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Identifying and Ranking Student Support Strategies in Higher Education Using Hybrid MCDM Technique

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Abstract

Colleges are not spared of such complicated issues dealing with how to effectively establish and enact strategies that can maximize student achievement and quality of education. In this research, a hybrid Multi-Criteria Decision-Making (MCDM) model involving the Fuzzy Analytic Hierarchy Process (FAHP) and the Technique for Order Preference by similarity to ideal solution (TOPSIS) shall be proposed as a way of estimating and ranking student support mechanisms. FAHP is employed to obtain the relative values of criteria where uncertainty is involved whereas TOPSIS is used to obtain the closeness coefficient of each alternative in terms of being close to the ideal solution. To explain the versatility and applicability of the model, a case study is carried out. Decision Matrix is developed based on the survey of 400 students of different institutions in Andra Pradesh and opinion of senior faculties with over 15 years of experience. The strategies that are considered to support student in academics, career guidance, counselling, peer mentoring, and financial aid are considered in terms of criteria are considered to be as accessibility, effectiveness, satisfaction, cost efficiency, and impact on retention. The findings unveil the best practices in their respective fields as to the role of career-oriented assistance and interactive online learning settings in enhancing academic success. The last approach is financial aid, perhaps because of its relative inaccessibility and bureaucratic nature. The graphical presentation of the analysis based on bar and radar charts also shows the performance disparities between the alternatives which gives intuitive results to the academic administrators. The results confirm that the hybrid FAHP -TOPSIS model is a powerful, versatile, and transparent decision-support mechanism that can address the inherent ambiguity and subjectivity of educational assessment. This paper adds a replicable methodological paradigm which is applicable to other decision contextures like curriculum planning, institutional ranking, and quality assurance.

Keywords: Higher Education, Fuzzy AHP, TOPSIS, Hybrid MCDM, Student Support, E-Learning Effectiveness, Decision Analysis, Educational Strategy Evaluation.

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Introduction

Nowadays, the nature of higher learning is on the quest to improve teaching, learning, and involvement of students in the education sector across the globe. Due to globalization, technological advancement, and the variety of learners and challenges, the educational environment is experiencing numerous and significant challenges, as it attempts to design and give priority to strategies that would guarantee student retention, academic achievement, and student growth.

Student support systems are crucial towards the realization of these goals, which include academic advisory, career guidance, psychological counseling, mentoring, and financial support. Equally, the performance of e- learning platforms and those academic strategies have become a key factor of institutional performance with the emergence of the digital learning ecosystem. Nonetheless, the evaluation and prioritization of these strategies incorporate several, interrelated and commonly contradictory criteria, such as the level of satisfaction, infrastructure, accessibility, cost-effectiveness, and learning outcomes. These are normally uncertain and qualitative criteria, and rely much on the judgment of experts and perception by the stakeholders. Traditional decision-making methods fall short of capturing this vagueness and subjectivity, necessitating a systematic and quantitative approach to derive reliable insights.

Several relevance applications of Fuzzy Analytic Hierarchy Process (FAHP) might be noted in the area of occupational hazards in the aquaculture sector (Ayvaz et al., 2024), global supplier risk factors (Chan & Kumar, 2007), Healthcare Technologies (Domínguez & Carnero, 2020), shopping mall site selection (Ghorui et al., 2020), road construction companies: (Janackovic et al., 2013), strategic marketing information systems (Koohathongsumrit & Luangpaiboon, 2022), construction of tunnels (Koohathongsumrit & Chankham, 2024), and many other areas. To ascertain the probability information and attain the transformation of fuzzy numbers to a cloud model, a new model utilizing interval-valued, hesitant fuzzy numbers (Zhu et al., 2024) is employed. In order to guarantee that employees are fully committed to finishing activities and accomplishing the objectives of the organization, (Perić et al., 2019) showed the significance of employee motivation and satisfaction. The components and their factor weights within the group, as well as the portion of the variation that is explained by common variables, were acquired through an examination of competences and PCA analysis in (Sančanin et al., 2024). This study gives main concern to applications in the educational setting. The qualities in the educational context are prioritized in this study. A combination of principal component analysis (PCA) and fuzzy analytic hierarchy process (FAHP) is used in (Sančanin et al., 2024), to rank 21st-century competencies developed throughout the educational process to improve the system by identifying the highest-ranked competency (Luyen & Thanh, 2022).

