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Research Article

Balancing Work-Life Challenges in Surgery: A Decision Analysis Using Circular Pythagorean Fuzzy WASPAS Approach

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Abstract: Balancing work-life challenges in pressured careers such as surgery can only be done with due consideration, bearing in mind that work-life conflict is inevitable and demands some strategies capable of addressing reasons related to preference and the rationality often associated with complex scenarios. So, these challenges require a robust framework that offers reliable and actionable insights. The contribution of this research is in developing a novel approach, known as the Circular Pythagorean Fuzzy Set Weighted Aggregated Sum Product Assessment (C-PyFS-WASPAS), that can be implemented to assess the performance of the alternative in the environment that is characterized by vagueness and imprecision. This framework integrates the advantages of the Weighted Aggregated Sum Product Assessment (WASPAS) method with flexibility in the Circular Pythagorean Fuzzy Set (C-PyFS) to address imprecision and subjective preference in decision-making. To show its viability, the proposed approach evaluates options regarding work-life balance for surgeons based on essential options such as adequate sleep, time management, goal congruence sessions, and work-life balance measures. The results show that the C-PyFS-WASPAS method provides better-understood results than previous methods and can provide significant information to decision-makers. Moreover, a sensitive analysis is conducted by varying the weight values, highlighting its performance towards stability. A comparison analysis has been performed to show its effectiveness, demonstrating that the proposed approach is more accurate than others. This framework has much potential in terms of real-world applications, and future research will build upon these concepts and adapt this approach to functioning in dynamic environments, as well as incorporate additional high-level computational methods for the benefit of a more extensive range of applications.

Keywords: Pythagorean fuzzy sets, Weighted Aggregated Sum Product Assessment (WASPAS) method, Circular Pythagorean fuzzy WASPAS, decision analysis, surgical workload, work-life balance

MSC: 68U01, 68V30, 68V99

1. Introduction

Work and Life Balance (WLB) is challenging in many high-demand specialties such as medical surgery. Maintaining the work and life balance in surgery is critical due to its highly demanding nature. Surgeons have to face demands such

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as instant decision-making, long working hours, and unpredictable working schedules, which may complicate their work-life balance. That is why they often find themselves in complex interdependencies between professional and personal life. Balancing work-life challenges in surgeons could be enhanced by addressing issues such as career sustainability, burnout management, and schedule management and developing various strategies and practices to balance professional and personal life [1]. Integrating work and life, especially in surgery, focuses on finding excellence in maintaining professional and personal wellbeing. The high prevalence of stress and burnout is another challenge in achieving work-life balance. Professions like surgery involve a high level of responsibility, precision, and commitment, and because of this, balancing work-life difficulties has become a significant area of study. By drawing insights from interdisciplinary studies such as healthcare management, organizational psychology, and decisional sciences, this research explores strategies to optimize and maintain WLB among surgical professionals [2]. WLB is critical to health and efficiency and has seen limited development in the surgical workforce. The studies indicate that the working environment in surgery increases occupational burnout, stress, and a decline in the professional's quality of life [3]. Surgeons must resolve professional responsibilities with personal satisfaction. However, the effectiveness of existing interventions is limited due to the absence of a structured framework for decision-making. Surgeons' work-life stress is not just an individual problem but a systems problem with implications for patient care, the professional team, and healthcare organizations.

The studies reveal how workplace stress affects employees' wellbeing and productivity. Surgical teams working in an operating theatre constitute a correctly high-pressured setting for the practice of conflicts between profession and personal welfare predominate. These conflicts highlight the need for a systematized decision-making model to reduce stress, increase performance, and increase personal satisfaction. The decision-making frameworks that address such concerns must consider the challenges of balancing one's professional duties and individual requirements and how uncertainty and ambiguity are features of these situations. In our everyday experiences, we face decision-making problems that aim to arrive at the best solution with available information. The Multi-Criteria Decision-Making (MCDM) technique can address more decision-making problems, which had recently gained significance in various applications, such as Shahid et al. [4], Razak et al. [5], Komazec et al. [6], and Malmir [7]. However, the problem statements are ambiguous and uncertain in the real world, complicating the crisp data analysis models. To overcome this, Zadeh [8] proposed Fuzzy Sets (FSs) in which each element is assigned to a membership degree between zero and one. This innovative practice has been applied in many facets to deal with vagueness and imprecision [9–11]. However, in an election example, voters may vote for particular candidates against others, spoil their ballot papers, or boycott the process altogether. FSs are likely to have difficulties describing such a complex interaction in which multiple degrees are presented, as it can only deal with one degree of membership. To tackle these intricacies, Atanassov [12] introduced the Intuitionistic Fuzzy Sets (IFSs) as an extension of FSs, which deals with the duplet degree of human opinion. As IFSs deals with a duplet degree of human opinion, it helps rank numerous ambiguous scenarios. Various researchers utilize it due to its ability to cope with uncertainties and conceptual flexibility [13, 14]. However, the IFS offers some limitations as the sum of the duplet lies within the zero-one interval, which makes it unreliable for some problems and demands a comprehensive structure for decision-making. To overcome this, Yager and Abbasov [15] introduced the concept of a Pythagorean Fuzzy Sets (PyFSs) by modifying the limitations of IFSs, i.e., the square sum of the duplet lies within the zero-one interval, which offers flexibility and applicability in decision-making fields [16, 17]. The IFSs and PyFSs offer reliability and deal with the duplet degree of human opinion, but they still fail to define the angular relationship between these degrees. To consider this, Atanassov [18] presented the concept of Circular IFSs (C-IFSs), which is further extended into Circular PyFSs (C-PyFSs) by Bozyigit et al. [19], which broadens the scope of FS theory with various applications [20, 21].

The Weighted Aggregated Sum Product Assessment (WASPAS) approach [22] was developed based on the domain of MCDM, which utilized both the Weighted Sum Assessment (WSA) and the Weighted Product Assessment (WPA) to achieve a better and more accurate ranking regarding the alternative. The WSA aggregates the overall score of an alternative concerning the quantitative and qualitative criteria values. However, in the WPA approach, the score is evaluated as the product of criteria ratings with the power of their weights. WASPAS improves decision-making accuracy, and integrating two models employs a hybrid weighted aggregation model. This approach is extensively utilized by various scholars across various fields, including the evaluation of e-commerce website [23], location selection of photovoltaic agriculture [24], ranking of migraine treatment drugs [25]. So, this paper aims to develop a C-PyFS-WASPAS approach to analyze the WLB challenges in surgery. The significant contributions of this paper are summarized as follows: To create a C-PyFS-WASPAS approach by incorporating C-PyFSs into the WASPAS method addressing uncertainty and ambiguity in MCDM; To introduce a systematic algorithm for the C-PyFS framework and define efficient decision-making; Further utilize them for evaluating and ranking choices within the WLB context for surgeons. A numerical evaluation illustrates how the proposed framework works, and to show its efficacy, a comparison analysis with decision-making methodologies is conducted.

