

An Integrated Approach of SAW, TOPSIS, and RAM for Ranking Alternatives: A Case Study in the Food Industry

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ABSTRACT

Multi-Criteria Decision Making (MCDM) stands as a widely employed technique for ranking alternatives and identifying the most suitable option across diverse domains. However, the inherent algorithmic variations among different MCDM methods can lead to discrepancies in the ranking outcomes when applied to the same problem. Consequently, to enhance the reliability of alternative rankings, it is crucial to address the problem using multiple distinct MCDM approaches. This study integrates three prominent methods: Simple Additive Weighting (SAW), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), and Root Assessment Method (RAM) to concurrently rank alternatives within a representative food-related example, specifically the nutritional value assessment of various nut types. The SAW, TOPSIS, and RAM methodologies were applied to rank eight types of nuts: almond, Brazil nut, cashew, hazelnut, macadamia, pecan, chestnut, and walnut, each characterized by nineteen distinct nutritional attributes. The results demonstrate a consistent identification of the top-ranked nut across all methods. Furthermore, the ranking order of the remaining alternatives exhibited minimal variation among the three approaches. Spearman's rank correlation coefficients were 0.905 between SAW and TOPSIS, 0.929 between SAW and RAM, and 0.976 between TOPSIS and RAM. These findings not only offer valuable guidance for consumers in selecting the optimal nut product, but also provide a clear direction for practitioners to consider the combined application of these three MCDM methods for ranking alternatives in other fields.

Keywords-MCDM; SAW; TOPSIS; RAM; nut-based foods

I. INTRODUCTION

MCDM is a widely used technique for ranking alternatives when each alternative is characterized by multiple criteria [1, 2]. Currently, over 200 distinct MCDM methods have been developed and implemented across diverse fields, spanning economics, engineering, medicine, military applications, and more [3, 4]. Nevertheless, the very diversity of MCDM methods presents a hurdle for users, as the outcomes of solving the same problem using different MCDM approaches can diverge [5, 6]. For this reason, numerous studies have reported that to ensure the accuracy of problem results, each problem should be solved using several different methods [7].

The SAW method is one of the oldest within the MCDM family and is also recognized as a foundation for the development of other methods [8]. Despite its long-standing history, recent research continues to apply this method to address problems across various domains [9-11]. TOPSIS is one of the most frequently utilized methods among MCDM techniques [12-14]. RAM is a new method, having emerged in September 2023 [15]. Despite its short existence, this method has garnered considerable attention from researchers, as it can be applied for ranking alternatives in various fields, such as

ranking fire-resistant materials [16], mushroom cultivation solutions [17], and the financial health of banks [18], among others. However, to the best of the authors' knowledge, the combined application of these three specific methods for the simultaneous ranking of alternatives within a single problem has not been documented in any scientific publication. This novelty constitutes the primary motivation for the integrated utilization of the aforementioned methods in the present study.

Components, such as energy, protein, total fat, saturated fat, fiber, and so forth, play a pivotal role in consumer well-being. Energy serves as the primary fuel source for sustaining vital bodily functions. Protein is essential for the construction and repair of tissues and muscles. Total fat provides energy and aids in vitamin absorption. Saturated fat intake necessitates careful management to mitigate cardiovascular risks, while polyunsaturated and monounsaturated fats offer benefits to cardiovascular health. Carbohydrates furnish rapid energy, and fiber supports digestion and blood glucose regulation, among other functions. Maintaining a balance of these constituents in the daily diet is fundamental for preserving good health [19-22]. Nut-based foods, such as almonds, cashews, hazelnuts, and pistachios, are food categories that contain significant amounts of these nutrients [23, 24]. Consequently, these nuts are

frequently utilized as health-promoting products. Selecting a particular type of nut requires consideration of not just a few parameters, but rather a substantial number of factors, including energy, protein, total fat, saturated fat, fiber, and so on. However, this has become a challenge for consumers because the value of nutritional components across different nut varieties varies, and can even be inversely related. For instance, one type of nut might possess a higher energy content than another but concurrently have a lower protein level, or a certain nut might have a greater calcium content than another while exhibiting a lower iron content. This situation motivates the search for methodologies to identify the nut variety considered the most optimal among multiple alternatives. To address this issue, the application of MCDM methods is essential.