Numerous innovative MCDM models have recently been introduced by researchers to enhance decision-making efficiency, accuracy, and strategic outcomes (Tan et al., 2021; Shyur & Shih, 2006; Hu et al., 2014). These approaches have gained increasing popularity due to their ability to evaluate and compare multiple alternatives simultaneously. Nevertheless, the classical MCDM approaches are slowly becoming ineffective when it comes to the complexity of the contemporary decision-making issues. In practical situations, in most instances, one MCDM methodology is insufficient to process complex decision scenarios (Zarei et al., 2021). Thus, it has been necessary to integrate two or more MCDM models or integrate MCDM with other methods of analysis in order to obtain stronger and more effective decision-making (Li et al., 2020). The primary aim of this type of integration is to exploit the strengths of each of the methods and balance them out with the limitations inherent in each method. For instance, (Goswami & Behera, 2023).

A hybrid MCDM model, which is a combination of COPRAS and ARAS was proposed by (Goswami & Behera, 2023) to determine the best replacement robot. In different research, the authors have applied FAQT-2 to select robots and have shown that the hybrid MCDM method was much more reliable and consistent than the traditional methods of single method MCDM methods (Soltan et al., 2023). The Fuzzy-AHP and TOPSIS models are more flexible and comprehensive decision-making tools because they consider uncertainty in decision criteria, as well as alternatives. These are commonly-used methods in the field of multi-criteria decision-making (MCDM) [1920].

Based on the foregoing literature review, it might be observed that Multi-Criteria Decision-Making (MCDM) techniques have become significant due to its ability to create model scenarios of decisions that employ both qualitative and quantitative parameters. The Analytic Hierarchy Process (AHP) is one of them, and it offers a systematic process of determining the relative importance of criteria, whereas Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) ranks alternatives in respect of their similarity to the ideal solution. However, in the practical learning environment, the judgments of experts are hardly crisp and deterministic and thus the introduction of Fuzzy logic in AHP increases the ability to deal with uncertainty resulting in the Fuzzy Analytic Hierarchy Process (FAHP). The hybrid FAHP-TOPSIS model can be used to identify and rank strategies and prioritize them in uncertain conditions, which is a powerful decision-support tool when integrated with TOPSIS.

Despite the fact that a significant number of studies have used MCDM methods in educational assessment like university ranking, performance assessment, and curriculum assessment, there is still a tendency of lack of attention on the incorporation of hybrid fuzzy decision models in determining and ranking student support techniques that have direct effect on student outcomes. In addition, current studies tend to test e-learning or other support systems in isolation as opposed to a single analytical system that describes the interplay between academic, psychological, and infrastructural variables. Moreover, crisp data are not uncommon in earlier models, disregarding the indeterminacy/vagueness of the decision-making processes of experts. This leaves a research gap in the development of fully comprehensive, uncertainty-conscious methodologies, which could steer the institutional decision-maker to policy intervention based on data. Thus, a common and hybrid MCDM-based framework is obviously required to evaluate various strategies based on the various dimensions of the higher education.

The novelty of the research is that fuzzy logic is combined with classical MCDM techniques in order to solve uncertainty in human judgment. Lastly there might be the anticipated results of the decision that is increasing its accuracy. This is in contrast to previous research which only studies one domain at a given time, as the research will be able to analyze both student support systems as well as the e-learning strategies and will provide a comparative and scalable decision framework that can be used in any one area of education. Moreover, since FAHP is used to weight the criteria and TOPSIS is applied to rank the strategies, the proposed hybrid model will guarantee subjectivity and objectivity of the decision-making process. Interpretative clarity is further enhanced by the presence of graphical charts including bar and radar charts that help to convert a large number of numerical outputs into practical information. Such a hybridized and holistic approach adds a methodological innovation to educational decision analytics as well as provides a paradigm to be replicated in multi-domain application to higher education management.

The main objectives of this research are as follows:

1. To expand a hybrid Fuzzy AHP-TOPSIS model in the process of assessing and ranking strategies to improve student performance in higher education (Tran et al., 2024).
2. To identify and find out the most important criteria affecting student support and the effectiveness of e-learning with the help of expert consultation and literature analysis.
3. To use the model of the suggested student support strategies to prove its flexibility and strength.
4. To observe and analyze the results of the ranking based on bar charts and radar charts to make decisions intuitively.
5. To offer recommendations at the policy-level to higher education administrators and stakeholders to improve institutional effectiveness.

