NSS
Neutrosophic Sets and Systems, Vol. 82, 2025
University of New Mexico

Advanced Combined Multi-Criteria Decision-Making Methodology with IndetermSoft Set for Comprehensive Analysis of Blended Physical Education Teaching in Colleges Framework

Xueda Yang*

Yan 'an University, Yan'an, 716000, Shaanxi, China

*Corresponding author, E-mail: Yxd19761977@163.com

Abstract: Prioritizing and weighing criteria is a crucial step in the decision-making process for many qualities. The stepwise weight assessment ratio analysis (SWARA) is the most often used multi-criteria decision-making (MCDM) weighting methods. The SWARA approach is the most effective way to evaluate criteria when policies are at the center of decision-making. Expert consultation is used to prioritize the criteria in the first phase, and the weighing procedure is the second crucial step. By adding the reliability assessment of experts' ideas as the first stage, this study aims to use SWARA method to compute the criteria weights of Blended Physical Education Teaching in Colleges. Then we use the root assessment method (RAM) to rank the alternatives. IndetermSoft set is used in this study to deal with indeterminacy and uncertainty in the values of the criteria. This study uses five criteria and ten alternatives to be evaluated.

Keywords: Multi-Criteria Decision Making; IndetermSoft Set; Blended Physical; Education; Colleges Teaching.

1. Introduction

Blended physical education (PE) teaching in colleges has emerged as a modern instructional approach, integrating both digital learning tools and traditional in-person training to enhance student engagement and performance. This hybrid model aims to combine the benefits of online instructional materials, interactive simulations, and virtual coaching with hands-on physical training, teamwork, and skill development. The rise of digital technology in education has enabled instructors to extend their learning beyond the gymnasium, allowing students to review techniques, track progress, and receive personalized feedback through digital platforms. However, the effectiveness of this approach varies significantly based on factors such as course design, technological infrastructure, instructor proficiency, and student adaptability[1], [2].

Evaluating the effectiveness of blended PE teaching requires a comprehensive framework that assesses both cognitive and physical learning outcomes. Unlike conventional PE programs that primarily focus on physical activities, blended models emphasize conceptual understanding, self-paced learning, and technology-assisted performance tracking. Key evaluation criteria include student engagement, retention of practical skills, the adaptability of digital resources, physical fitness improvement, and instructor competency in integrating technology. A well-structured evaluation ensures that students not only develop their physical abilities but also acquire theoretical knowledge that enhances their overall understanding of exercise science, sports psychology, and biomechanics[3], [4].

Despite its advantages, blended PE teaching faces several challenges that need to be addressed for effective implementation. Variability in student participation, digital literacy, and access to high-quality online resources can create disparities in learning experiences. Additionally, not all sports and physical activities can be effectively taught through digital platforms, as some require direct instructor supervision and real-time feedback. The transition from traditional, instructor-led coaching to a hybrid approach demands that educators develop new teaching strategies, integrate emerging technologies, and balance online learning with hands-on training[5], [6]. Proper assessment of these challenges allows institutions to refine their blended PE programs, ensuring a well-rounded, inclusive, and engaging learning environment for all students.

The effective evaluation of blended PE teaching plays a crucial role in shaping future educational strategies. By using data-driven evaluation methods, student feedback, and performance metrics, institutions can identify areas for improvement and optimize curriculum design. As blended learning continues to evolve, colleges must embrace innovative assessment frameworks, including Multi-Criteria Decision-Making (MCDM) models, to quantify teaching effectiveness and enhance student outcomes. A well-structured evaluation system will ensure that blended PE teaching remains a dynamic, impactful, and sustainable approach, fostering both academic excellence and physical well-being in higher education[7], [8].

The MCDM theories unquestionably began with the development of the simple additive weighting (SAW) approach. To choose the best alternative or alternatives, the number of options is assessed based on several criteria. A decision matrix with criteria and options is the simplest way to represent this kind of decision-making problem. It is necessary to weigh and normalize the matrix. Ranking the options and choosing the best one, that is, the most significant or desirable—is the final goal. How to determine the weights of the choice criteria is one of the most crucial elements of every decision-making issue.

Therefore, several approaches have been developed to solve various issues with the decision-making process. Developing existing techniques in various aspects, developing new ways to increase the capacity to adapt to various demands, and generating new concepts in the field, such dynamic MCDM created in the previous ten years, are the three principles that comprise this growth[9], [10].

The contributions of this study are organized as follows:

We proposed an MCDM model for Analysis Blended Physical Education Teaching in Colleges.

Two MCDM methods are used such as SWARA methodology to compute the criteria weights and the RAM method to rank the alternatives.

IndetermSoft Set is used to dela with indeterminacy in the criteria values of this study.

This study uses five criteria and ten alternatives to be evaluated by three experts and decision makers.

1.1 Research Motivation

Blended Physical Education (PE) teaching has gained popularity in colleges due to its ability to combine traditional face-to-face instruction with digital learning tools. This hybrid approach enhances student engagement, provides flexibility, and allows for personalized learning experiences. However, evaluating the effectiveness of blended PE programs remains a challenge. Many factors, such as student participation, digital adaptability, skill retention, physical fitness improvements, and instructor competency, influence learning outcomes. Traditional assessment methods lack a structured framework to measure these factors effectively. Additionally, decision-making in education often involves uncertainty and subjective judgments, making it difficult to derive clear conclusions. This research aims to bridge this gap by introducing a structured, data-driven evaluation method to assess the success of blended PE teaching in colleges.

1.2 Research Objective

The goal of this study is to develop a Multi-Criteria Decision-Making (MCDM) framework to assess and improve blended PE teaching in colleges. This framework integrates two powerful decision-making techniques:

1. Stepwise Weight Assessment Ratio Analysis (SWARA) – Used to determine the importance of different evaluation criteria.
2. Root Assessment Method (RAM) – Applied to rank different teaching alternatives based on expert evaluations.

