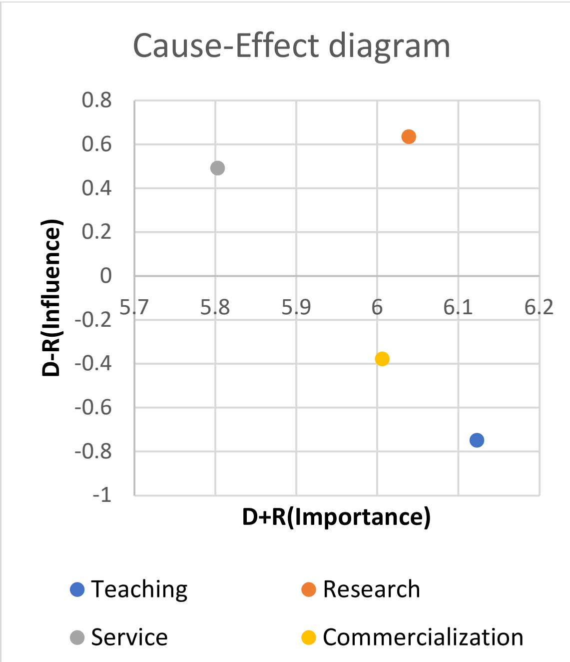

Figure 1: Cause- Effect Diagram

Table 13 presents the performance metric (Si) and corresponding ranks for the alternatives Benone, Bemane, and Begu-Ellah. The Si values indicate the relative performance of each alternative, with a higher Si value indicating a higher rank. Benone, with an Si of 0.7, secures the top rank (1), while Begu-Ellah and Bemane follow with Si values of 0.583 and 0.488, earning ranks 2 and 3, respectively.

Table 13: Defuzzified Value And Final Ranking

	Si	Rank
Benone	0.7	1
Bemane	0.488	3
Begu-Ellah	0.583	2

In Table 13 and Figure 2, representation of Si values and their corresponding ranks for alternatives Benone, Bemane, and Begu-Ellah, each alternative is depicted by a vertical bar. The height of each bar is directly proportional to the Si value, aligning with the convention that higher Si values correspond to better ranks. Benone, with an Si value of 0.7, is represented by the tallest bar, indicating its top-ranking position. Following closely, Begu-Ellah's bar is slightly shorter with an Si value of 0.583, reflecting its second-place ranking. Bemane's bar, the shortest among the three, corresponds to its Si value of 0.488, denoting its third-place ranking. This visual presentation succinctly illustrates the hierarchy of alternative performance, making it easy to discern the relative standings based on Si values. From the above, Benone is the best candidate to be promoted based on TRSC criteria following external assessment of the submitted documents based on the criteria. This study findings is somehow similar to [26] study which also obtained Si values for alternatives(Cloud Service Provider) and ranked based on the Si Values. However, this study differs in focus from [26]

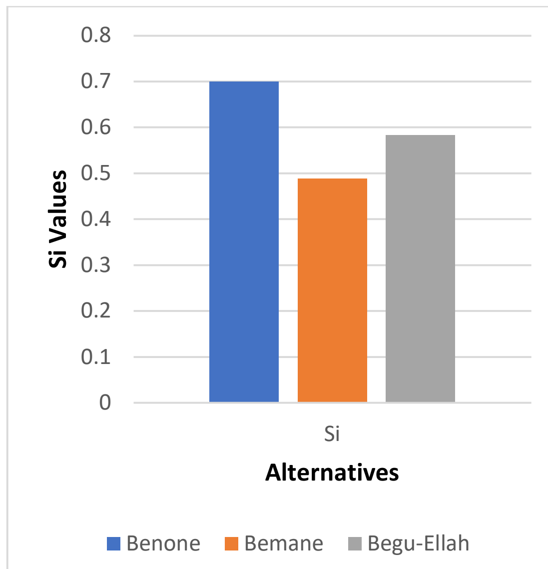

Figure 2: Ranking Of The Alternatives Based On The Defuzzified Values.

5. CONCLUSION

The primary goal of this research was to introduce an innovative model, referred to as Fuzzy DEM-SAW (Fuzzy DEMATEL-SAW), designed to evaluate three lecturers based on the TRSC criteria, ultimately ranking them for promotion from Senior Lecturer to Associate Professor. This study combines Fuzzy Logic, a branch of Artificial Intelligence, with two Multi-Criteria Decision-Making (MCDM) methods from operations research: DEMATEL and SAW. This integrated approach effectively addresses the complex criteria involved in lecturers' promotions, managing uncertainty while ranking lecturers based on the

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TRSC criteria. The Fuzzy DEMATEL method establishes and disentangles the intricate interdependencies among the TRSC criteria and assigns weights to these criteria. Subsequently, the Fuzzy SAW method ranks the four lecturers based on the TRSC criteria using the weights determined by the Fuzzy DEMATEL technique. In the application of the Fuzzy DEM-SAW model to specific lecturers; Benone, Bemane, and Begu-Ellah reveals insightful results. Benone, with a Fuzzy Decision-Making (Si) value of 0.7, secures the top rank, indicating robust overall performance across the TRSC criteria. Begu-Ellah closely follows with a Si value of 0.583, while Bemane claims the third rank with a Si value of 0.488. These rankings provide a quantitative foundation for decision-making in the context of promotion considerations. However, it is essential to acknowledge the limitations of this study. The model's efficacy is contingent upon factors such as the availability and precision of data, the selection of fuzzy set parameters, and the inherent subjectivity in expert evaluations. Additionally, the generalizability of the model may vary across different academic contexts and disciplines. Looking ahead, future research endeavors should focus on further validating and calibrating the model using diverse datasets and expert panels to enhance its robustness and generalizability.