Preliminaries

The hybrid FAHP-TOPSIS model is constructed on the premises of the fuzzy set theory and the multi-criteria decision-making (MCDM). The section provides key definitions, concepts, and theorems that form the mathematical basis of the approach applied in this study.

Multi-Criteria Decision-Making (MCDM)

An MCDM model aims at obtaining a ranking function ($R(A_i)$) that ranks all alternatives based on their performance. Multi-Criteria Decision-Making (MCDM) is a set of methods that are applied to assess and rank a finite group of alternatives, according to a set of criteria, which tend to be conflicting.

Let $A = \{A_1, A_2, \dots, A_m\}$ be the set of alternatives and $C = \{C_1, C_2, \dots, C_3\}$ be the set of evaluation criteria.

The decision matrix is represented as

$$D = \left[x_{\{ij\}}\right]_{\{m \times n\}},$$

($x_{\{ij\}}$) is the ranking of alternative (A_i) against criterion (C_j).

Fuzzy Set Theory (Zadeh, 1965)

A fuzzy set of a universe ($\tilde{A}$) in a universe (X) is defined as

$$\tilde{A} = \{(x, \mu_{\{\tilde{A}\}}(x)) \mid x \in X\},$$

and ($\mu_{\{\tilde{A}\}}(x)$: $X \rightarrow [0,1]$) is the membership function that represents the degree of membership of (x) in the fuzzy set ($\tilde{A}$).

Triangular Fuzzy Numbers (TFNs)

A triangular fuzzy number (TFN) is represented as

$$\tilde{a} = (l, m, u),$$

Where (l), (m), and (u) denote the lower, modal, and upper bounds respectively. The corresponding membership function is:

$$\mu\{\tilde{a}\}(x) = \begin{cases} \{x-1\}/\{m-l\} l \leq x \leq m, x < l \\ \{u-x\} m \leq x \leq u, x > u. \end{cases}$$

Operations on Triangular Fuzzy Numbers

For two TFNs ($\tilde{a}_1 = (l_1, m_1, u_1)$) and ($\tilde{a}_2 = (l_2, m_2, u_2)$):

$$\tilde{a}_1 \oplus \tilde{a}_2 = (l_1 + l_2, m_1 + m_2, u_1 + u_2),$$

$$\tilde{a}_1 \ominus \tilde{a}_2 = (l_1 - u_2, m_1 - m_2, u_1 - l_2)$$

$$\tilde{a}_1 \otimes \tilde{a}_2 = (l_1 l_2, m_1 m_2, u_1 u_2),$$

$$\tilde{a}_1 \oslash \tilde{a}_2 = \left(\frac{\{l_1\}}{\{u_2\}}, \frac{\{m_1\}}{\{m_2\}}, \frac{\{u_1\}}{\{l_2\}}\right)$$

Defuzzification

To transform a TFN into a crisp value, there is sometimes a requirement to apply the centroid (center of gravity) method:

$$\{Defuzz\}\tilde{a}_1 = \frac{\{l + m + u\}}{\{3\}}$$

The approach yields one scalar, the fuzzy evaluation which may be subjected to additional calculation (e.g., derivation of weights in FAHP).

Theorem 2.1 (Consistency of FAHP Weights)

When the fuzzy pairwise comparison matrix ($\tilde{A}$) is given to be reciprocal together with triangular consistency, the fuzzy weights obtained ($W = (w_1, \ldots, w_n)$) is a consistent priority vector.

Theorem 2.2 (Monotonicity of TOPSIS Ranking)

Assuming that, in all criteria of benefit, (A_i) *and* (A_k), (A_i) does no more (or no less) poorly than (A_k), and makes (at least) one better, then ($CC_i > CC_k$).

The mathematical foundation of the above theoretical constructs is the implementation of FAHP--TOPSIS in the decision-making process of higher education. It is their combination that facilitates the management of uncertainty, consistency of logic and quantitative rigor in reviewing strategies of supporting students.

Generalized Methodology

The process of defining and ranking the successful strategies in tertiary education (either systems of student support or e-learning) cannot be made without a systematic and data-driven methodology. The Hybrid Multi-Criteria Decision-Making (MCDM) framework with the integration of Fuzzy Analytic Hierarchy Process (FAHP) and Technique of Order Preference by Similarity to Ideal Solution (TOPSIS) is embraced in this study. This combined solution combines both fuzzy weighting that is expert-based and objective performance assessment to present a complete decision support solution.