1.1 *Problem statement*

Managing work-life conflicts is a crucial problem in work and personal life in a demanding field such as surgery when professional activities are intertwined with the roles of a doctor, a worker, and a patient. Despite a vast literature emphasis on the importance of work-life balance, it fails to address the multifaceted nature of these challenges in a structured, actionable, and comprehensive solution. For example, studies on surgeons' work-life integration highlight the importance of mental health support and schedule but often don't consider the complexities of integrating individual needs with patients' care demands and the hospital's goals. Similarly, studies on wellbeing for surgeons highly focus on the symptoms of work-life imbalance but neglect the holistic frameworks to address these systematic challenges. These gaps in research call for a decision-making approach that integrates wider dimensions to establish a sustainable, actionable solution.

1.2 *Objectives and contributions*

The main aim of this study is to establish a decision-making model for assessing the work-life problems involved in the surgical population. Thus, this framework aims to select factors and systematically rank them. To help consultants recognize the factors that contribute to work-life imbalance in their surgical careers and to provide a framework on which decisions are made about their working lives, this paper seeks to offer a directed framework for identifying those factors. Moreover, the research identifies how institutional interventions (such as time management and wellness programs) can foster a work-life balance for surgeons while maintaining a high standard for hospitals' reputation and patient care. The research contributes to many interests. Firstly, it introduced a decision-making framework that addresses the complexities of balancing work and life for surgeons. Secondly, this paper can integrate knowledge in healthcare management, organizational behaviour, and decision sciences to fill the recognized literature gaps and present a comprehensive understanding of work-life issues. Additionally, the proposed framework suggests specific practical advice for surgeons and healthcare managers that can foster workforce resilience and increase job satisfaction. Moreover, the research also raises broader system failure issues where it is clear that to develop sustainable healthcare systems, there must be policy change. Altogether, this study goes beyond a theoretical contribution to the discussion of work-life balance by offering specific interventions that can be used to promote surgeons' well-being and, concurrently, patients' well-being.

This paper is organized as follows: Section 2 presents the literature review related to WLB in surgery and identifies the research gap. Section 3 defines the preliminaries, which assist in understanding the proposed section. In proposed section 4, a WASPAS approach for evaluating the C-PyFS information has been presented and further utilized in defining the decision algorithm. Then, its numerical utilization for evaluating the WLB challenges in surgery has been given. Section 5 concludes the whole discussion by discussing its limitations and future direction.

2. Literature review

This section presents the literature review on WLB in surgery (Table 1) and discusses prior studies to identify the research gap.

Table 1. Prior studies on WLB in surgery

	Focus	Model	Findings	Relevance to research
Jain et al. [26]	Explores burnout in surgeons and highlights its consequences, causes, and potential remedies.	Qualitative analysis through observational data and case reports.	Identifies that high stress, long working hours, and lack of institutional support are key factors of burnout in surgeons.	Emphasized the importance of paying much attention to the surgeon's burnout as a part of the work-life balance intervention plan.
Lu et al. [27]	Reviews the trends for burnout in orthopaedic surgeons and the causes of work-life disequilibrium.	A survey-based cross-sectional study analyzing burnout trends and work-life drivers.	The work-life challenges are reduced autonomy, work overload and insufficient support.	Reinforces the need to work towards specific work-life aspects, not burnout in surgical practice.
Mu et al. [28]	Investigate the relationship between work overload, work-life imbalance, and burnout among healthcare workers while highlighting the specific factors.	Cross-sectional survey with statistical analysis (e.g., regression models) to investigate the relationship.	Concludes that groups of surgical specialities are more likely to complain of poor work-life balance and burnout compared to other medical disciplines.	Gives evidence to the fact that surgeons, for instance, face higher work interferences with work life as a focal explanation of the study.
Atiq et al. [29]	Assess the impact of workplace anxiety, work-life balance, and mental stress on doctors' mental health in South Punjab.	Quantitative research was carried out by using questionnaires. Correlation analysis is used.	Illustrates how stress at the workplace and work-life conflict affect health and wellbeing and levels of job satisfaction.	Supports decision-making in work-life balance issues about mental health and deserves support.
El Boghdady and Gallo [3]	Emphasizing surgeon wellbeing, focusing on the need for systemic changes to improve work-life balance and reduce burnout.	Narrative review synthesizing current research and proposing systemic interventions.	Encourages organizational innovations that promote favorable working conditions, such as chiropractic flexibility, flexible working hours for surgeons, and wellness provision.	This is coherent with the study's aim of revealing institutional intervention measures for enhancing work performance and quality of life among surgeons.

2.1 *Research gap*

Despite the focus on work-life balance as a necessary element for surgeons' health, it remains a relatively recent phenomenon in the literature; thus, the research presented in this paper identifies several gaps hindering the further progress of modern interventions. Studies such as those by Lu et al. [27] and Jain et al. [26] stress the importance of burnout, its prevalence, and its correlation with work-life imbalance. However, these studies focus on descriptive data, neglecting the structured and practical framework to address these challenges. Moreover, the study by Mu et al. [28] highlights the influence of workload on surgeons but doesn't identify the integrative models that focus on the interplay between personal and professional factors. Additionally, Atiq et al. [29] underscore the relationship between mental stress, workplace anxiety, and work-life balance. Yet, their approach does not investigate the application of decision-making criteria to navigate these challenges efficiently. El Boghdady and Gallo's [3] research for enhancing the well-being of surgeons fails to provide a systematic and comprehensive methodology for aligning organizational initiatives with one's preferences. In these studies, there is a clear gap in the absence of an MCDM-based decision-making framework. This research aims to bridge the gap by providing a structured, MCDM-based decision-making framework that integrates the multifaceted dimensions of work-life imbalances in surgeons. Unlike existing approaches, it incorporates long working hours, poor team coordination, handling complications, and risk of errors into a holistic framework, providing actionable solutions to achieve sustainable work-life integration. This contribution addresses an essential gap in the existing literature, offering theoretical developments and practical solutions to increase surgeon wellbeing and enhance professional resilience.