Additionally, the study incorporates the IndetermSoft Set theory to handle uncertainties and imprecise values in the decision-making process. By combining these techniques, the proposed framework provides a structured and reliable method for evaluating blended PE programs, helping educators and policymakers make informed improvements to teaching strategies.

1.3 Gaps in Existing Methods

Although blended PE teaching offers numerous benefits, current evaluation methods face several limitations:

1. Lack of a systematic framework – Most existing studies do not provide a clear decision-making structure to assess multiple influencing factors.
2. Challenges in dealing with uncertainty – Many evaluation models struggle with ambiguous or incomplete data, leading to less reliable results.
3. Limited integration of hybrid decision-making techniques – Traditional methods often focus on a single evaluation technique, which limits their ability to provide accurate and well-balanced rankings.

4. Difficulty in assessing both qualitative and quantitative aspects – Most models focus on numerical performance metrics while ignoring subjective factors such as teaching effectiveness and student adaptability.

To overcome these challenges, this study introduces a hybrid approach that integrates SWARA, RAM, and IndetermSoft Set theory to create a more comprehensive and adaptable evaluation model.

1.4 Research Contribution

This study makes several key contributions to the field of educational decision-making and blended learning evaluation:

1. Proposes a hybrid MCDM-based evaluation framework specifically designed for assessing Blended PE Teaching in Colleges.
2. Introduces IndetermSoft Set theory to handle uncertainty in expert judgments, improving the reliability of the evaluation process.
3. Combines SWARA and RAM methodologies to provide a more accurate and structured ranking system for different teaching approaches.
4. Develops a new assessment model that evaluates five key criteria and compares ten different teaching alternatives, offering a comprehensive performance analysis.
5. Demonstrates the effectiveness of the proposed framework through real-world case studies, validating its ability to enhance educational decision-making in higher education.
6. Provides valuable insights for educators, administrators, and policymakers to refine blended PE curriculum design and improve teaching effectiveness.

2. IndetermSoft Set

P(H) is the powerset of H, H is a non-empty subset of U, and U is a universe of discourse. Assume that and is an attribute and that A is a collection of its values. An IndetermSoft Set (Function) is a function F: A → (H) regarding the values of one or more attributes, there is some ambiguity in set A.

There is some indeterminacy in P(H).

- ✓ Alternatively, F(v) = indeterminate (uncertain, ambiguous, or not unique) if there is at least one attribute value $v \in A$.
- ✓ Or any combination of the three circumstances.

Smarandache [11], [12] defined an IndetermSoft Set as a soft set that has a specific amount of indeterminate (ambiguous, uncertain, alternative, contradictory) data or technique.

3. SWARA-RAM Methodology

This section is divided into two main steps. In the first step, we show the steps of the SWARA method to compute the criteria weights. In the second step, we show the steps of the RAM method to rank the alternatives.

First Step

In this step, we apply the SWARA method [13], [14].

Initial ranking of the criteria.

The criteria are ranked based on their importance by experts and decision makers.

Determine the coefficient of the criteria for each expert and decision maker.

$$Y_j = \begin{cases} 1 & if\ j = 1 \\ x_j + 1 & if\ j > 1 \end{cases} \tag{1}$$

Compute the initial weight of criteria

$$r_j = \begin{cases} 1 & if\ j = 1 \\ \frac{r_j}{y_j} & if\ j > 1 \end{cases} \tag{2}$$

Compute the relative weights of criteria.

$$w_j = \frac{r_j}{\sum_{j=1}^{n} r_j} \tag{3}$$

Second Step

In this step, we apply the RAM method [15], [16].

Build the decision matrix

$$D = \begin{bmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mn} \end{bmatrix}; i = 1, \dots m; j = 1, \dots, n \tag{4}$$

Normalize the decision matrix

$$q_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}} \tag{5}$$

Compute the weighted decision matrix.

$$s_j = q_{ij} w_j \tag{6}$$

Compute the sum of weighted values for beneficial and non-beneficial criteria such as:

$$Z_{+i} = \sum_{j=1}^{n} S_{+ij} \tag{7}$$

$$Z_{-i} = \sum_{j=1}^{n} S_{-ij} \tag{8}$$

Compute the overall value of each alternative.

$$F_i = \sqrt[2+Z_{-i}]{2 + Z_{+i}} \tag{9}$$

Rank the alternatives using the value of F_i

4. Implementation Process of MCDM Approach

This section shows the implementation of two MCDM methods. We have three experts to evaluate the criteria and alternatives. They use the scale between 0.1 to 0.9. They evaluate the criteria and alternatives based on their experience. We use five criteria of this study such as: Interactive Learning Engagement (High), Adaptability of Digital Learning Resources (Excellent), Practical Skill Retention (Strong), Physical Fitness Improvement (Significant), Instructor's Digital Teaching Competency (Expert, Basic). The alternatives show ten colleges.

First Step

We show the results of the SWARA method to compute the criteria weights.

We initial ranking the criteria.

We determine the coefficient of the criteria for each expert and decision maker using Eq. (1).

Eq. (2) is used to compute the initial weight of criteria

Eq. (3) is used to compute the relative weights of criteria as shown in Fig 1.