Step 1: Problem Definition and Data Structuring Two independent decision problems are formulated:

Case Study: Prioritizing Student Support Strategies (e.g., Academic Advising, Career Guidance, Counseling, etc.) by qualitative factors (e.g., Accessibility, Academic Impact, Emotional Support, Cost-effectiveness, and Technological Integration). Every problem is modeled as a decision matrix $D = [x_{\{ij\}}]$ where $x_{\{ij\}}$ is the performance rating of alternative A_i of criterion on C_j.

Step 2: Determination of Criteria Weights Using FAHP

The Fuzzy AHP is taken to obtain the weights of criteria in order to integrate the uncertainty of the human judgment. The steps include:

1. Pairwise Comparison Matrix Construction: Experts make linguistic judgments (e.g. equally important, moderately important, strongly important) which take the form of Triangular Fuzzy Numbers (TFNs).

$$A = [\tilde{a}_{ij}] = \begin{pmatrix} 1 & \tilde{a}_{12} & \cdots & \tilde{a}_{1n} \\ \tilde{a}_{21} & 1 & \cdots & \tilde{a}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{a}_{n1} & \tilde{a}_{n2} & \cdots & 1 \end{pmatrix}$$

2. Fuzzy Synthetic Extent Calculation: For each criterion (C_i),

$$S_i = \frac{\{\sum_j \tilde{a}_{\{ij\}}\}}{\{\sum_i \sum_j \tilde{a}_{\{ij\}}\}}$$

3. Defuzzification: The fuzzy weights are defuzzified using the centroid method:

$$w_i = \frac{\{l_i + m_i + u_i\}}{3}$$

4. Normalization: The final crisp weights are normalized:

$$W_i = \frac{\{w_i\}}{\{\sum_i w_i\}}$$

The FAHP weights accommodate the ambiguity among the preferences of decisions given by experts.

Step 3: Performance Evaluation and Normalization

Every option is discussed based on all criteria with normalized scores based on survey, expert or institutional performance measures. The normalized decision matrix is computed as:

$$w_i = \frac{\{x_{\{ij\}}\}}{\left\{\sqrt{\{\sum_i x_{\{ij\}}^2\}}\right\}}$$

Step 4: Weighted Normalized Decision Matrix

The weights of the FAHP are multiplied with the normalized matrix to get the weighted normalized decision matrix:

$$v_{\{ij\}} = w_j \times r_{\{ij\}}$$

This integrates both the importance of criteria and the performance of alternatives. Step 5: Determination of PIS and NIS

Two reference points are identified: Positive Ideal Solution (PIS):

$$V^+ = \{max(v_{\{ij\}}) | j \in J\}$$

Negative Ideal Solution (NIS):

$$V^- = \{max(v_{\{ij\}}) | j \in J\}$$

Step 6: Distance Measures and Closeness Coefficient

Euclidean distance of the alternatives to PIS and NIS will be calculated as:

$$S_i^+ = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^+\right)^2}$$

$$S_i^- = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^-\right)^2}$$

The Closeness Coefficient (CC) for each alternative is then obtained as:

$$CC_i = \frac{S_i^-}{S_i^+ + S_i^-}$$

A higher (CC_i) indicates greater proximity to the ideal solution and thus a higher ranking.

Step 7: Ranking and Visualization

The list of alternatives is descending according to (CC_i). Represented are: Visualization tools like bar charts and radar charts are used to represent them.

Bar Chart: The total rank in terms of closeness coefficients. Radar Chart: Multidimensional performance of all criteria.

Intuitive insights into the relative merits of each strategy are made easy with the help of these visual tools.

Step 8: Validation and Sensitivity Analysis

The sensitivity analysis is carried out by changing the weights of FAHP in order to evaluate the sensitivity of the rankings. The similarity of ranking order with variations indicates robustness of a model.

The methodology therefore gives an integrated decision-making model which can be adapted to various fields of higher learning.

Case Study - Application of Hybrid MCDM to Rank Student Support Strategies in a University

It is the creation of the fuzzy decision-making matrix that involves both student perceptions and expert opinions to achieve validity of the evaluation framework. A total of 400 students in the Andhra Pradesh based institutions were surveyed to derive their opinions on the effectiveness of the various support and e-learning strategies. The questionnaire has been formulated based on a five-point language scale whose range varies between Very Poor to Excellent which are fuzzy numbers (0.1, 0.3, 0.5), (0.3, 0.5, 0.7), (0.5, 0.7, 0.9), and (0.7, 0.9, 1.0).