3. Preliminaries

This section highlights basic notions, such as the Circular Pythagorean Fuzzy Sets (C-PyFSs) and its operational laws.

Definition 1 [19] Consider a universal discourse to be U. A C-PyFS C_P is defined as:

$$C_P = (m_{C_P}(x),\, nm_{C_P}(x),\, r_{C_P}(x);\, x \in U) \tag{1}$$

With a condition $0 \le sum\left(m^2_{C_P}(x),\, nm^2_{C_P}(x)\right) \le 1$ and $r_{C_P}(x) \in [0,\, 1]$. The triplet $(m_{C_P}(x),\, nm_{C_P}(x),\, r_{C_P}(x))$ defines the membership, non-membership, and radius of a circle around each term, respectively. Moreover, the hesitancy degree is determined by $h = \sqrt{1 - m_{C_P}(x) - nm_{C_P}(x)}$. The triplet $(m_{C_P}(x),\, nm_{C_P}(x),\, r_{C_P}(x))$ is known as Circular Pythagorean Fuzzy Value (C-PyFV), can be written as $(m_{C_P},\, nm_{C_P},\, r_{C_P})$.

Definition 2 [19] Consider $C_{P_i} = \left(m_{C_{P_i}},\, nm_{C_{P_i}},\, r_{C_{P_i}}\right)$; $i = 1,\, 2$ be a C-PyFV. Then, the operational laws based on C-PyFS are:

(a)

$$C_{P_1} \oplus C_{P_2} = \left(\left(\sqrt{m^2_{C_{P_1}} + m^2_{C_{P_2}} - m^2_{C_{P_1}} m^2_{C_{P_2}}}\right),\, \left(nm_{C_{P_1}} nm_{C_{P_2}}\right),\, \left(r_{C_{P_1}} r_{C_{P_2}}\right)\right) \tag{2}$$

(b)

$$C_{P_1} \otimes C_{P_2} = \left(\left(m_{C_{P_1}} m_{C_{P_2}}\right),\, \left(\sqrt{nm^2_{C_{P_1}} + nm^2_{C_{P_2}} - nm^2_{C_{P_1}} nm^2_{C_{P_2}}}\right),\, \left(\sqrt{r^2_{C_{P_1}} + r^2_{C_{P_2}} - r^2_{C_{P_1}} r^2_{C_{P_2}}}\right)\right) \tag{3}$$

(c)

$$\lambda C_{P_i} = \left(\left(\sqrt{1 - \left(1 - \left(m_{C_{P_i}}\right)^2\right)^\lambda}\right),\, \left(\left(nm_{C_{P_i}}\right)^\lambda\right),\, \left(\left(r_{C_{P_i}}\right)^\lambda\right)\right),\, \lambda > 0 \tag{4}$$

(d)

$$C^\lambda_{P_i} = \left(\left(\left(m_{C_{P_i}}\right)^\lambda\right),\, \left(\sqrt{1 - \left(1 - \left(nm_{C_{P_i}}\right)^2\right)^\lambda}\right),\, \left(\sqrt{1 - \left(1 - \left(r_{C_{P_i}}\right)^2\right)^\lambda}\right)\right),\, \lambda > 0 \tag{5}$$

Definition 3 [19] Consider $C_{P_i} = \left(m_{C_{P_i}},\, nm_{C_{P_i}},\, r_{C_{P_i}}\right)$; $i = 1, 2$ be a C-PyFV. Then, to determine the resultant term of C_{P_i}, the score and accuracy function is defined as

$$S\left(C_{P_i}\right) = \left(m^2_{C_{P_i}} - nm^2_{C_{P_i}}\right) \times r_{C_P} \in [-1,\, 1] \tag{6}$$

$$A\left(C_{P_i}\right) = \left(m^2_{C_{P_i}} + nm^2_{C_{P_i}}\right) \times r_{C_P} \in [0,\, 1] \tag{7}$$

The score $S(C_{P_i})$ and accuracy $A(C_{P_i})$ functions determine the resultant term, further assisting in ranking alternatives in decision-making.

3.1 *WASPAS approach [30]*

The WASPAS approach was first proposed by Zavadskas et al. [31], which gained the attention of scholars as a valuable technique for managing uncertain and challenging real-life situations. This approach integrates the two key models, the Weighted Sum Assessment (WSA) and the Weighted Product Assessment (WPA), to offer a flexible and comprehensive approach to decision-making under multiple criteria. The steps involved in this approach are outlined below:

(a) Form a decision matrix using experts' opinions or the given data and categorize each criterion as a benefit or cost type.

(b) Normalized the formed decision matrix as

$$\bar{x}_{ij} = \frac{x_{ij}}{\max_i x_{ij}};\ x \in B$$
$$\bar{x}_{ij} = \frac{\min_i x_{ij}}{x_{ij}};\ x \in C \tag{8}$$

Where B represents the benefit type, C be the cost type and $\bar{x}_{ij}$ is the normalized value of x_{ij}.

(c) Evaluate the WSA and WPA as

$$Q_{iWSA}^{(1)} = \sum_{j=1}^{n} \bar{x}_{ij} w_j = \left(\left(\sqrt{1 - \prod \left(1 - \left(m_{C_{P_i}} \right)^2 \right)^w} \right), \left(\prod \left(nm_{C_{P_i}} \right)^w \right), \left(\prod \left(r_{C_{P_i}} \right)^w \right) \right) \tag{9}$$

$$Q_{iWPA}^{(2)} = \prod_{j=1}^{n} (\bar{x}_{ij})^{w_j} = \left(\left(\prod \left(m_{C_{P_i}} \right)^w \right), \left(\sqrt{1 - \prod \left(1 - \left(nm_{C_{P_i}} \right)^2 \right)^w} \right), \left(\sqrt{1 - \prod \left(1 - \left(r_{C_{P_i}} \right)^2 \right)^w} \right) \right) \tag{10}$$

where $Q_{iWSA}^{(1)}$ is the WSA score and $Q_{iWPA}^{(2)}$ is the WPA score.