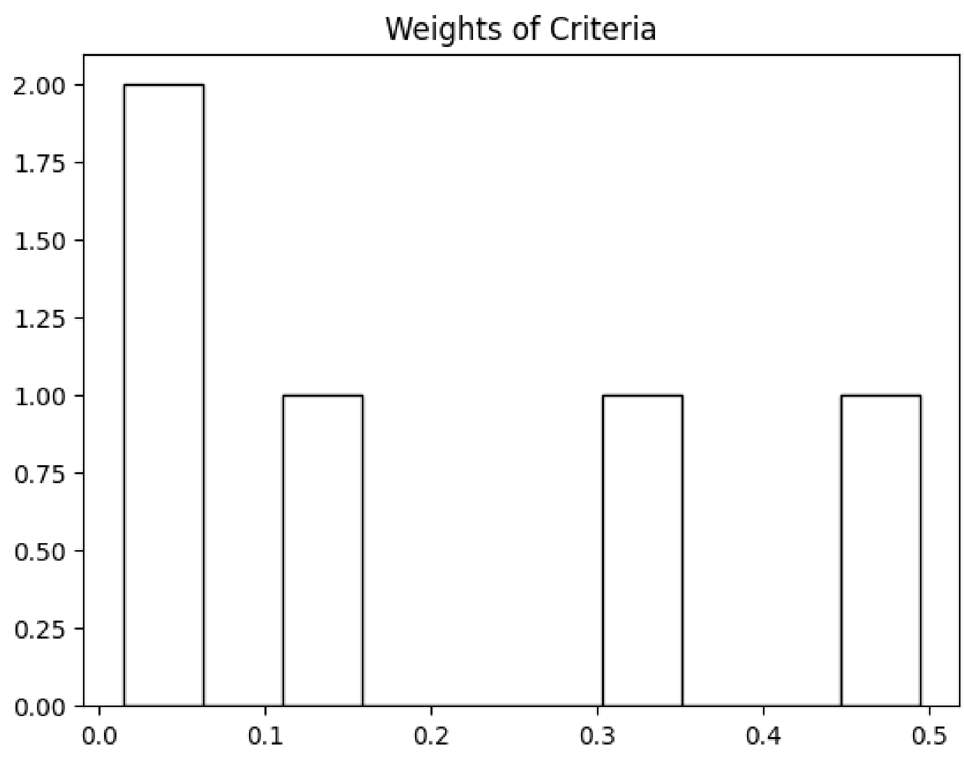

Fig 1. The importance of each criterion.

Second Step

In this step, we show results of the RAM method. This study uses the IndetermSoft set to deal with indeterminacy of the sub criteria. This study has indeterminacy in fifth criterion only. So, we apply the RAM method under these values in each step. In the first stage, we selected the Expert as a sub criterion. In the second stage, we select Basic as a sub criterion. In the third stage, we select Expert and Basic as sub criterion.

In the first stage

Eq. (4) is used to build the decision matrix. Then we combine the decision matrix as shown in Fig 2.

Eq. (5) is used to normalize the decision matrix as shown in Fig 3.

Eq. (6) is used to compute the weighted decision matrix as shown in Fig 4.

Eq. (7 and 8) are used to compute the sum of weighted values for beneficial and non-beneficial criteria.

Eq. (9) is used to compute the overall value of each alternative as shown in Fig 5.

Then we rank the alternatives using the value of F_i.

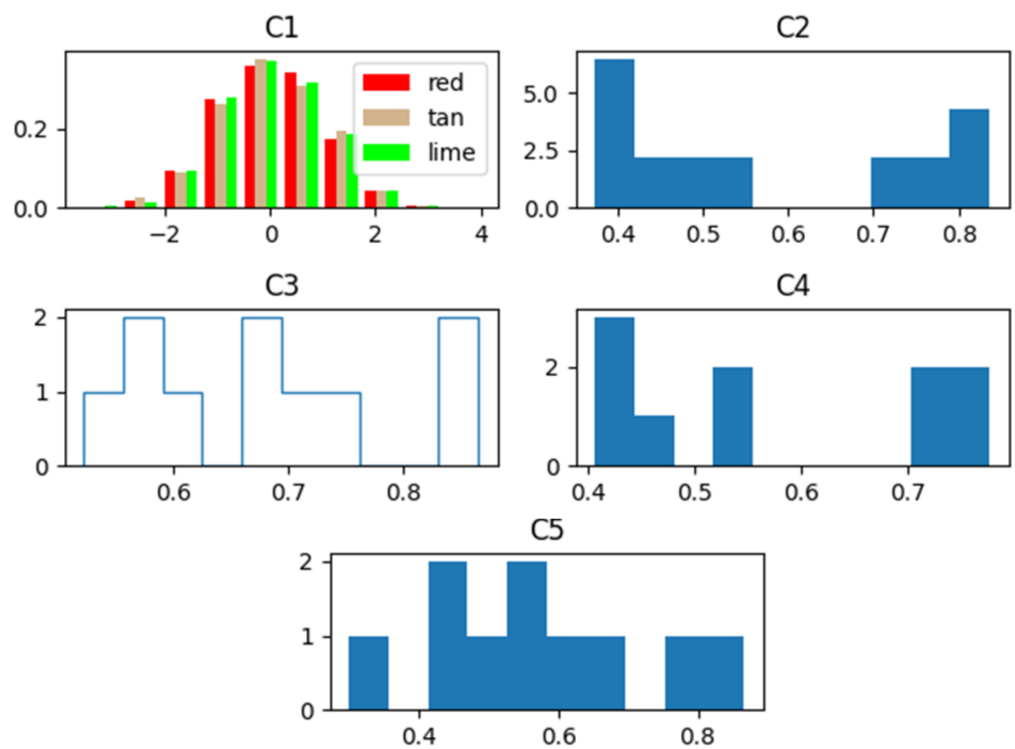

Fig 2. The decision matrix.

