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Multicriteria decision analysis tool for faculty performance evaluation in higher education institutions

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Abstract Higher education institutions (HEIs), which are the major economic drivers in a nation, rely on their faculty for quality. The quality of faculty performance is assessed through performance appraisal methods. Performance appraisal methods help management assess the performance of employees and further the scope of improvement. Traditional methods of performance evaluation based on quantitative data involve more mathematical calculations than scientific approaches. The drawback of these methods is that they consider overall scores and not the individual factors of performance. This is exceptionally relevant when there are multiple disciplines in HEIs. In this study, the Multi-Criteria Decision Analysis (MCDA) model using MACBETH is used to explore its usefulness in explicitly dealing with the trade-offs between performance measures, making the process of performance measurement and management more transparent and defendable. Faculty performance across different disciplines was considered in this study, and faculty performance was evaluated using the MACBETH score. The advantage of MACBETH is that weight can be assigned to specific criteria, and accordingly, analysis can be carried out. Based on which criteria are assigned the highest weight, that factor is considered for the final output. In this study, the results obtained showed significant differences in the performance rankings of the faculty members when compared to those of the traditional methods, suggesting that the FSTs are useful tools for performing performance appraisals.

Keywords: performance management, MACBETH, quality, recruitment

1. Introduction

Education is one of the major drivers of the economic growth of a nation, and higher education institutions (HEIs) contribute significantly to this growth. Higher education institutions are primarily involved in knowledge development and contribute to a knowledge society. These institutions rely on their faculty for fulfilling these objectives; hence, evaluating faculty performance is a challenging task for education managers. The role of faculty in higher education institutions has undergone a paradigm shift wherein they are involved in multiple activities, viz., teaching, research, administration, consultancy, and cocurricular activities. The evaluation of faculty members based on multiple criteria is itself a complex phenomenon involving qualitative and quantitative judgment and requires a scientific model to ensure transparency and reliability (Swart & Duncan, 2005). Performance appraisals are used not only for decision making regarding promotions, transfers or increments but also for designing career paths and training and development activities (Grandzol, 2005). Hence, identifying the factors affecting performance and understanding their relationships are among the most important steps in the design of performance measurement systems.

Huberman (2004) describes teachers as an integral component of the success of an education system. The rapid change from an elite to a mass system of HE to produce employable graduates to meet market needs has widened demands for both internal and external accountability (Blackmore & Blackwell, 2003; Abukari & Corner, 2010), indicating that 'higher education operates in a context of competition, interdependence, interconnectedness and exploitation at an unprecedented level and that no one entity could claim to live in isolation'.

Ensuring quality through internal evaluations, audit mechanisms and external bodies and examiners is an effective way to respond to rapid changes in the global scenario. Accountability, while being most visible at the strategic level, begins with the institution's employees through the evaluation of their performance. Braskamp and Ory (1994) described the evolution of faculty evaluation in terms of changing purposes and methods. Early evaluation was based on "informal assessment" by the chair or dean.

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As outlined by Vicky (2002), some of the appraisal methods include ranking, trait scales, critical incidents, narratives, and criteria-based methods. Terrence and Joyc (2004) mentioned a few other methods, including management-by-objectives (MBO), work planning and review, 360^0 appraisal and peer review. All of these techniques have their own advantages and disadvantages; hence, it is imperative for most organizations to mix and match different techniques for their own performance appraisal systems to fulfill their organizational needs. To ensure that the results of performance appraisals are useful and reasonable, it is important for performance appraisal systems to consistently produce reliable and valid results for the management of an organization. The role of a faculty member is no longer a knowledge transferring process; it has become a knowledge sharing process (Tripathi & Suri, 2010).

Teachers in today's academic environment are expected to perform teaching, research, service, and other related activities, as outlined by management. As each of these activities contributes to the overall growth and development of the organization, every teacher must focus on individual growth in these areas to be sustainable in this competitive era. The imbalance between teaching and research has led to concerns about the quality of academic work and performance management issues (Blackmore & Blackwell, 2003; Blackmore & Fraser, 2003; Lyons & Ingersoll, 2010). The results of the study conducted by Punia and Siwatch (2010) suggest that no single system of performance appraisal is preferred by faculty members and that a new system of appraisal involving specific weightages of various academic and allied activities seems to be needed.