(d) A combined generalization Q_i of WSA and WPA for the WASPAS approach is defined as

$$Q_i = 0.5 Q_{iWSA}^{(1)} + 0.5 Q_{iWPA}^{(2)} \tag{11}$$

(e) To increase efficacy and reliability, a more generalized form is defined as

$$Q_i = \lambda Q_i^{(1)} + (1 - \lambda) Q_i^{(2)};\ \lambda \in [0, 1] \tag{12}$$

- If $\lambda = 0$, WASPAS is altered into WPM.
- If $\lambda = 1$, WASPAS is altered into WSM.

(f) Rank the alternatives based on Eq. (12) outcomes and select the optimal alternative.

4. A WASPAS approach for evaluating C-PyFS information

This section defines the WASPAS approach for evaluating the C-PyFS information that effectively handles the complexities and uncertainty inherent in the C-PyFS information. This approach offers a more unified approach to fuzzy decision-making due to the flexibility of C-PyFS and the stability of WASPAS. The initial step of the WASPAS approach by considering the C-PyFS information is the formation of a decision matrix from the opinion of experts by C-PyFV and categories of the criterion as benefit type or cost type, which is then normalized by

$$\bar{x}_{ij} = \frac{x_{ij}}{\max_i x_{ij}};\ x \in B$$
$$\bar{x}_{ij} = \frac{\min_i x_{ij}}{x_{ij}};\ x \in C \tag{13}$$

As B represents the benefit type, where $\max_i x_{ij} = (\max(m_{C_P}), \min(nm_{C_P}), \max(r_{C_P}))$. For C, i.e., cost type, where $\min_i x_{ij} = (\min(m_{C_P}), \max(nm_{C_P}), \min(r_{C_P}))$ and $\bar{x}_{ij}$ represents the normalized value of x_{ij}.

The WASPAS approach integrates two models to define an optimality model. The first one is the WSA, widely applicable in MCDM and measures different alternatives against specific decision metrics. According to WSA, as introduced by MacCrimon [32] and later refined by Triantaphyllou and Mann [33] the total relative importance of the alternative is computed using the formula:

$$Q^{(1)}_{i_{WSA}} = \sum_{j=1}^{n} \bar{x}_{ij} w_j \tag{14}$$

Where w_j represents the relative importance of each criterion. The WPM, developed by Miller and Starr [34] and also explored by Triantaphyllou and Mann [33], evaluates the total relative importance of alternatives by

$$Q^{(2)}_{i_{WPA}} = \prod_{j=1}^{n} (\bar{x}_{ij})^{w_j} \tag{15}$$

For WSA, the product of $\bar{x}_{ij} w_j$ Definition 2 (c) is obtained and summed up by Definition 2 (a). However, for WPA, the power operation defined in Definition 2 (d) is utilized first, and then the product is evaluated by the operation law defined in Definition 2 (b).

The integration of these two methodologies makes the WASPAS method superior for decision-making evaluation. A combined generalization of WSA and WPA for the WASPAS approach is obtained by

$$Q_i = \lambda Q^{(1)}_i + (1-\lambda) Q^{(2)}_i;\ \lambda \in [0, 1] \tag{16}$$

• If $\lambda = 0$, WASPAS is altered into WPM.
• If $\lambda = 1$, WASPAS is altered into WSM.
Rank the alternatives based on outcomes obtained from the score value of Q_i and select the optimal alternative.

4.1 *WASPAS-based evaluation of MCDM using C-PyFS information*

This section defines the WASPAS approach to address an MCDM problem characterized by C-PyFS information. To tackle such challenges effectively, a practical decision-making technique is presented below.

(1) Evaluation of MCDM

This section provides the framework for developing an MCDM technique that incorporates existing decision information within a system where information is complex and uncertain using C-PyFS information. To highlight the efficiency and advantage of the proposed methodology, the decision-making framework is modified to handle C-PyFS information. For a decision-making problem, consider a collection of alternatives to be $\psi = \left(\psi_1, \psi_2, \psi_3, \ldots, \psi_\phi\right)$ and a collection of criteria be $\xi = (\xi_1, \xi_2, \xi_3, \ldots, \xi_\varpi)$. A set of corresponding weight vectors $\upsilon = (\upsilon_1, \upsilon_2, \upsilon_3, \ldots, \upsilon_\varpi)$ of each criterion must satisfy the limitations $\upsilon \in [0, 1]$ and $\sum_{o=1}^{\varpi} \upsilon_o = 1$, which is determined (hypothetically) from the opinion of experts. To solve the MCDM problem effectively, the steps of the WASPAS approach for evaluating the C-PyFS information are summarized in the Algorithm, as shown in Figure 1.

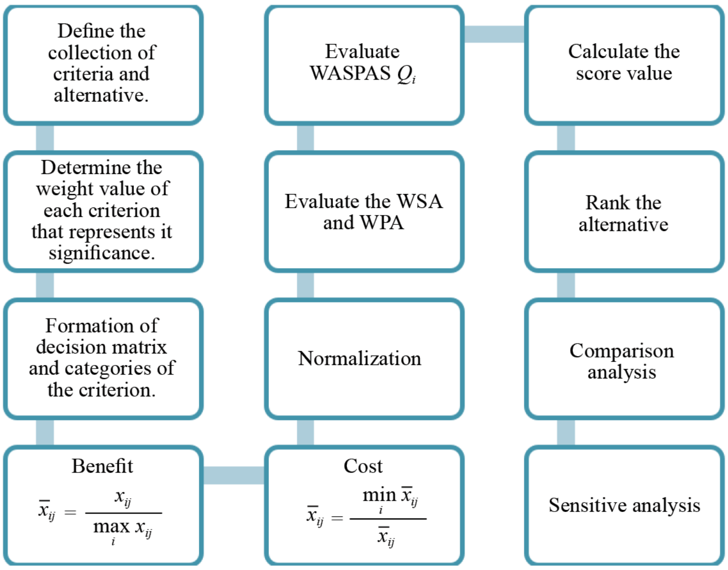


Figure 1. WASPAS approach for evaluating C-PyFS information

(2) Numerical Evaluation

This section considers the decision-making problem of balancing Work-Life Challenges in Surgery to illustrate the proposed approach.