To get the opinions of experts, five top faculty members and academic administrators with a minimum of fifteen years of experience in student engagement were used. These experts offer pairwise comparison of the evaluation criteria by using the Fuzzy Analytic Hierarchy Process (FAHP) scale in order to establish the relative significance of the importance of accessibility, academic impact, emotional support, cost efficiency, and technological integration.

The responses that are developed using the fuzzy averaging techniques produce the fuzzy decision matrix immediately. Each component is the overall assessment of a given strategy within a given criterion in the form of Triangular Fuzzy Number (TFN). This matrix was used as the main input in the Fuzzy TOPSIS analysis which allowed calculation of normalized values, weighted scores, and closeness coefficients used to obtain the final ranking of the strategies.

Problem Definition

The aim of the study is to improve student contentment and retention conducted at a higher education institution. The university faces difficulty in finding a strategy that improves academic success and welfare of the students. The purpose of this work to identify and rank student support strategies with the help of hybrid MCDM approach.

Student Support Strategies Considered (Alternatives)

The considered student support strategies are academic advising, career guidance, counselling, peer mentoring, financial aid and online support.

Table 1: Support Strategies for Student Development and Well-Being

Code	Support Strategy
S_1	Academic Advising and Mentoring
S_2	Career Guidance and Internship Support
S_3	Psychological Counseling and Wellness Programs
S_4	Financial Aid and Scholarship Schemes
S_5	Online Learning Support (LMS, digital resources, tutorials)

To emphasize on the support strategies that are significant in enhancing student development, the following table 1 is employed. It involves academic counseling/ mentoring, career counseling such as internship programs, psychological counseling, money support and web-based courses. The measures will be directed towards the provision of holistic

support, which will assist the students in receiving the required guidance, mental health, financial and access to online learning tools to achieve success in their academic and personality spheres.

Evaluation Criteria

Strategies are evaluated under criteria accessibility, effectiveness, satisfaction, cost efficiency, and impact on retention.

Table 2: Criteria for Evaluating Student Support Strategies

Code	Criterion	Description
C_1	Accessibility	Ease of student access and availability of resources
C_2	Impact on Academic Performance	Influence on grades and skill development
C_3	Emotional and Social Support	Effect on mental health, belongingness, and motivation
C_4	Cost-effectiveness	Efficiency of resource utilization
C_5	Technological Integration	Use of ICT tools and data-driven support

This table 2 shows the criteria of evaluating student support strategies based on the factors of accessibility, academic impact, emotional support, cost-effectiveness, and technological integration. All these contribute to the assurance of the easy accessibility of support systems, improvement of academic performance, emotional well-being, efficient utilization of the resources, and the use of technology to provide better service to students.

Linguistic Scale → Triangular Fuzzy Numbers (TFNs) Used

Table 3: Linguistic Terms and their Corresponding Saaty-like Values and TFN (Triangular Fuzzy Numbers)

Linguistic term	Saaty-like value	TFN (l, m, u)
Equally important	1	(1, 1, 1)
Weak / Slightly more important	1/2	(0.5, 1, 1.5)
Moderately more important	2/3	(0.67, 1, 2)
Moderately strong / between 1 & 3	1.0–2.0	(1, 1.5, 2)
Strongly more important	3	(1, 2, 3)
Slightly less important	1/3	(0.33, 0.5, 1)

This table 3 gives language words and their respective Saaty-like values and Triangular Fuzzy Numbers (TFN). The values differ in the degree of importance (between "Equally important" (value of 1 and TFN of (1, 1, 1)) to degrees of being weak / slightly more important" (value of 1/2) and strongly more important). The TFN values are the lower, middle, and upper levels of importance which offer a fuzzy way of determining subjective importance of something when making a decision.

Reciprocity rule for TFNs: if $(\tilde{a}_{\{iy\}} = (l, m, u))\ then\ (\tilde{a}_{\{yi\}} = (1/u, 1/m, 1/l))$.

Hybrid MCDM Framework

We use a two-stage hybrid method combining:

1. Fuzzy AHP (FAHP) – to derive weights of evaluation criteria.
2. Fuzzy TOPSIS – to rank student support strategies based on those criteria.