Most of the recent studies reveal that some of the performance methods will conflict with one another, and ultimately, it is difficult for an organization to excel in all of them simultaneously; therefore, trade-offs among these measures are inevitable. Therefore, making trade-offs explicit is another important step in developing evaluation systems. This concept was supported by many authors who recognized the existence and need to evaluate trade-offs among performance measures (Cross & Lynch, 1988/89; Silveira & Slack, 2001; Eccles & Pyburn, 1992; Fitzgerald, 1991; Richardson, 1985).

To address the above problems/difficulties, Bana e Costa and Vansnick (Costa & Beinat, 2005; Costa & Chagas, 2004) proposed the MACBETH approach—measuring attractiveness by a categorical-based evaluation technique. The MACBETH model has been extensively used in various evaluation contexts and for various mathematical foundations to construct reusable evaluation models, as in faculty evaluation. The MACBETH approach makes absolute judgments based on differences in attractiveness rather than on ratios of priority or importance, as required by the AHP method. The MACBETH approach uses semantic judgments to elicit information from decision makers and incorporates systematic theoretical and semantic checks on the consistency of judgments. The MACBETH approach is considered an interactive technical procedure that supports the construction of numerical scales of intervals, which aim at quantifying the difference in attractiveness between two alternatives considered based on semantic judgments. However, MACBETH deals with cardinal value scales in a more innovative way because, unlike the AHP, which is based on the concept of priority/importance and on ratio scales, the MACBETH methodology makes use of scales of difference of attractiveness, considered more appropriated, among other things, to project repulsive judgments (Costa et al., 2002; Costa et al., 2003; Costa et al.,1999; Costa & Vansnick, 1997). MACBETH can also play a fundamental role in the field of performance measurement and management.

Considering the importance of the problem and the interplay of different factors involved in faculty performance, in this study, we propose the design of an evaluation method for faculty performance using a multicriteria decision analysis (MCDA) model. The MCDA models facilitate both qualitative and quantitative indicators for evaluation and thus may be the method of choice considering the diverse responsibilities played by HEI faculty.

The aim of this study was to explore the usefulness of MACBETH in explicitly dealing with the trade-offs between performance measures and in making the process of performance measurement and management more transparent and defendable.

2. Need for the study

Evaluating faculty performance is a complex process that can involve accessing multiple dimensions of different indicators/criteria and objectives. Furthermore, a single criterion cannot handle the complexity of the current higher education system or related problems. Hence, MCDA-M MACBETH provides a flexible tool that is useful for decision makers when mapping problems. Scientists believe that the MACBETH can serve as a scientific decision-making tool for evaluating the performance of university faculty.

3. Materials and Methods

This is a descriptive study on the annual performance scores of faculty members in higher education institutions. Annual performance appraisal involves the submission of faculty performance across different domains, such as teaching, administrative responsibilities, research and feedback, by students, peers, and heads of departments. In this study, the academic performance indicator (API) scores of faculties belonging to different disciplines, viz., medical, dental and pharmacy disciplines, of a higher education institution were considered. The data were obtained after permission was obtained from

the authorities of the institution, and data cleaning was performed to eliminate incomplete information. Only those scores that were complete across different domains were considered for further analysis. A total sample of 372 faculty members was included in the study. The scores were entered into an MS Excel spreadsheet, and statistical analysis was carried out using MacBeth software. The API scores are categorized into criterion I for teaching (A1 to A4); II for cocurricular (B1 to B3); III for research (C1 to C12); and IV for feedback (D1 to D3) from students, peers, and the head of the department, with a total score of 300 for 22 indicators under these four major criteria, as shown in Figure 1. The individual scores for each criterion were entered into an MS Excel spreadsheet, and the data were evaluated using the Macbeth approach.

The objectives of using this model for performance evaluation were as follows:

- To define a coherent set of evaluation criteria for faculty performance considering the use of MACBETH academics, research, and cocurricular work and feedback from stakeholders.
- The faculty scores in the MACBETH software were used to integrate quantitative and qualitative dimensions to describe individual faculty performance across various disciplines.
- To test the usefulness of the application of the Macbeth performance evaluation for arriving at decisions as objectively and as unambiguously as possible.