(2.1) Case Study: Balancing Work-Life Challenges in Surgery

Medical surgeons work in a challenging environment where every hour is stressful and full of horrors. The pressure to perform in a stressful situation makes the surgeon more vigilant and active, but it may also result in fatigue, burnout, anxiety, and more serious consequences. Numerous factors contribute to the stress of surgeons, such as long working hours, work and life balances, burnout, patient outcomes, poor team coordination, instant decision-making, handling complications, time management, risk of errors, and dealing with death. If these factors remain to continue, they may result in severe consequences. To cope with these challenges, they required high cognitive and physical abilities. Moreover, it is essential to identify alternatives such as adequate sleep, time scheduling, stress managing workshops, counseling or therapies, work-life balance initiatives, wellness programs, goal alignment sessions, and work relief through vacations that can reduce burnout.

We have considered a collection of criteria $\xi = (\xi_1, \xi_2, \xi_3, \ldots, \xi_5)$ in assisting medical surgeons in reducing their stress and burnout includes long working hours, work and life balances, poor team coordination, handling complications, and risk of errors based on the following techniques (alternatives) $\psi = (\psi_1, \psi_2, \psi_3, \ldots, \psi_5)$ including adequate sleep, time scheduling, work-life balance initiatives, goal alignment sessions, and work relief through vacations. Experts can count on these alternatives to improve the mental health of their surgeons, which will, in turn, contribute to their better performance. The weight values w_j of the criterion ξ is hypothetically taken as (0.27, 0.19, 0.09, 0.23, 0.22); $\sum w_j = 1$ from the opinion of experts. Moreover, the experts can count on these alternatives to improve the mental health of their surgeons, which will, in turn, contribute to their better performance.

Here is a brief overview of the criteria and alternatives. To identify the appropriate criteria and alternatives for this study, consultations are conducted with a panel of five experts, including senior hospital administrators, heads of surgical departments, and medical psychologists possessing extensive experience within their respective fields. The experts selected for this role demonstrate a comprehensive understanding of stress management in workplace environments and within the specialized area of healthcare surgery. The formulation of criteria (e.g., long working hours, team dynamics, critical decision-making) and potential solutions, i.e. alternatives (e.g., adequate rest, health support), entailed review of literature studies in Joseph et al. [35] and AbdELhay et al. [36], and participation in brainstorming sessions with professionals. This process ensures the model adhered to an evidence-based and practical framework. The C-PyFS method is employed to quantify the insights gathered from the experts' feedback. A collective agreement is achieved among the experts, who evaluate the alternatives against each criterion to formulate the final decision matrix. No further aggregation is necessary, as the matrix is securely established in a collaborative expert context opinion.

Criteria:

(a) Long Working Hours

The long working hours examine the impact of prolonged working duration that results in high stress among medical surgeons. Due to their profession's demands, surgeons are more prone to long working hours, often affecting their mental and physical health and decision-making ability.

(b) Work and Life Balances

The demanding nature of work leaves medical surgeons little time for their personal lives. As a result, they cannot balance their work and personal lives and face struggles in spending quality time with their relatives. Most surgeons give very little time to themselves and family, which may lead to feelings of isolation. Spending no time with family and friends welcomes many stresses for an individual, ultimately affecting their job satisfaction and overall wellbeing.

(c) Poor Team Coordination

Poor team coordination always results in poor outcomes, no matter how expert a senior may be. When the team working under a surgeon lacks coordination, it disturbs the workflow. It can significantly impact the surgeon's mental health, the team, and the work environment. Misunderstandings may arise, hence increasing the workload. Effective team coordination will ensure smooth functioning and promote a healthy work environment.

(d) Handling Complications

Every profession encounters some complications, but a medical surgeon must make sound decisions on the spot. To make decisions urgently, a surgeon must have high problem-solving skills. Surgeons have been pressured to make critical decisions on unexpected issues. If a surgeon is experiencing poor mental health or facing stress or burnout, their ability to make crucial decisions may be compromised, and the patient's safety will be jeopardized.

(e) Risk of Errors

The risk of errors in any surgery may arise from various factors such as inadequate sleep, poor time management, excessive workload, or prolonged working hours. Surgeons facing these issues also face poor mental health, which ultimately impairs their focus ability. Suppose a surgeon is not mentally present at the time of surgery. In that case, the risk of errors will be increased, which will question the patient's safety. Addressing these issues must be crucial to minimize the mistakes.

Alternatives:

(a) Adequate Sleep

Proper sleep is always required to work correctly and maintain overall health. Adequate sleep enhances surgeons' decision-making ability and helps maintain optimal cognitive functioning. A well-rested surgeon is always more focused, vigilant, and active. It is recommended that everyone get at least 7-9 hours of sleep every night, and the same is true for surgeons.

(b) Time Scheduling

Appropriate time management is crucial in performing all tasks properly. Surgeons must schedule their functions according to their prioritization. Organized tasks elaborate defined working hours, scheduled time for surgeries, scheduled time for other tasks, recoveries, and personal rest. This will maintain the standard for patient care and ultimately reduce stress.

(c) Work-Life Balance Initiatives

Work-life balance initiatives are essential in promoting the overall well-being of medical surgeons. Various factors (such as designed downtime, reduced long working hours, and on-call hours) can be involved in these initiatives to reduce the overall stress level; therefore, a surgeon can perform his duty well. Fostering work-life balance initiatives can prevent adverse outcomes such as job dissatisfaction and burnout. All these initiatives will contribute to better patient care.

(d) Goal Alignment Sessions

Sessions for goal alignment are arranged for the team, which assists them in collaborating and coordinating properly. They embrace all the information about the objectives of their tasks, expectations from them, and their roles. It also includes the training provided to them to give urgent assistance to surgeons in the surgeries. These sessions ensure that surgeons, nurses, anesthesiologists, and administrative staff collaborate to achieve common goals. This will ultimately foster a healthy work environment and reduce stress.

(e) Work Relief through Vacations

Taking holidays from routine always results in better consequences. Allowing vacations to a medical surgeon makes him more relaxed from his profession's physical and mental demands. It will assist in reducing stress and burnout, restoring his emotional wellbeing. Holidays allow people to spend time in leisure activities and quality time with themselves, friends, and family, which is far from the daily routine. This ultimately enhances mood and overall satisfaction with oneself and one's job. Decision-makers should schedule holidays for surgeons and design timetables to ensure uninterrupted patient care.

(3) Algorithmic Implementation

The steps of the WASPAS approach are implemented as follows. Form a decision matrix based on the opinion of experts by considering the C-PyFS information and assigning the C-PyFV to each alternative, as displayed in Table 2.