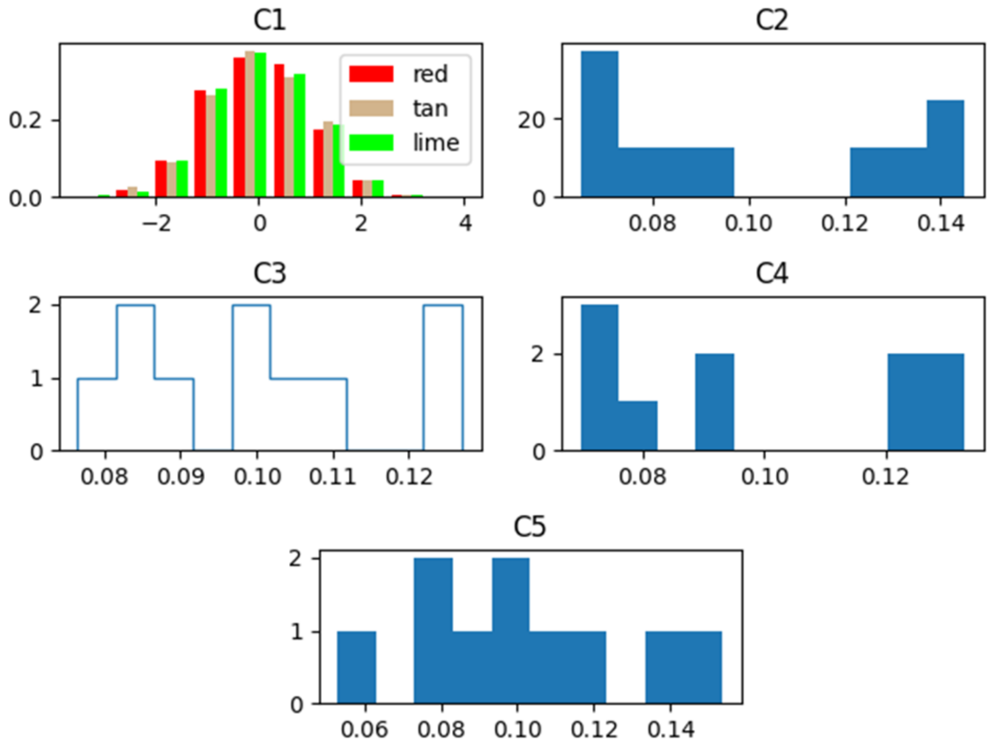

Fig 3. Normalized values.

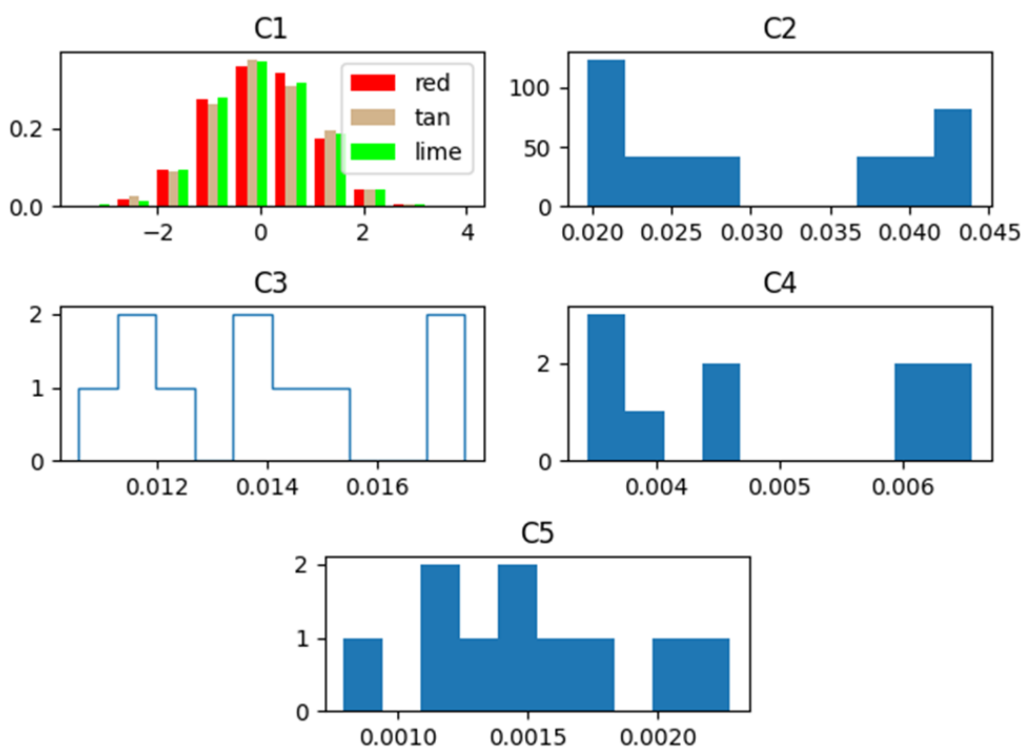

Fig 4. Weighted decision matrix.

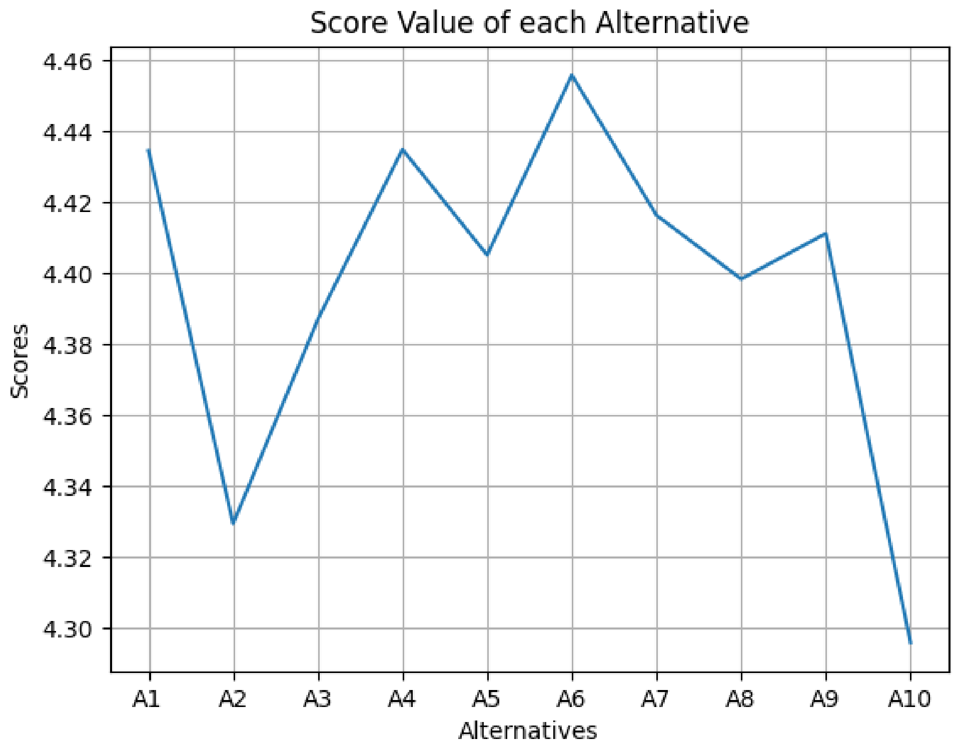

Fig 5. Overall score of each alternative.