The MACBETH model has been extensively used in various evaluation contexts and for various mathematical foundations to construct reusable evaluation models, as in faculty evaluation. The MACBETH approach's absolute judgments are based on differences in attractiveness rather than on ratios of priority or importance, as required by the analytic hierarchy process (AHP) method. Both the MACBETH and AHP are multicriteria decision analysis models (MCDA) that facilitate both qualitative and quantitative indicators for evaluation and thus may be the methods of choice considering the diverse responsibilities of faculty.

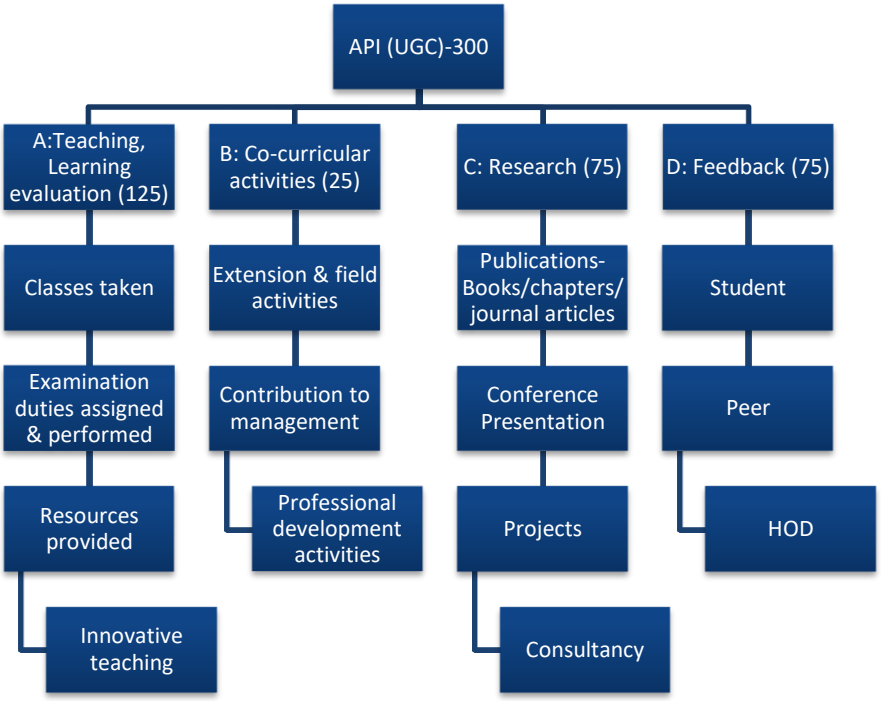

Figure 1 Criteria (A to D) for faculty performance evaluation as per the University Grants Commission, India.

MACBETH measures attractiveness via a categorical-based evaluation technique and has been extensively used in various evaluation contexts and mathematical foundations to construct reusable evaluation models, as in faculty evaluation. The MACBETH approach uses semantic judgments to elicit information from decision makers and incorporates systematic theoretical and semantic checks on the consistency of judgments. The MACBETH approach is considered an interactive technical procedure that supports the construction of numerical scales of intervals, which aim at quantifying the difference in attractiveness between two alternatives considered based on semantic judgments. However, MACBETH deals with cardinal value scales in a more innovative way because, unlike the AHP, which is based on the concept of priority/importance and on ratio scales, the MACBETH methodology depicted in Figure 2 makes use of scales of difference of attractiveness, considered more appropriate, among other things, to project repulsive judgments.

The M-MacBeth software developed by Bana e Costa facilitates the following steps:

- Complete model structuring
- Management of complex problems involving qualitative value scores and weights

- Interactive sensitivity and robustness analyses

As judgments are entered into the software, their consistency is automatically verified. A numerical scale is generated that is entirely consistent with all the decision makers' judgments. Through a similar process, weights are generated for the criteria

The value tree was constructed using the faculty API scores with weights for the four major criteria shown in Figure 3. The major criteria (I to IV) are placed at the first level, and the 22 indicators (A1 to D3) are placed at the second level. For convenience of analysis, the criteria C1 to C12 are summarized as C1, and criteria D1 to D3 are summarized as D1. The weights were distributed among the four major criteria as 35, 15, 45, and 5, with more weight given to criterion III, i.e., research. Figure 3 depicts the value tree constructed according to the abovementioned scores.