While MCDM techniques, such as SAW, TOPSIS, and RAM, have been increasingly applied across various fields [9-18], no prior research has been found to utilize all three methods concurrently for ranking alternatives within a specific problem. This gap motivates the present study to employ these three methods together to rank eight types of nuts, thereby addressing the aforementioned challenge of identifying the optimal option.

II. MATERIALS AND METHODS

A. Selected Multi-Criteria Decision Making Methods

Assume there are m alternatives to be ranked, each described by n criteria. Let x_{ij} represent the value of criterion j for alternative i , where $j = 1$ to n , and $i = 1$ to m . Let w_j be the weight of the j^{th} criterion. The ranking of alternatives using MCDM methods is performed as follows:

1) The SAW Method

The procedure for ranking alternatives using the SAW method is [25]:

Step 1: Determine the normalized values using:

$$n_{ij} = \frac{x_{ij}}{\max x_{ij}} \quad (1)$$

Apply equation (1) for criteria where "larger is better."
Apply equation (2) for criteria where "smaller is better:"

$$n_{ij} = \frac{\min x_{ij}}{x_{ij}} \quad (2)$$

Step 2: Calculate the score V_i for each alternative using:

$$V_i = \sum_{j=1}^n w_j \cdot n_{ij} \quad (3)$$

Step 3: Rank the alternatives based on the principle that the best alternative is the one with the highest score V_i .

2) The Technique for Order Preference by Similarity to Ideal Solution Method

The TOPSIS method is employed to rank the alternatives according to the following procedure [26]:

Step 1: Determine the normalized values using:

$$n_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}} \quad (4)$$

Step 2: Calculate the weighted normalized values using:

$$Y = w_j \cdot n_{ij} \quad (5)$$

Step 3: Identify the positive ideal solution A^+ and the negative ideal solution A^- for the criteria using:

$$A^+ = \{y_1^+, y_2^+, \dots, y_j^+, \dots, y_n^+\} \quad (6)$$

$$A^- = \{y_1^-, y_2^-, \dots, y_j^-, \dots, y_n^-\} \quad (7)$$

where (6) and (7) are the best and worst values, respectively, of the normalized value y_j^+ and y_j^- for criterion j .

Step 4: Determine the separation measures S_i^+ and S_i^- using:

$$S_i^+ = \sqrt{\sum_{j=1}^n (y_{ij} - y_j^+)^2} \quad i = 1, 2, \dots, m \quad (8)$$

$$S_i^- = \sqrt{\sum_{j=1}^n (y_{ij} - y_j^-)^2} \quad i = 1, 2, \dots, m \quad (9)$$

Step 5: Calculate the closeness coefficient C_i for each alternative using:

$$C_i = \frac{S_i^-}{S_i^+ + S_i^-} \quad i = 1, 2, \dots, m; \quad 0 \leq C_i \leq 1 \quad (10)$$

Step 6: Rank the alternatives based on the principle that the alternative with the highest closeness coefficient C_i is the best.

3) The Root Assessment Method

The RAM method is applied to rank the alternatives by sequentially performing the following steps [15]:

Step 1: Normalize the data using:

$$r_{ij} = \frac{x_{ij}}{\sum_{i=1}^m x_{ij}} \quad (11)$$

Step 2: Calculate the weighted normalized values of the criteria using:

$$y_{ij} = w_j \cdot r_{ij} \quad (12)$$

Step 3: Calculate the total weighted normalized score of the criteria:

Apply (13) for criteria where "larger is better:"

$$S_{+i} = \sum_{j=1}^n y_{+ij} \quad (13)$$

Apply (14) for criteria where "smaller is better:"

$$S_{-i} = \sum_{j=1}^n y_{-ij} \quad (14)$$

Step 4: Calculate the RI_i score for each alternative using:

$$RI_i = \frac{2 + S_{-i}}{\sqrt{2 + S_{+i}}} \quad (15)$$

Step 5: Rank the alternatives in descending order of their RI_i scores. To facilitate the application of the three methods mentioned above, Figure 1 presents a flowchart illustrating the sequence of steps for each method.

B. Selected Types of Nut-based Foods

Table I compiles 19 nutritional components (hereafter referred to as 19 criteria) commonly employed for evaluating the nutritional composition of nut-based foods [19-22]. Table II

presents a compilation of the nutritional values for eight commonly consumed nut varieties: almonds, Brazil nuts, cashews, hazelnuts, macadamia nuts, pistachios, chestnuts, and walnuts [27]. Images of these eight product types are provided in Figure 2.