In the second stage

We normalize the decision matrix as shown in Fig 6.

We compute the weighted decision matrix as shown in Fig 7.

We compute the overall value of each alternative as shown in Fig 8.

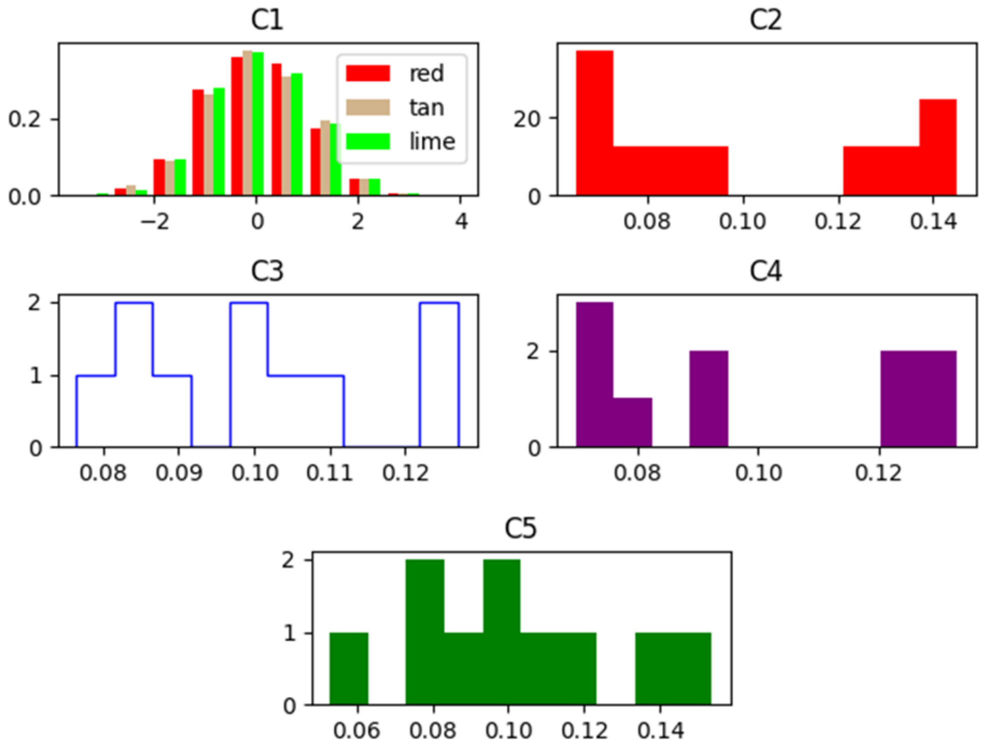

Fig 6. Normalized values.

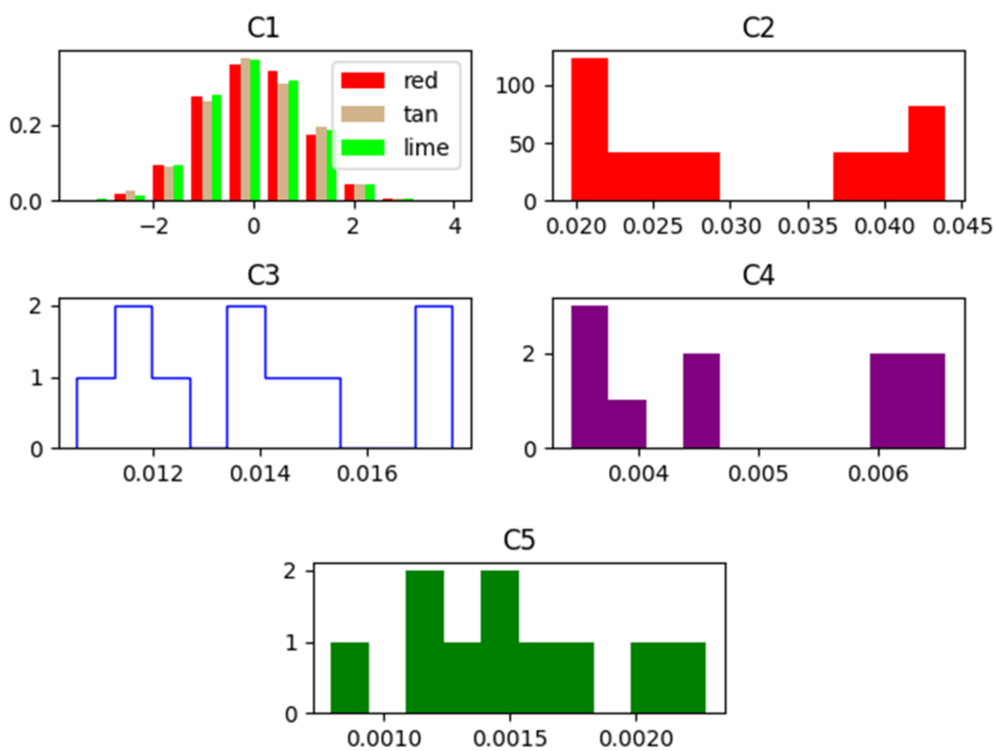

Fig 7. Weighted decision matrix.