Phase 1: Fuzzy AHP for Criteria Weighting

Pairwise comparison matrix $(\tilde{A} = [\tilde{a}_{\{ij\}}])\ (TFNs)$

Rows = criterion being compared (i), Columns = criterion compared to (j).

$$\tilde{A} = \begin{bmatrix} (1,1,1) & (0.5,1,1.5) & (1,1.5,2) & (0.33,0.5,1) & (1,1,1.5) \\ (0.67,1,2) & (1,1,1) & (1,2,3) & (1,1.5,2) & (0.5,1,1.5) \\ (0.5,1,1.5) & (0.33,0.5,1) & (1,1,1) & (1,1.5,2) & (1,1,1.5) \\ (1,2,3) & (0.5,1,1.5) & (0.33,0.5,1) & (1,1,1) & (1,1,1.5) \\ (0.67,1,2) & (1,2,3) & (0.5,1,1.5) & (0.5,1,1.5) & (1,1,1) \end{bmatrix}$$

Interpretation notes (example):

- Entry ((1,2)) = (0.5,1,1.5) means Accessibility (C1) is judged “weakly important” relative
- to Academic Impact (C2).

- Entry ((4,1) = (1,2,3)) means Cost-effectiveness (C4) is judged strongly more important than Accessibility (C1) (you can change any of these if you want different expert judgments).

Sample Fuzzy Pairwise Comparison Matrix (Triangular Fuzzy Numbers)

Table 4: Pairwise Comparison Matrix with Saaty-like Values and Triangular Fuzzy Numbers (TFN)

Criteria	C_1	C2	C_3	C_4	C_5
C_1	(1,1,1)	(0.5,1,1.5)	(1, 1.5,2)	(1/3, 0.5,1)	(1,1, 1.5)
C2	(2/3,1,2)	(1,1,1)	(1,2,3)	(1, 1.5,2)	(0.5,1, 1.5)
C_3	(0.5,1, 1.5)	(1/3, 0.5,1)	(1,1,1)	(1, 1.5,2)	(1,1, 1.5)
C_4	(1,2,3)	(0.5,1, 1.5)	(1/3, 0.5,1)	(1,1,1)	(1,1, 1.5)
C_5	(2/3,1,2)	(1,2,3)	(0.5,1, 1.5)	(0.5,1, 1.5)	(1,1,1)

In this table 4, the pairwise comparison of five criteria (C 1 to C 5) is done with the help of Saaty-like values and Triangular Fuzzy Numbers (TFN). The values are used to show how relatively important criteria are, with fuzzy values being used to give a range of equally important (1, 1, 1) to different degrees of importance (moderately important, weakly important). The method assists in the quantification of the subjective ratings in decision making.

After defuzzification and normalization, the weights obtained are:

Table 5: Weight Distribution for Evaluation Criteria

Criterion	C_1	C2	C_3	C_4	C_5
Weight	0.18	0.27	0.24	0.15	0.16

This table 5 demonstrates the weight, which is allocated to five evaluation criteria (C1 to C5). The weights indicate the comparative weight of each criterion in the evaluation process. C 2 is the heaviest with 0.27 weight indicating its greater importance whereas C 4 is the lightest with 0.15 weight, which, therefore, is a comparatively less important part of what will be evaluated at the final. C_1, C3 and C5 have weights of 0.18, 0.24, and 0.16 which indicate their moderate significance.

Thus, Impact on Academic Performance (C_2) and Emotional & Social Support (C_3) are most important.

Phase 2: Fuzzy TOPSIS for Ranking Fuzzy Decision Matrix (simplified form)

$$\widetilde{D}^{(1)} = \begin{bmatrix} (0.5,0.7,0.9) & (0.6,0.8,1.0) & (0.5,0.7,0.9) & (0.3,0.5,0.7) & (0.5,0.7,0.9) \\ (0.6,0.8,1.0) & (0.8,1.0,1.0) & (0.5,0.7,0.9) & (0.4,0.6,0.8) & (0.6,0.8,1.0) \\ (0.5,0.7,0.9) & (0.4,0.6,0.8) & (0.8,1.0,1.0) & (0.3,0.5,0.7) & (0.5,0.7,0.9) \\ (0.4,0.6,0.8) & (0.6,0.8,1.0) & (0.4,0.6,0.8) & (0.7,0.9,1.0) & (0.3,0.5,0.7) \\ (0.7,0.9,1.0) & (0.6,0.8,1.0) & (0.6,0.8,1.0) & (0.5,0.7,0.9) & (0.8,1.0,1.0) \end{bmatrix}$$

(Ratings are in linguistic variables like Low, Medium, High converted to fuzzy numbers)