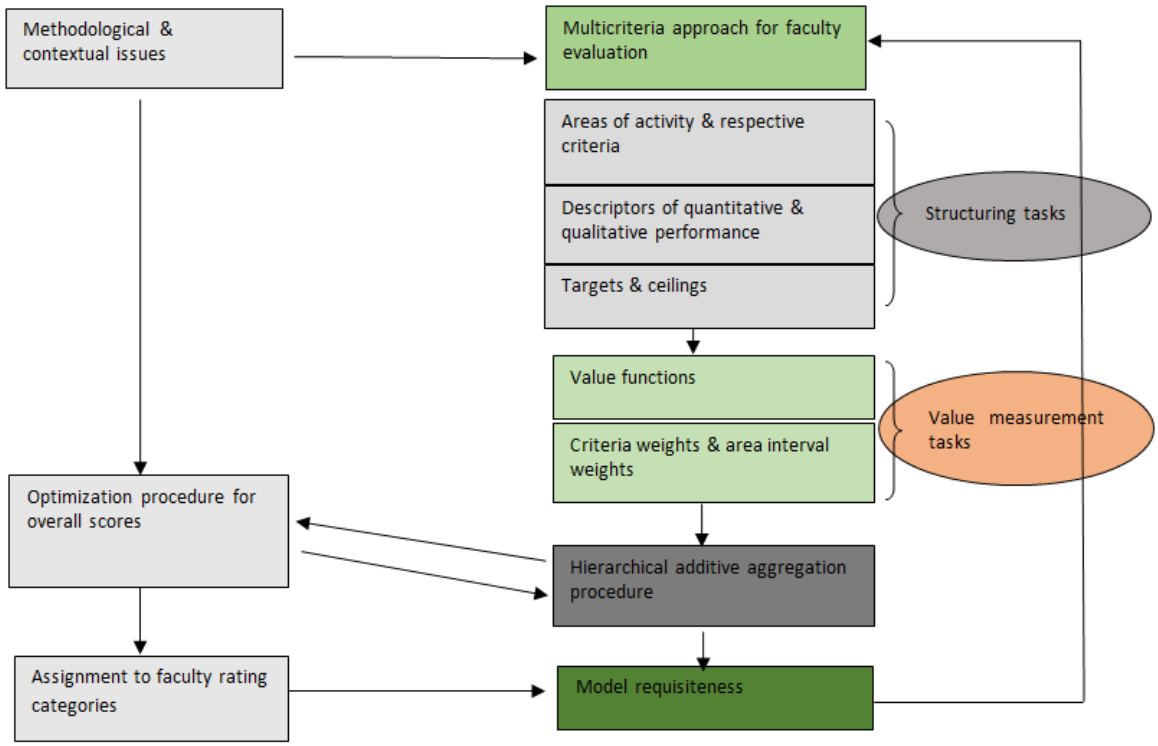

Figure 2 Key components of the process of building a MACBETH model for faculty evaluation (adopted from C.A. Bana e Costa, M.D. Oliveira/Omega 40 (2012) 424–43).

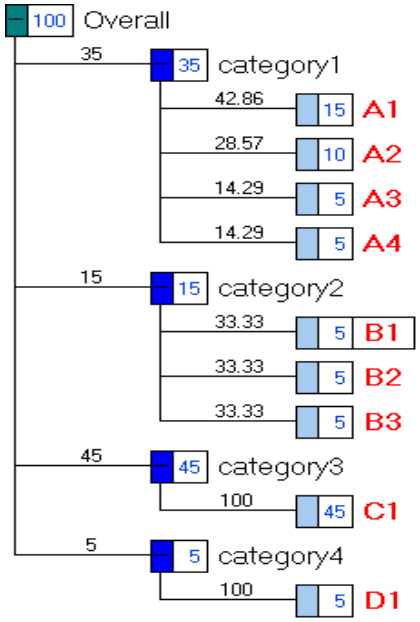

Figure 3 Value Tree of the Faculty Performance Criteria.

4. Results and discussion

The scores of individual faculties against four major criteria comprising 22 indicators were analyzed using MACBETH software, and the value tree was constructed with greater weighting for criterion III, i.e., research. The analysis obtained is described in the following section (Table 1).

Table 1 Performance of medical (MC), dental (H), and pharmaceutical (PC) faculty members.