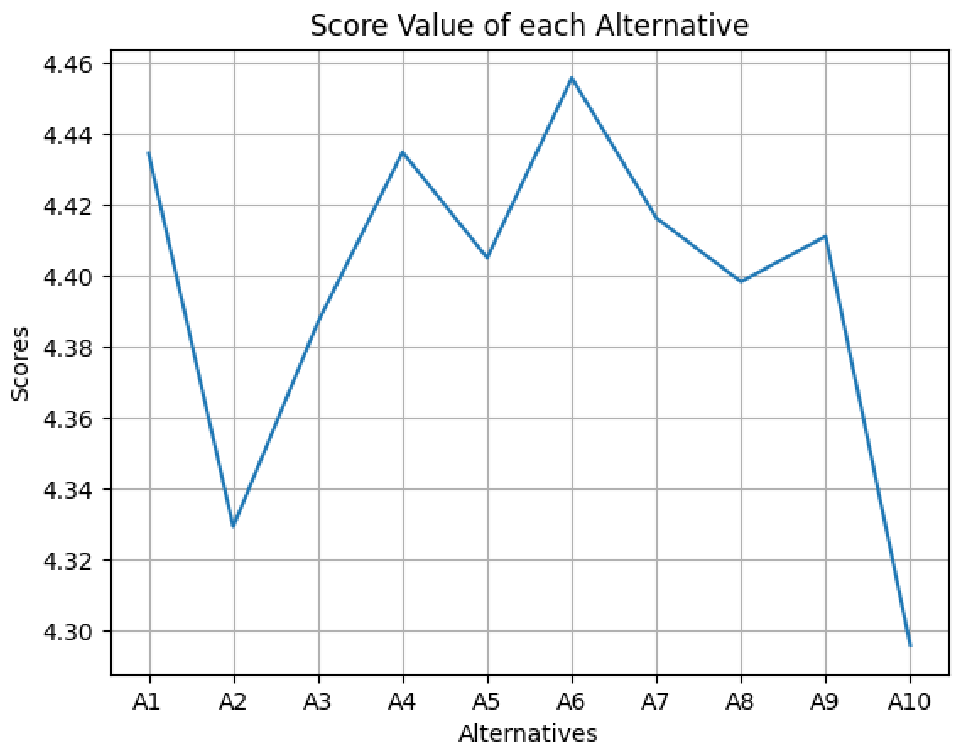

Fig 8. Overall score of each alternative.

In the third stage

We normalize the decision matrix as shown in Fig 9.

We compute the weighted decision matrix as shown in Fig 10.

We compute the overall value of each alternative as shown in Fig 11.

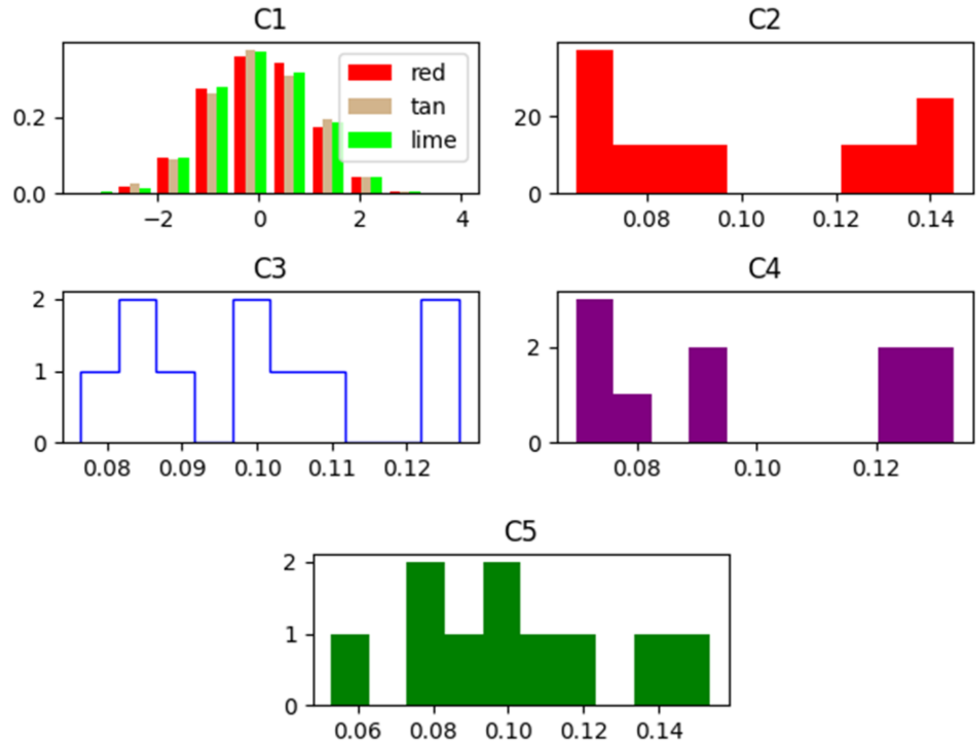

Fig 9. Normalized values.