Table 2. Decision matrix based on the opinion of experts

	ψ_1			ψ_2			ψ_3			ψ_4			ψ_5		
	m	*nm*	*r*	*m*	*nm*	*r*	*m*	*nm*	*r*	*m*	*nm*	*r*	*m*	*nm*	*r*
ξ_1	0.3	0.7	0.5	0.1	0.4	0.2	0.3	0.4	0.4	0.3	0.5	0.4	0.2	0.2	0.2
ξ_2	0.3	0.3	0.3	0.2	0.4	0.3	0.3	0.4	0.3	0.2	0.4	0.3	0.3	0.1	0.2
ξ_3	0.4	0.4	0.4	0.2	0.3	0.2	0.2	0.5	0.4	0.3	0.4	0.4	0.3	0.3	0.3
ξ_4	0.6	0.3	0.4	0.5	0.0	0.2	0.2	0.2	0.2	0.4	0.3	0.3	0.3	0.1	0.2
ξ_5	0.3	0.4	0.4	0.2	0.3	0.2	0.2	0.4	0.3	0.7	0.1	0.4	0.3	0.5	0.4

Since the criterion consists of both types, i.e., benefit and cost, it is normalized according to Eq. (8), and the result is stated in Table 3.

Table 3. Normalized decision matrix

	ψ_1			ψ_2			ψ_3			ψ_4			ψ_5		
	Cost			Benefit			Cost			Benefit			Cost		
	m	nm	r	m	nm	r	m	nm	r	m	nm	r	m	nm	r
ξ_1	0.20	0.42	0.32	0.09	0.35	0.20	0.12	0.36	0.27	0.18	0.43	0.30	0.19	0.39	0.33
ξ_2	0.20	0.53	0.37	0.16	0.40	0.26	0.13	0.37	0.28	0.10	0.36	0.22	0.19	0.42	0.33
ξ_3	0.18	0.53	0.35	0.11	0.32	0.20	0.13	0.34	0.27	0.16	0.41	0.27	0.19	0.34	0.30
ξ_4	0.16	0.54	0.34	0.32	0.01	0.20	0.13	0.43	0.31	0.22	0.26	0.25	0.18	0.42	0.33
ξ_5	0.19	0.49	0.35	0.13	0.26	0.18	0.14	0.38	0.30	0.42	0.05	0.30	0.18	0.31	0.28

For ψ_1, as it is the cost type criteria, the normalization is done as

$$\bar{x}_{ij} = \frac{\min_i x_{ij}}{1 + x_{ij}};\ x \in C \ \text{ and } \ x_{11} = (0.3, 0.7, 0.5) \tag{17}$$

$$\min_i x_{i1} = (\min(m_{C_P}), \max(nm_{C_P}), \max(r_{C_P})) = (0.3, 0.7, 0.5) \tag{18}$$

$$\bar{x}_{11} = \frac{\min_i x_{i1}}{1 + x_{11}} = \frac{0.3}{1+0.3}, \frac{0.7}{1+0.7}, \frac{0.5}{1+0.7} = (0.2, 0.42, 0.32) \tag{19}$$

By following the same steps, we can normalize the decision matrix. The WSA $Q^{(1)}_{i_{WSA}}$ and WPA $Q^{(2)}_{i_{WPA}}$ are evaluated, and their outcome are displayed in Table 4.

Table 4. Evaluation of WSA and WPA

	WSA $\left(Q^{(1)}_{i_{WSA}}\right)$			WPA $\left(Q^{(2)}_{i_{WPA}}\right)$		
	m	nm	r	m	nm	r
ψ_1	0.1877	0.4912	0.3431	0.18631	0.49816	0.34395
ψ_2	0.1910	0.1458	0.2047	0.14723	0.29583	0.20789
ψ_3	0.1293	0.3777	0.2893	0.12894	0.38029	0.29027
ψ_4	0.2533	0.2266	0.2682	0.19909	0.32854	0.27260
ψ_5	0.1868	0.3790	0.3149	0.18668	0.38495	0.31640

The WSA and WPA are calculated by Eqs. (9) and (10) as:

$$Q^{(1)}_{11_{WSA}} = \left(\left(\sqrt{1 - \prod\left(1 - \left(m_{C_{P_i}}\right)^2\right)^w}\right), \left(\prod\left(nm_{C_{P_i}}\right)^w\right), \left(\prod\left(r_{C_{P_i}}\right)^w\right)\right). \tag{20}$$

$$\sqrt{1-\prod\left(1-\left(m_{C_{P_i}}\right)^2\right)^w} = \sqrt{1-\left(\begin{array}{l}(1-(0.2)^2)^{0.27}\times(1-(0.2)^2)^{0.19}\times(1-(0.18)^2)^{0.09}\\ \times(1-(0.16)^2)^{0.23}\times(1-(0.19)^2)^{0.22}\end{array}\right)} = 0.1877. \tag{21}$$

$$\left(\prod\left(nm_{C_{P_i}}\right)^w\right) = (0.42)^{0.27}\times(0.53)^{0.19}\times(0.53)^{0.09}\times(0.54)^{0.23}\times(0.49)^{0.22} = 0.4912. \tag{22}$$

$$\left(\prod\left(r_{C_{P_i}}\right)^w\right) = 0.3431. \tag{23}$$

Thus, we have that $Q^{(1)}_{11_{WSA}}$ = (0.1877, 0.4912, 0.3431). The weight values of criteria are taken with (0.27, 0.19, 0.09, 0.23, 0.22). Similarly, we can calculate $Q^{(2)}_{i_{WPA}}$ by Eq. 10 with $Q^{(2)}_{11_{WPA}}$ = (0.1863, 0.4981, 0.3439). Rank the alternatives based on outcomes obtained from the score value of WASPAS Q_i such that higher scores mean better performance. The alternative with the highest value is chosen as the most appropriate, as shown in Table 5.

Table 5. Score value of WASPAS Q_i and ranking

	WASPAS Q_i			Score value	Ranking
	m	nm	r		
ψ_1	0.249101	0.116242	0.203948	0.009899	1
ψ_2	0.227528	0.031517	0.080174	0.004071	4
ψ_3	0.172633	0.065882	0.137185	0.003493	5
ψ_4	0.302663	0.06151	0.112342	0.009866	2
ψ_5	0.24879	0.092198	0.149707	0.007994	3

The Q_i values are calculated by Eq. (12) by taking $\lambda = 0.9$. We have that $Q_i = \lambda Q_i^{(1)} + (1-\lambda)Q_i^{(2)}$; and $Q_1 = 0.9Q_{11}^{(1)} + (1-0.9)Q_{11}^{(2)}$. Using operational laws (scalar multiplication and addition), we get $Q_1 = (0.249, 0.116, 0.2039)$. Then, the score value is calculated by Eq. (6) as follows:

$$S(Q_1) = \left((0.249)^2 - (0.116)^2\right)\times 0.2039 = 0.00989 \tag{24}$$

The graphical representation of score values of WSA and WPA, and ranking of alternatives based on the score values of WASPAS Q_i are displayed in Figure 2.