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Appendices

Table 3: Direct-Relation Matrix for Criteria Comparison

	Teaching	Research	Service	Commercialization
Teaching	(0.000,0.000,0.000)	(0.306,0.556,0.722)	(0.250,0.361,0.556)	(0.306,0.528,0.778)
Research	(0.528,0.722,0.806)	(0.000,0.000,0.000)	(0.361,0.611,0.806)	(0.583,0.806,0.861)
Service	(0.528,0.722,0.833)	(0.306,0.556,0.806)	(0.000,0.000,0.000)	(0.361,0.583,0.833)
Commercialization	(0.472,0.722,0.944)	(0.139,0.361,0.583)	(0.306,0.472,0.722)	(0.000,0.000,0.000)

Table 4: Fuzzy Normalized Decision Matrix for Criteria Evaluation

	Teaching	Research	Service	Commercialization
Teaching	(0.000,0.000,0.000)	(0.118,0.215,0.280)	(0.097,0.140,0.215)	(0.118,0.204,0.301)
Research	(0.204,0.280,0.312)	(0.000,0.000,0.000)	(0.140,0.237,0.312)	(0.226,0.312,0.333)
Service	(0.204,0.280,0.322)	(0.118,0.215,0.312)	(0.000,0.000,0.000)	(0.140,0.226,0.322)
Commercialization	(0.183,0.280,0.365)	(0.054,0.140,0.226)	(0.118,0.183,0.280)	(0.000,0.000,0.000)

Table 5: Fuzzy Total-Relation Matrix for Criteria Interrelationships

	Teaching	Research	Service	Commercialization
Teaching	(0.097,0.380,1.869)	(0.158,0.453,1.806)	(0.150,0.394,1.749)	(0.187,0.512,2.030)
Research	(0.323,0.739,2.399)	(0.081,0.378,1.837)	(0.219,0.558,2.053)	(0.313,0.707,2.331)
Service	(0.298,0.683,2.404)	(0.175,0.517,2.074)	(0.080,0.328,1.814)	(0.226,0.601,2.323)
Commercialization	(0.253,0.614,2.262)	(0.108,0.414,1.880)	(0.167,0.431,1.889)	(0.078,0.352,1.917)

Table 6: Crisp Total-Relation Matrix for Criteria Hierarchy

	Teaching	Research	Service	Commercialization
Teaching	0.633	0.673	0.621	0.759
Research	0.984	0.618	0.787	0.948
Service	0.946	0.758	0.577	0.867
Commercialization	0.874	0.652	0.671	0.617

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Table 7: The crisp total- relationships matrix by considering the threshold value

	Teaching	Research	Service	Commercialization
Teaching	0	0	0	0.759
Research	0.984	0	0.787	0.948
Service	0.946	0.758	0	0.867
Commercialization	0.874	0	0	0

Table 9: Characteristics of Criteria

	Name	Type	Weight
1	Teaching	+	(0.416,0.416,0.416)
2	Research	+	(0.299,0.299,0.299)
3	Service	+	(0.179,0.179,0.179)
4	Commercialization	+	(0.106,0.106,0.106)

Table 10: Fuzzy Linguistic Scale

Code	Linguistic terms	L	M	U
1	Very Low	0	0	0.2
2	Low	0	0.2	0.4
3	Medium	0.2	0.4	0.6
4	High	0.4	0.6	0.8
5	“Very High	0.6	0.8	1
6	Excellent	0.8	1	1

Table 11: Normalized fuzzy matrix

	Teaching	Research	Service	Commercialization
Benone	(0.520,0.720,0.840)	(0.520,0.680,0.800)	(0.240,0.360,0.520)	(0.160,0.280,0.440)
Bemane	(0.040,0.160,0.360)	(0.360,0.560,0.720)	(0.480,0.680,0.760)	(0.320,0.440,0.600)
Begu-Ellah	(0.040,0.200,0.400)	(0.560,0.760,0.880)	(0.440,0.640,0.800)	(0.440,0.600,0.720)

Table 12: Normalized fuzzy matrix

	Teaching	Research	Service	Commercialization
Benone	(0.619,0.857,1.000)	(0.591,0.773,0.909)	(0.300,0.450,0.650)	(0.222,0.389,0.611)
Bemane	(0.048,0.190,0.429)	(0.409,0.636,0.818)	(0.600,0.850,0.950)	(0.444,0.611,0.833)
Begu-Ellah	(0.048,0.238,0.476)	(0.636,0.864,1.000)	(0.550,0.800,1.000)	(0.611,0.833,1.000)

Table 13: Weighted Normalized Fuzzy Decision Matrix

	Fuzzy Score
Benone	(0.511,0.709,0.869)
Bemane	(0.297,0.487,0.681)
Begu-Ellah	(0.373,0.589,0.782)