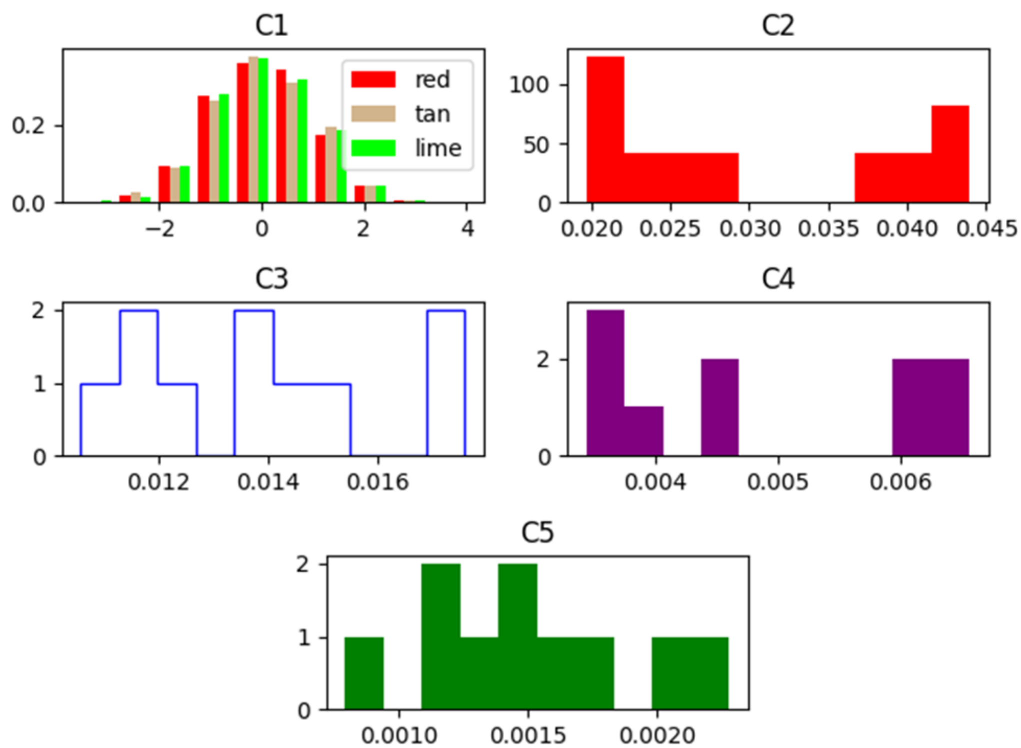

Fig 10. Weighted decision matrix.

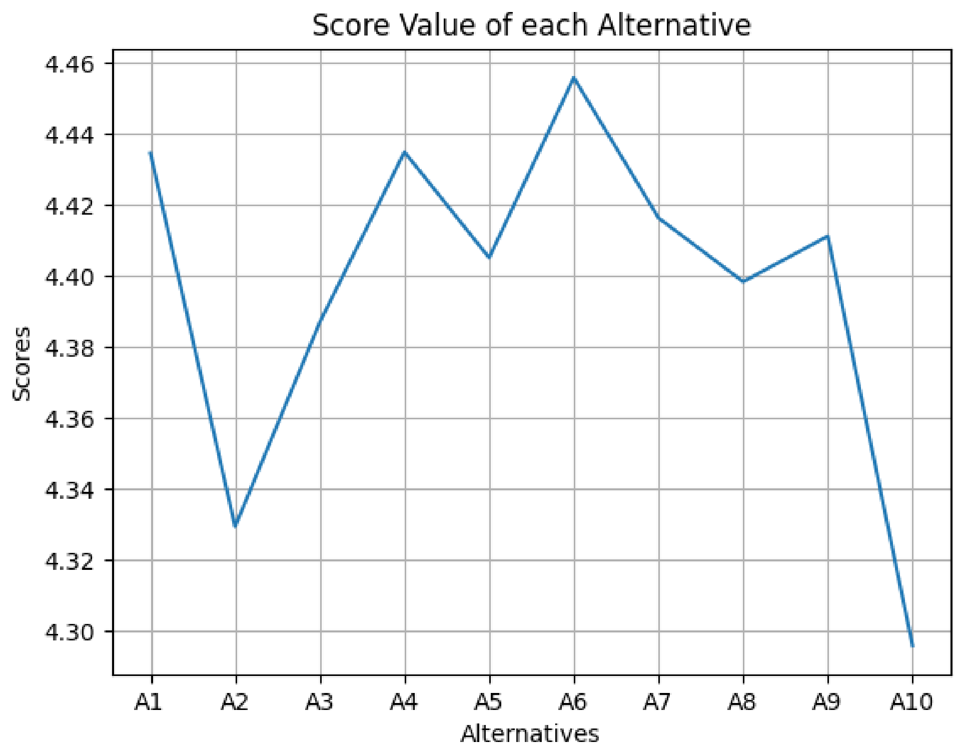

Fig 11. Overall score of each alternative.

Finally, we ranked the alternatives based on three stages as shown in Fig 12. We show the alternative 6 is the best and alternative 10 is the worst.

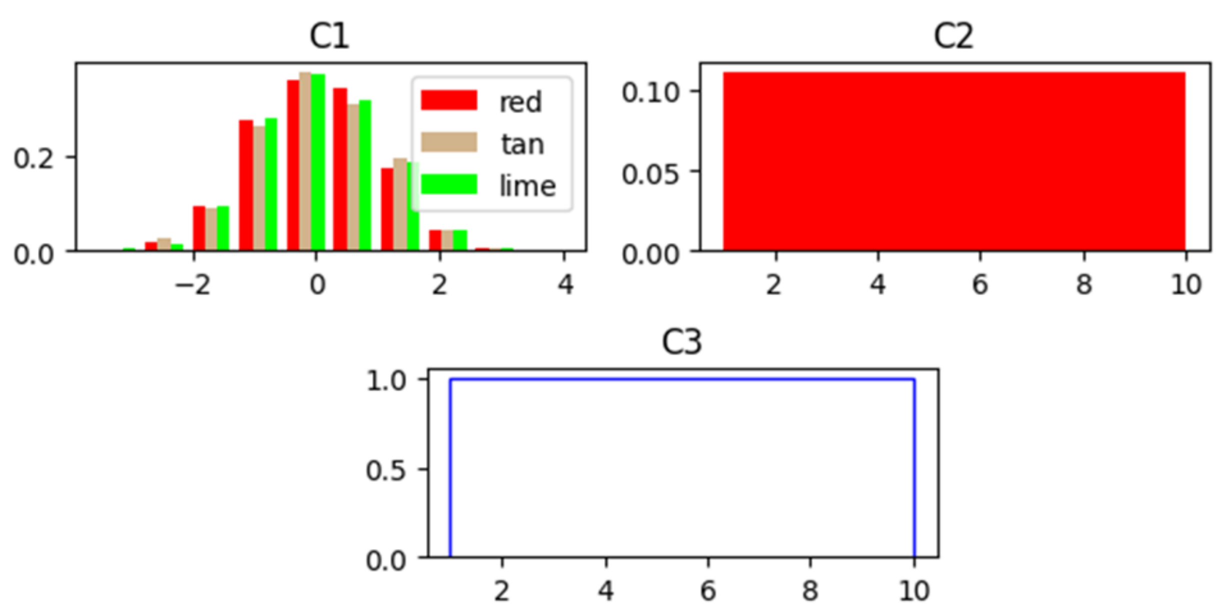

Fig 12. Final ranks of alternatives.