	A1	A2	A3	A4	B1	B2	B3	C1	D1
H1	50	20	20	25	5	15	15	148.8	62
H2	46	20	10	5	10	5	12	17	58.67
H3	34	20	20	25	0	15	8	69.62	61.3
H4	50	20	20	25	0	5	5	66.3	59.3
H5	40.5	20	20	25	0	15	15	32.5	70.28
H6	20	20	20	25	0	15	15	17	55.95
H7	20	16	20	25	20	15	9	76.5	66.63
MC1	50	20	20	25	0	15	19	49	70.5
MC2	50	19	18	24	20	14	26	73	66.75
MC3	48	18	18	25	2	13	10	44	61.5
MC4	50	20	20	25	0	17	12	5	54.2
MC5	50	20	20	25	0	15	21	36.7	60.7
MC6	50	20	20	25	10	10	15	26.6	55
MC7	50	20	20	25	20	15	10	30	65
PC1	50	20	20	25	20	10	15	75	73
PC2	50	20	20	18	20	15	15	75	49.5
PC3	50	20	20	25	15	15	15	26.2	53
PC4	50	20	20	25	15	15	15	29	68
PC5	46	20	20	25	10	15	9	75	67.08
PC6	50	15	15	25	20	15	14	75	68.6
PC7	50	15	20	25	20	15	9	75	69.3

A representative sample was drawn from each discipline, viz., medicine, dentistry, or pharmacy, with seven faculty members representing each discipline; a total of 21 faculty members were considered for further ranking analysis across various cadres, as shown in Figure 4.

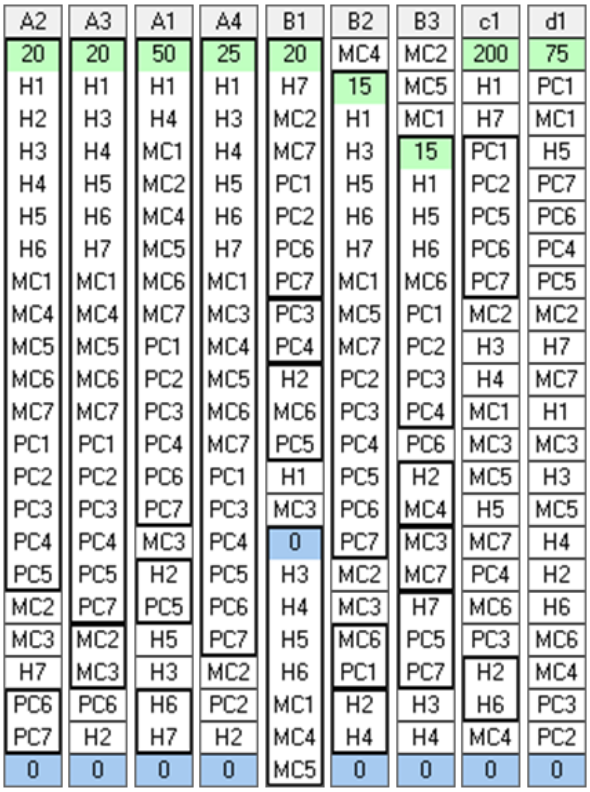

Figure 4 Ranking of faculty from the medical (MC), dental (H), and pharmacy (PC) disciplines

Figure 4 shows the rankings of faculty members belonging to all three disciplines based on their performance in the four criteria. According to the weightage, the faculty who had better performance scores in research (C1) had higher ranking when compared to others whose performance scores were lower in the research component despite higher scores in other criteria.

Figure 5 shows the rankings of faculty across disciplines and across cadres. As shown in the second column depicting the overall score, faculty from dental colleges (H1) were ranked first, followed by faculty from medical colleges (MC2) and then Pharmacy faculty (PC1). If we compare the performance of these faculties by adding scores to all the indicators, then the rankings would be different. This analysis gives weight to research; hence, faculty members who had higher scores in the research component, despite lower scores in other components, could outdo in terms of performance rankings when compared to faculty members who had higher scores in all other components except research. This clearly demonstrates to the managers which of the faculty are good at research, and similarly, the same analysis can be performed by changing weight for different indicators, such as teaching and administrative indicators. This approach provides an important tool for decision making regarding recruitment, selection, promotion, assignment of important research projects and succession planning. This evaluation method provides faculty with the opportunity to recognize their strengths and weaknesses and thereby the scope of improvement. The results are reliable and reproducible and based on scientific methods. Hence, this tool can be applied across different disciplines as an important tool for education managers in decision making. Compared to other methods of evaluation, such as the analytic hierarchy process (AHP) and conventional methods, comparisons are evaluated on a ratio scale for AHP and on an interval scale for MACBETH. The decision maker needs to know which scale is better suited to yield their preferences.