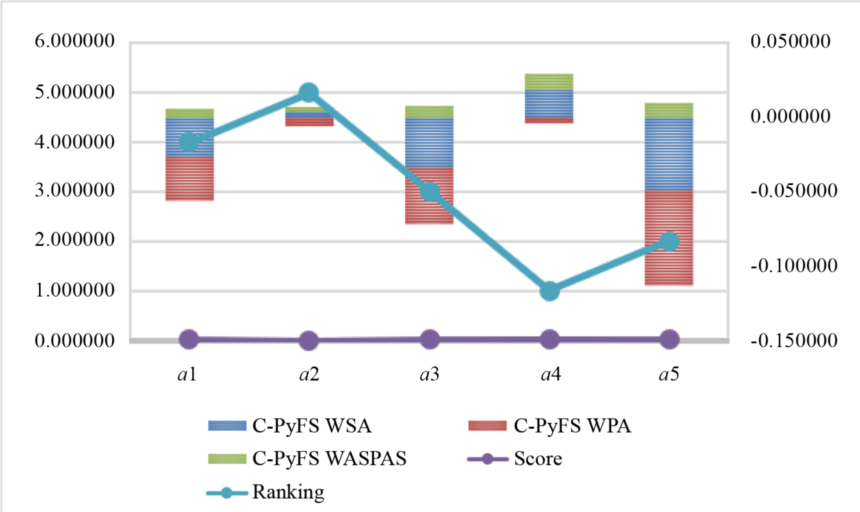


Figure 2. Graphical representation of outcomes of WSA, WPA, and WASPAS

4.2 *Result discussion*

Figure 2 defines the analysis performed using the WASPAS approach and presents a definite preference ranking of all the possible measures in the context of work-life balance in surgery. The findings indicate that the criterion ψ_1 stood out and topped all others due to its high aggregate score which shows that the long working hours can adversely impact a person's health and mind. Long shifts are linked to feeling burnt out, reduced awareness, and a lower ability to make medical decisions. Then, ψ_4, i.e., handling complications, stood out second ranking value and topped all remaining others due to its high aggregate score. It shows that a surgeon's ability to cope with sudden challenges during operations is key to their success. Managing problems effectively relates to safer patients, lower stress on doctors and nurses, and improved job performance, mainly in environments like surgery. The second most important criterion was ψ_5, risk of errors significantly influences surgeons' mental health and how well they perform their duties. If doctors are tired or overworked mentally, they tend to commit more errors that harm the surgery results. Therefore, taking care of this factor is crucial for ensuring accurate surgeries and top outcomes. Finally, ψ_2 work and life balance were placed fourth, showing that, although it is crucial for overall health, on-duty surgeons experienced other stressors as more urgent during high-intensity surgery. Lastly, Incomplete teamwork i.e. ψ_3 shows that it can throw off the surgical process and make surgeons more stressed and less able to decide. Working for a long period reduces focus, leads to burnout and may impact clinical decisions. These findings suggest that measures to boost the ability to deal with complications, minimize errors and improve team collaboration should be emphasized for the benefit of medical surgeons. In addition to these essential strategies, having clear rules and policies to help with workload and work-life integration is essential.

4.3 *Sensitive analysis and comparison*

A sensitivity analysis was conducted to check the validity of the proposed model, where the criteria weights were changed slightly to see how the results were affected. The purpose was to study how different criteria weights affect the final placement of alternative. During this analysis, a slight change of ± 5% and ± 10% was made to the criterion ψ_1 and the remaining criteria were adjusted to keep the total weight sum value of 1. In addition to the other scenarios, hypothetical weights were added to check how the model operates when the assumptions change completely.

According to Figure 3, minor symmetrical variations of ± 5% and ± 10% in weights did not influence the total ranking of the alternatives considered. Therefore, as long as the criteria are not significantly assigned different weights, the model can be stable. The scores were slightly changed, but the rank order stayed the same, showing that the model is dependable under such fluctuations.

However, if the initial weight values were not preserved in a hypothetical scenario, observable changes in the ranking transpired, potentially introducing bias in the results. This illustrates that alterations in weight can considerably influence decisions when the criteria differ in significance. Essentially, the analysis indicates that the model can accommodate minor variations in the importance of each criterion, yet it should be approached with caution in the presence of substantial variations. Employing such validation enhances the model's robustness and underscores the necessity of expert assessment of the weights.

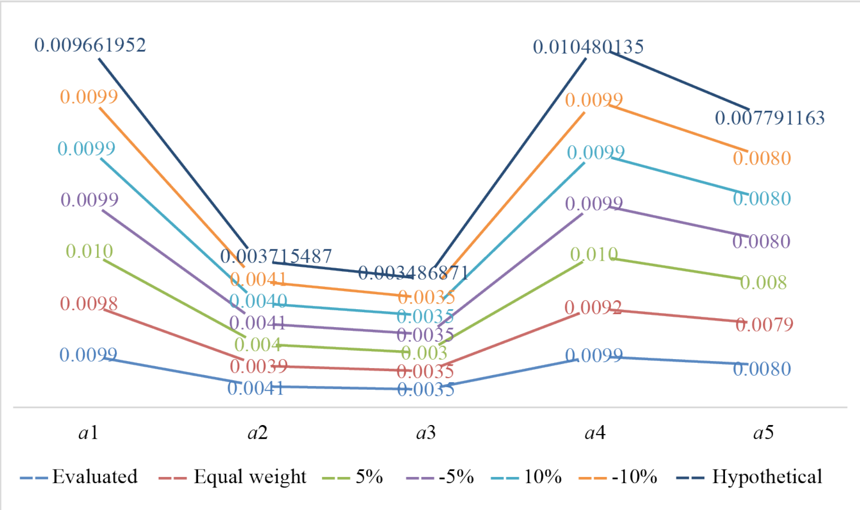
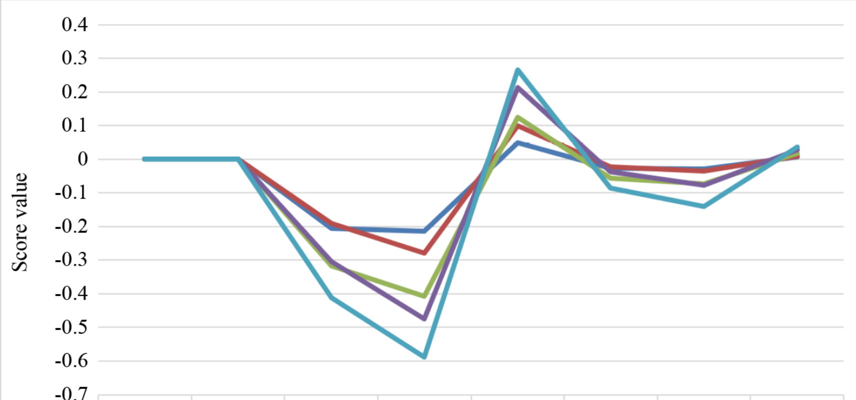