5. Conclusions and Future Directions

Making important decisions and setting policies are top priorities for any organization. A key challenge has always been establishing a systematic approach to decision-making and applying effective techniques to resolve complex issues. To achieve successful outcomes, structured and well-planned methods should be used. Multi-Criteria Decision-Making (MCDM) is considered a valuable tool for making critical decisions, especially in complex environments. Among MCDM techniques, Stepwise Weight Assessment Ratio Analysis (SWARA) is recognized as a practical and effective method for weighing and prioritizing criteria in decision-making. In this study, we applied the Root Assessment Method (RAM) to rank alternatives in the evaluation of Blended Physical Education Teaching in Colleges. Additionally, the IndetermSoft Set was used to handle uncertainty in sub-criteria, ensuring a more reliable and robust decision-making process. The study was conducted using five evaluation criteria and ten alternatives, with results indicating that alternative 6 performed the best, while alternative 10 had the lowest ranking. Future Directions are:

- Expanding the model to evaluate other educational disciplines and hybrid learning programs.
- Integrating artificial intelligence and machine learning to improve decision-making accuracy.
- Testing the framework across multiple institutions to enhance its scalability and adaptability.
- Incorporating real-time data analytics to refine decision-making based on live student performance metrics.
- Exploring additional hybrid decision-making methods to further optimize evaluation processes.

References

[1] S. Feng, “Applied Research on College Sports Blended Learning Based on Moodle Platform.,” *Educ. Sci. Theory Pract.*, vol. 18, no. 5, 2018.

[2] W. Zhu, “[Retracted] Research on the Blended Teaching Mode Reform of University Physical Education Curriculum Based on the Integration of 5G Cloud Computing and Multimedia,” *Mob. Inf. Syst.*, vol. 2021, no. 1, p. 4035878, 2021.

[3] N. Vernadakıs, M. Gıannousı, E. Tsitskari, P. Antonıou, and S. Kıoumourtzoglou, “A comparison of student satisfaction between traditional and blended technology course offerings in physical education,” *Turkish Online J. Distance Educ.*, vol. 13, no. 1, pp. 137–147, 2012.

[4] H. Liu *et al.*, “Development and students’ evaluation of a blended online and offline pedagogy for physical education theory curriculum in China during the COVID-19 pandemic,” *Educ. Technol. Res. Dev.*, vol. 70, no. 6, pp. 2235–2254, 2022.

[5] F. Song, “Research on the Necessity of Using Blended Teaching Mode in Physical Education in Colleges and Universities,” in *Proceedings of 5th International Workshop on*

Education Reform and Social Sciences (ERSS 2022), 2022, pp. 464–468.

[6] C. Wang, Y. Yuan, and X. Ji, "The effects of a blended learning model on the physical fitness of Chinese university students: a cluster randomized controlled trial in basketball education," *BMC Public Health*, vol. 24, no. 1, p. 2451, 2024.

[7] C. Wang, Y. Yuan, and X. Ji, "Effects of blended learning in physical education on university students' exercise attitudes and basketball skills: a cluster randomized controlled trial," *BMC Public Health*, vol. 24, no. 1, p. 3170, 2024.

[8] W. Zheng, Y.-Y. Ma, and H.-L. Lin, "Research on blended learning in physical education during the COVID-19 pandemic: A case study of Chinese students," *Sage Open*, vol. 11, no. 4, p. 21582440211058196, 2021.

[9] M. Mohamed and A. Elsayed, "A novel multi-criteria decision making approach based on bipolar neutrosophic set for evaluating financial markets in egypt," *Multicriteria Algorithms with Appl.*, vol. 5, pp. 1–17, 2024.

[10] A. Abdel-Monem, S. S. Mohamed, and A. S. Aziz, "A Multi-Criteria Decision Making Methodology for Assessment Performance of Electrocoagulation System," *Multicriteria algorithms with Appl.*, vol. 1, pp. 19–30, 2023.

[11] F. Smarandache, *New types of soft sets "hypersoft set, indetermsoft set, indetermhypersoft set, and treesoft set": an improved version*. Infinite Study, 2023.

[12] F. Smarandache, *Practical applications of IndetermSoft Set and IndetermHyperSoft Set and introduction to TreeSoft Set as an extension of the MultiSoft Set*. Infinite Study, 2022.

[13] S. H. Zolfani, E. K. Zavadskas, and Z. Turskis, "Design of products with both International and Local perspectives based on Yin-Yang balance theory and SWARA method," *Econ. Res. istraživanja*, vol. 26, no. 2, pp. 153–166, 2013.

[14] D. Stanujkic, D. Karabasevic, and E. K. Zavadskas, "A framework for the selection of a packaging design based on the SWARA method," *Eng. Econ.*, vol. 26, no. 2, pp. 181–187, 2015.

[15] A. Sotoudeh-Anvari, "Root Assessment Method (RAM): A novel multi-criteria decision making method and its applications in sustainability challenges," *J. Clean. Prod.*, vol. 423, p. 138695, 2023.

[16] I. M. Hezam, A. M. Ali, K. Sallam, I. A. Hameed, A. Foul, and M. Abdel-Basset, "An Extension of Root Assessment Method (RAM) Under Spherical Fuzzy Framework for Optimal Selection of Electricity Production Technologies Toward Sustainability: A Case Study," *Int. J. Energy Res.*, vol. 2024, no. 1, p. 7985867, 2024.

Received: Oct 14, 2024. Accepted: March 11, 2025