Options	Overall	A1	A2	A3	A4	B1	B2	B3	c1	d1
[all upper]	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
H1	83.86	100.00	100.00	100.00	100.00	25.00	100.00	100.00	74.40	82.67
MC2	73.01	100.00	95.00	90.00	96.00	100.00	93.33	173.33	36.50	89.00
PC1	70.08	100.00	100.00	100.00	100.00	100.00	66.67	100.00	37.50	97.33
PC2	68.78	100.00	100.00	100.00	72.00	100.00	100.00	100.00	37.50	66.00
PC6	67.36	100.00	75.00	75.00	100.00	100.00	100.00	93.33	37.50	91.47
PC7	66.99	100.00	75.00	100.00	100.00	100.00	100.00	60.00	37.50	92.40
PC5	65.65	92.00	100.00	100.00	100.00	50.00	100.00	60.00	37.50	89.44
MC1	62.06	100.00	100.00	100.00	100.00	0.00	100.00	126.66	24.50	94.00
PC4	59.81	100.00	100.00	100.00	100.00	75.00	100.00	100.00	14.50	90.67
MC7	59.42	100.00	100.00	100.00	100.00	100.00	100.00	66.67	15.00	86.67
MC5	59.30	100.00	100.00	100.00	100.00	0.00	100.00	140.00	18.35	80.93
H7	58.65	40.00	80.00	100.00	100.00	100.00	100.00	60.00	38.25	88.84
PC3	58.18	100.00	100.00	100.00	100.00	75.00	100.00	100.00	13.10	70.67
H3	57.62	68.00	100.00	100.00	100.00	0.00	100.00	53.33	34.81	81.73
H4	57.20	100.00	100.00	100.00	100.00	0.00	33.33	33.33	33.15	79.07
MC6	55.49	100.00	100.00	100.00	100.00	50.00	66.67	100.00	13.30	73.33
MC3	55.07	96.00	90.00	90.00	100.00	10.00	86.67	66.67	22.00	82.00
H5	54.15	81.00	100.00	100.00	100.00	0.00	100.00	100.00	16.25	93.70
MC4	49.40	100.00	100.00	100.00	100.00	0.00	113.33	80.00	2.50	72.26
H6	43.55	40.00	100.00	100.00	100.00	0.00	100.00	100.00	8.50	74.60
H2	43.20	92.00	100.00	50.00	20.00	50.00	33.33	80.00	8.50	78.23
[all lower]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Weights :		0.1500	0.1000	0.0500	0.0500	0.0500	0.0500	0.0500	0.4500	0.0500

Figure 5 Overall scores for faculty from medical, dental and pharmacy disciplines based on criteria I to IV.

The analysis can also help education managers in human resource inventory management and human resource audits. Knowledge management has a competitive advantage, especially when there is a dearth of talent in the education sector. A gap in the demand and supply of qualified and skilled human resources necessitates such analysis, which provides information about the existing knowledge and skill inventory within the organization. With the education sector becoming increasingly competitive and expanding, there will always be this gap, and recruiting and retaining talented faculty will be a challenge for management. This study aimed to assess the performance of faculty members on multiple criteria using scientific soft computing models, and the results obtained reflected the strengths and advantages of the individual faculty members according to the respective criteria. The results also help in designing future training and development programs for the faculty, thereby providing opportunities for career development and progress in their respective fields.

5. Conclusions

Higher education institutions are engaged in teaching, research and community activities and hence need faculty who can contribute to fulfilling these objectives. Recruitment and selection processes aim at procuring the best, and education managers often find doing so difficult and challenging. Human resource management in the education sector is unique, unlike in other sectors, because modern day teachers multitask and need extensive training to deliver the expected resources. Evaluating performance becomes challenging considering the multiple roles played by teachers. Teaching is the primary objective, and research and administrative and community activities play additional roles. The use of soft computing tools can aid in selecting the right candidate based on need. This study was conducted with M-MACBETH software using the academic performance scores of faculty members from three different disciplines. There was significant variation in their performance according to the weight assigned when compared to overall scores. This provided insight into the application of modern evaluation methods in decision-making as well as future planning.

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Ethical considerations

Not applicable.

Conflict of interest

The authors declare no conflicts of interest.

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