The data presented in Table II reveal the impossibility of selecting a single nut variety that simultaneously guarantees the maximum value across all nineteen parameters, from C1 to C19. A few brief examples will clarify this observation. For instance, Brazil nuts exhibit a higher value for criterion C1 compared to almonds, but the value for criterion C2 in Brazil nuts is lower than that of almonds.

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C19. A few brief examples will clarify this observation. For instance, Brazil nuts exhibit a higher value for criterion C1 compared to almonds, but the value for criterion C2 in Brazil nuts is lower than that of almonds. In another example, almonds have a higher C1 value than cashews, yet both C2 and C3 values for cashews surpass those of almonds. Examining other nut types similarly demonstrates the absence of any single nut, all 19 of criteria values of which exceed those of all other nut varieties. This implies that a nut can be only identified when all of its criteria are considered "largest" through a comparative evaluation. Naturally, this determination cannot be made solely by observing the data in Table II; instead, mathematical methods must be applied to rank the nut varieties based on these 19 criteria. MCDM methods are useful tools for addressing problems of this nature [7, 8].

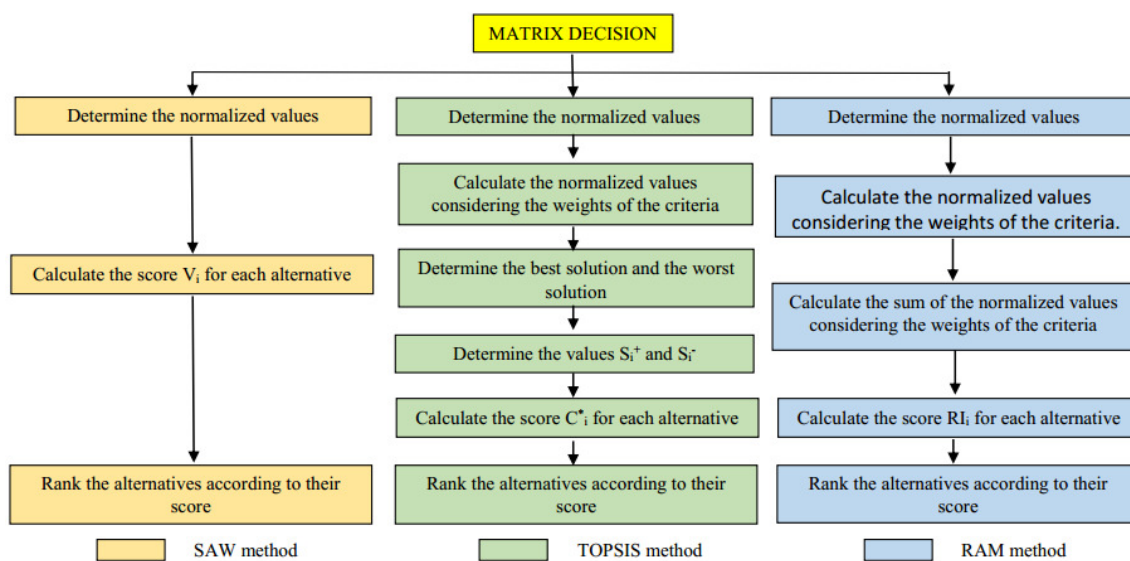


Fig. 1. Flowchart of considered MCDM methods.



Fig. 2. Nutrient particles.

TABLE I. SIGNIFICANCE OF SELECTED NUTRITIONAL COMPONENTS [19-22]