Table 6: Triangular Fuzzy Numbers (TFN) for Strategy Evaluation Across Criteria

Strategy	S_1	S2	S_3	S_4	S_5
C_1	(0.5,0.7,0.9)	(0.6,0.8,1.0)	(0.5,0.7,0.9)	(0.4,0.6,0.8)	(0.7,0.9,1.0)
C2	(0.6,0.8,1.0)	(0.8,1.0,1.0)	(0.4,0.6,0.8)	(0.6,0.8,1.0)	(0.6,0.8,1.0)
C_3	(0.5,0.7,0.9)	(0.5,0.7,0.9)	(0.8,1.0,1.0)	(0.4,0.6,0.8)	(0.6,0.8,1.0)
C_4	(0.3,0.5,0.7)	(0.4,0.6,0.8)	(0.3,0.5,0.7)	(0.7,0.9,1.0)	(0.5,0.7,0.9)
C_5	(0.5,0.7,0.9)	(0.6,0.8,1.0)	(0.5,0.7,0.9)	(0.3,0.5,0.7)	(0.8,1.0,1.0)

This table 6 compares five strategies (S 1 to S 5) on five criteria (C 1 to C 5). The fuzzy values are the extent of importance of every combination of strategy-criteria, which provides a flexible means of determining their value. As an example, the TFN (0.5, 0.7, 0.9) of Strategy S 1 and Criterion C 1 suggests different emphasis of the importance of 0.5 to 0.9.

After normalization and distance calculation Compute the closeness coefficient (CC):

Table 7: Evaluation of Strategies Based on CC Values and Ranking

c	S_1	S2	S_3	S_4	S_5
CC Value	0.71	0.78	0.69	0.58	0.63
Rank	2	1	3	5	4

This table 7 provides the analysis of five strategies (S 1 to S 5) in terms of their CC value, and rank respectively. The CC values mean the level of effectiveness or performance of every strategy and the better the strategy the higher the value. Strategy S 2 has the largest CC value 0.78 and is ranked 1st and Strategy S 4 the lowest CC value is 0.58 and it is ranked 5. The ranking is the performance of each strategy as compared to the others with S 2 being the best and S 4 being the worst.

Interpretation of Results

Best Strategy Career Guidance and Internship Support (S2) take first place, indicating that direct employability and career outcomes are some of the key motivators of students.

Second: Academic Advising and Mentoring (S1) facilitates individual learning and early intervention.

Last: Financial Aid (S_4), which could be because of the lack of access and complexity of the bureaucracy.

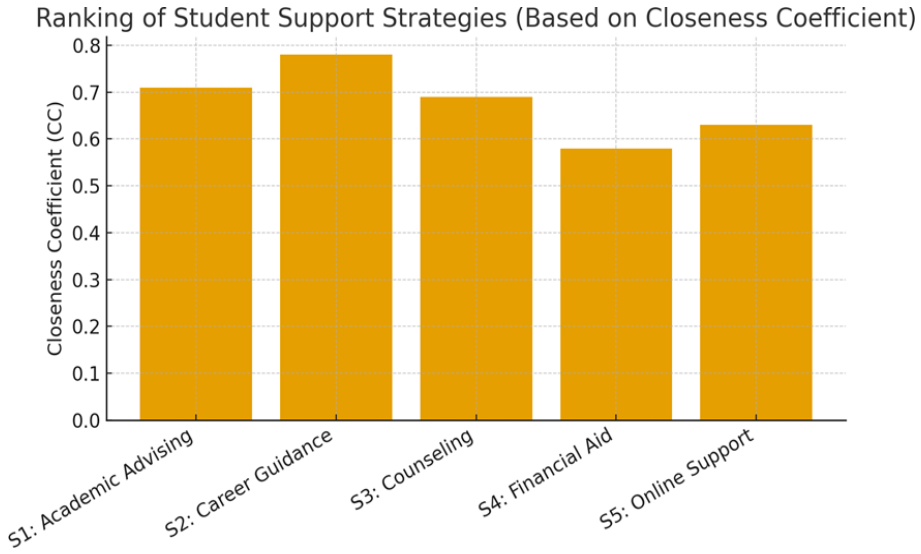


Fig. 1: Bar Chart – Showing the Overall Ranking of Each Student Support Strategy Based on the Closeness Coefficient