Figure 3. Sensitivity analysis

Moreover, a comparative study examines several fuzzy frameworks and aggregation techniques to show how effective the proposed method is and how general it can be. The comparison shows that this model more accurately reflects how sensitive decisions are to changes and variability. The idea can also refer El-Araby et al. [37]. The results in the Figure 4 show how different fuzzy frameworks perform differently with the various aggregation methods used. Both IFS and CIFS are ineffective, and the alternatives cannot be ranked. The WASPAS approach within the C-PyFS framework allows for more effective differentiation between various alternative. The range of output values is wider, and they clearly show the different structures in the decisions, which means the model responds better to changes in the context. Moreover, C-PyFS can be reduced to the standard PyFS by taking $r = 0$. Therefore, C-PyFS is more flexible than typical models and can be applied more effectively to problems that include unclear or human-related challenges, such as balancing work and personal lives among surgeons.

Figure 4 illustrates the score values of the WASPAS, WSA, and WPA approaches to highlight the versatility of the WASPAS approach. Since the WSA and WPA approaches use additive and multiplicative methods, respectively. However, the WASPAS method integrates these approaches and contains both frameworks. This integration enables WASPAS to effectively utilize the strengths of both WSA and WPA and improve the ranking precision and stability. The proposed additive model, combined with the multiplicative model of the WASPAS method, eliminates the shortcomings of applying each separately compared to other methods, allowing for better consideration of MCDM problems.



	IFS	CIFS	PyFS WSA	PyFS WPA	PyFS WASPAS	C-PyFS WSA	C-PyFS WPA	C-PyFS WASPAS
*a*5			-0.1087	-0.1133	0.0534	-0.0494	-0.0637	0.0096
*a*4			0.0128	-0.0683	0.0878	0.0189	-0.0042	0.0103
*a*3			-0.1259	-0.1280	0.0255	-0.0334	-0.0386	0.0083
*a*2			0.0152	-0.0658	0.0508	0.0042	-0.0058	0.0024
*a*1			-0.2061	-0.2134	0.0485	-0.0268	-0.0289	0.0062

Figure 4. Comparison analysis

5. Conclusions

The WASPAS method represents a reliable MCDM approach, recognized for its precise ability to rank alternatives. The traditional WASPAS method fails to handle uncertain situations effectively within intricate decision-making frameworks. This research introduces a framework that strengthens the WASPAS approach to handling uncertain data by developing the C-PyFS method. The extended C-PyFS WASPAS method identifies work-life challenges faced by surgeons. After evaluating several options such as sleep, time management and work-life balance programs, it becomes clear that proper sleep stands out as the best approach to achieving better life balance, highlighting its critical role in maintaining surgeons' health. Goal alignment sessions and work-life initiatives illustrate their potential because they demonstrate how supportive environments can integrate personal and professional objectives. The effectiveness of work relief through vacations and time scheduling appears limited compared to other strategies, which could benefit from combining with additional measures for stronger results. These findings offer valuable insights for healthcare administrators, particularly in high-stress settings, to improve practices and propose effective methods for alleviating stress experienced by employees and clients. The sensitive analysis shows that the model is reliable, as minor adjustments in criteria weights do not alter the outcomes. Additionally, comparing the C-PyFS-WASP approach with alternative methods highlights its superior ability to differentiate options and establish clearer priorities, affirming its trustworthiness and relevance in critical decision-making. This algorithm-based framework applies to other domains, providing universal relevance.

5.1 *Limitations and future directions*

The proposed C-PyFS WASPAS approach offers a robust methodology for addressing complex and uncertain decision-making scenarios, such as balancing work-life challenges for surgeons. However, the approach provides some limitations, including the biases of weight values and its reliance on subjective weight assignments, which may affect the evaluation outcomes. The computational complexity of the proposed approach model may make its usability difficult for decision-makers unfamiliar with advanced mathematical techniques. The framework's static nature limits its adaptability to dynamic, real-time decision-making scenarios. So, the current study points out the following main limitations:

i. Since experts are part of the model, different groups of experts could affect its findings differently.

ii. Since MCDM methods are based on fuzzy logic, decision-makers without related expertise may find them challenging to use because they are unfamiliar with advanced mathematical techniques.

iii. Since real-time updates are not supported, the framework is less adaptable as decisions progress.

iv. Scalability problems may arise for the model, since solving many criteria and alternatives can make it more challenging to use and consume more computer resources.

Future research could focus on integrating Machine Learning (ML) and neural network [38] techniques to automate weight assignments and reduce subjective bias. In the case of real-time data and changing parameters of the decision-making criteria, dynamic decision-support systems would have benefited their operations. Furthermore, statistical methodologies, including Spearman's rank correlation coefficient and Analysis of Variance (ANOVA), will be employed to compare various decision-making models and evaluate the similarity of their outcomes. This will enable more structured comparative analyses and ensure consistency across diverse approaches. Moreover, it can be extended to a type 2 fuzzy set [39], Takagi-Sugeno (T-S) fuzzy systems [40], spherical fuzzy set [41], neutrosophic hypersoft set [42] which further refine its utility, ensuring its relevance in addressing increasingly complex decision-making challenges.

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Conflict of interest

The authors declare that there is no conflict of interest.

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