No.	Ingredient	Unit	Role	Symbol
1	Energy	kcal	This component represents the amount of fuel the body receives from food, essential for all life activities, from movement to basic bodily functions. Energy reflects the amount of fuel the body obtains from food, necessary for all life activities, from movement to basic bodily functions.	C1
2	Protein	g	Protein is a component that builds muscles, bones, skin, enzymes, and hormones, a crucial factor for the growth, repair, and maintenance of tissues in the body. Protein is a building block for muscles, bones, skin, enzymes, and hormones, vital for tissue growth, repair, and maintenance.	C2
3	Total fat	g	Total fat represents a reserve energy source, supports vitamin absorption, protects organs, and is a necessary factor for brain function and hormone production.	C3
4	Saturated fat	g	Saturated fat should be consumed in moderation, as excessive consumption can increase bad cholesterol, potentially causing cardiovascular diseases.	C4
5	Polyunsaturated fat	g	Polyunsaturated fat is good for the heart, reduces bad cholesterol, and supports brain function.	C5
6	Monounsaturated fat	g	Monounsaturated fat helps lower bad cholesterol and increase good cholesterol, is beneficial for cardiovascular health.	C6
7	Carbohydrates	g	Carbohydrates are the body's main source of energy, especially for the brain and muscles.	C7
8	Fiber	g	Fiber supports digestion, maintains stable blood sugar, and reduces cholesterol, helping to create a feeling of fullness and supporting weight management.	C8
9	Calcium	g	Calcium is important for strong bones and teeth, muscle and nerve function, and is necessary for blood clotting.	C9
10	Iron	mg	Iron is a component of hemoglobin, transporting oxygen in the blood; iron deficiency causes anemia and fatigue.	C10
11	Potassium	mg	Potassium maintains electrolyte balance, regulates blood pressure and muscle function, and supports nerve function.	C11
12	Magnesium	mg	Magnesium participates in over 300 biochemical reactions, supports muscle, nerve, and immune system function, and helps regulate blood sugar and blood pressure.	C12
13	Zinc	mg	Zinc is important for the immune system, protein and DNA synthesis, and taste and smell function, supporting the wound healing process.	C13
14	Copper	mg	Copper participates in red blood cell formation, collagen synthesis, and iron absorption, supporting nerve and immune function.	C14
15	Vitamin B6	mg	Vitamin B6 participates in protein synthesis, red blood cell production, and brain function, supporting the immune system and reducing the risk of cardiovascular disease.	C15
16	Vitamin B9	g	Vitamin B9 is important for cell development, especially during pregnancy, helping to prevent birth defects.	C16
17	Vitamin B2	mg	Vitamin B2 participates in energy metabolism, cell function, and vision, supporting antioxidant activity.	C17
18	Niacin	mg	Niacin participates in energy metabolism, lowers cholesterol, and supports brain function and skin health.	C18
19	Alpha-tocopherol	mg	Alpha-tocopherol is a powerful antioxidant, protecting cells from damage, supporting the immune system and skin health.	C19

TABLE II. NUTRITIONAL VALUES OF SELECTED FOOD PRODUCTS [27]

Type	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19
Almonds	163	6	14	1.1	3.4	8.8	6.1	3.5	75	1.1	200	76	0.9	0.3	0	14	0.3	1	7.4
Brazil nuts	186	4.1	18.8	4.3	5.8	7	3.5	2.1	45	0.7	187	107	1.2	0.5	0	6	0	0.1	1.6
Cashews	157	5.2	12.4	2.2	2.2	6.7	8.6	0.9	10	1.9	187	83	1.6	0.6	0.1	7	0	0.3	0.3
Hazelnuts	178	4.2	17.2	1.3	2.2	12.9	4.7	2.7	32	1.3	193	46	0.7	0.5	0.2	32	0	0.5	4.3
Macadamia nuts	204	2.2	21.5	3.4	0.4	16.7	3.9	2.4	24	1.1	104	37	0.4	0.2	0.1	3	0	0.7	0.2
Pistachios	196	2.6	20.4	1.8	6.1	11.6	3.9	2.7	20	0.7	116	34	1.3	0.3	0.1	6	0	0.3	0.4
Chestnuts	159	5.8	12.9	1.6	3.9	6.8	7.8	2.9	30	1.1	291	34	0.6	0.4	0.5	14	0	0.4	0.7
Walnuts	185	4.3	18.5	1.7	13.4	2.5	3.9	1.9	28	0.8	125	45	0.9	0.5	0.2	28	0	0.3	0.2

III. RESULTS AND DISCUSSION

To simplify the problem, all 19 criteria were assumed to have equal importance, assigning each a weight of 1/19. The sequential application of (1-3) produced the V_i scores for the alternatives using SAW. Similarly, the sequential application of (4-10) generated the C_i scores for the alternatives deploying TOPSIS, and (11-15) were applied to calculate the RI_i scores for the alternatives employing RAM. All the calculated values are compiled in Table III. Subsequently, the alternatives were ranked using these different methods, and the resulting rankings are also summarized in Table III.