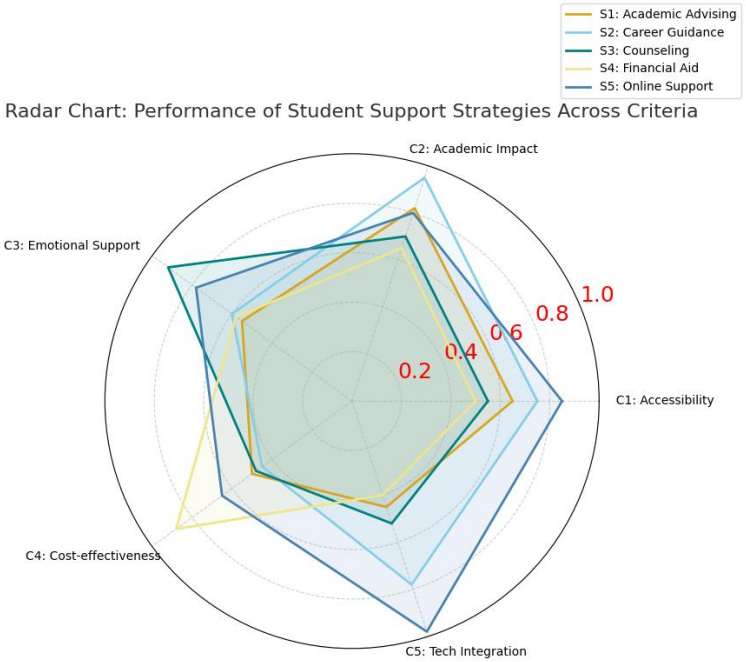


Fig. 2: Radar Chart – Illustrating How Each Strategy Performs Across All Evaluation Criteria

Managerial Implications

Institutions are encouraged to focus their attention on programs related to employability and networks of mentoring that enhance the incorporation of counseling and academic support. It must invest in programs that provide an increase in academic performance and psychological health.

A bar chart (Fig. 1) and a radar chart (Fig. 2). can show how well each strategy does on average across all criteria. The X-axis shows the criteria, the Y-axis shows the weighted scores, and each line shows a support strategy.

This case study shows how hybrid fuzzy MCDM can be used effectively to evaluate and rank ways to help students in college. FAHP and Fuzzy TOPSIS work well together to give administrators a clear way to rank things and a strong way to weight them. This gives them a systematic way to plan strategically and allocate resources.

Conclusion

This study clearly shows how to improve higher education by looking at how well, how useful, and how strong a hybrid Multi-Criteria Decision-Making (MCDM) framework that combines the Fuzzy Analytic Hierarchy Process (FAHP) and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) works. The survey is collected from various institutions in Andhra Pradesh and is validated with the support of senior faculty to formulate the decision matrix. A case study is conducted by analyzing student support strategies through five alternatives, evaluated based on diverse criteria. The proposed outcome suggests that Career Guidance was the most important strategy. This shows that there is a growing need for student development programs that focus on employability and are tailored to each student. The case study showed that the hybrid FAHP–TOPSIS framework was able to turn subjective expert evaluations into objective ones. The bar and radar charts make it easier for stakeholders to understand the results by showing them what they mean. This makes it easier for people in charge to look at different strategies and find areas where performance is lacking. In general, the research shows that hybrid MCDM models are a structured, clear, and flexible way to help make decisions that can deal with the problems and uncertainties that come with planning and policy in higher education. The framework not only sets the stage for future methodological improvements, but it also serves as a useful tool for academic administrators who want to make things better.

Several extensions can be pursued to enhance the real-world applicability of the proposed frame work MCDM such as integration with Neutrosphic Logic, hybridization with machine learning, dynamic MCDM for continuous evaluation and etc. Even it can be extended to diverse higher education decision such as curriculum development, faculty evaluation, sustainability planning and etc.

Declarations

Ethical Approval

The present study was conducted for academic research purposes involving voluntary participation of students in higher education institutions. The study did not involve medical procedures, clinical trials, or collection of sensitive personal data. Therefore, formal ethical approval was not required according to institutional guidelines. All procedures involving human participants were conducted in accordance with relevant institutional research guidelines and the ethical principles of the Declaration of Helsinki.

Consent to Participate

Informed consent was obtained from all individual participants included in the study. Participants were informed about the purpose of the research, and their participation was voluntary.

Consent to Publish

The authors confirm that informed consent for participation and publication was obtained from all participants. All data were collected anonymously and used only for academic research purposes.

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