TABLE III. SCORES OF FOOD TYPES AND THEIR RANKING BY DIFFERENT METHODS

Type	SAW method		TOPSIS method		RAM method	
	V_i	Rank	C^*_i	Rank	RI_i	Rank
Almonds	0.6670	1	0.5629	1	1.4835	1
Brazil nuts	0.5277	4	0.3326	5	1.4544	5
Cashews	0.5188	5	0.3113	6	1.4526	6
Hazelnuts	0.5729	2	0.4002	2	1.4612	2
Macadamia nuts	0.4491	8	0.2873	7	1.4477	8
Pistachios	0.4496	7	0.2623	8	1.4481	7
Chestnuts	0.5485	3	0.3943	3	1.4586	3
Walnuts	0.5088	6	0.3744	4	1.4554	4

The observation of the data in Table III reveals inconsistencies in the ranking of the nut varieties when evaluated using the different methods, namely SAW, TOPSIS, and RAM. This is a common occurrence when employing multiple MCDM methods to address the same problem, and has been documented in numerous reports [28, 29]. Specifically, SAW calculates a weighted sum for each alternative across all criteria. A higher weighted sum signifies a better ranking [25]. TOPSIS proceeds by identifying the best ideal solution and the worst ideal solution. Subsequently, it ranks the alternatives based on their shortest geometric distance from the best ideal solution and the longest geometric distance from the worst ideal solution [26]. As for RAM, the ranking of alternatives is based on the trade-off between benefit criteria and cost criteria [15]. However, it is also observed that the ranking of alternatives changes insignificantly when it is performed using different methods. Spearman's rank correlation coefficient, which simplifies the problem (16), was employed in this case. In (16), D_i represents the difference in the ranking of alternative i when ranked by different methods. The calculated Spearman's rank correlation coefficients are outlined in Table IV.

$$S = 1 - \frac{6 \sum_{i=1}^m D_i^2}{m(m^2-1)} \quad (16)$$

TABLE IV. SPEARMAN'S RANK CORRELATION COEFFICIENTS BETWEEN METHODS

	SAW	TOPSIS	RAM
SAW	1	0.905	0.929
TOPSIS		1	0.976
RAM			1

It is observed that the Spearman's rank correlation coefficients between the MCDM methods are all very high, with the lowest being 0.905. This demonstrates that the nutrient rankings are very stable when assessed using different methods. Furthermore, the application of any of the SAW, TOPSIS, or RAM methods consistently indicates that almonds rank 1st, hazelnuts rank 2nd, and chestnuts rank 3rd. The rankings of the remaining nuts do not vary significantly when assessed using different methods. These results strongly affirm the comparable effectiveness of the SAW, TOPSIS, and RAM methods within this study. Furthermore, the findings confirm that, among the eight nut types investigated, almonds emerge as the top preference for consumers.

IV. CONCLUSION

This study marks the first integration of three distinct Multi-Criteria Decision Making (MCDM) methods: Simple Additive Weighting (SAW), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), and Root Assessment Method (RAM), each characterized by unique algorithmic features. This combined approach was applied to the specific scenario of ranking eight types of nuts: almond, Brazil nut, cashew, hazelnut, macadamia, pecan, chestnut, and walnut. Notably, the application of all three methods consistently identified the same top-ranked alternative. Furthermore, the Spearman's rank correlation coefficient analysis indicates a comparable effectiveness among the three methodologies.

Among the eight nut types ranked in this study, almonds emerged as the top choice, possessing the following nutritional composition: energy at 163 kcal, protein at 6 g, total fat at 14 g, saturated fat at 1.1 g, polyunsaturated fat at 3.4 g, monounsaturated fat at 8.8 g, carbohydrate at 6.1 g, fiber at 3.5 g, calcium at 75 mg, iron at 1.1 mg, potassium at 200 mg, magnesium at 76 mg, zinc at 0.9 mg, copper at 0.3 mg, vitamin B6 at 0 mg, vitamin B9 at 14 μ g (micrograms), vitamin B2 at 0.3 mg, and alpha-tocopherol at 7.4 mg.

This study demonstrates the comparable performance of the SAW, TOPSIS, and RAM methods, but this finding is based on the evaluation of alternatives using crisp (real number) values for the criteria. Further research is necessary to determine whether this consistency holds true when addressing problems involving fuzzy number sets.

The ranking of nuts in this study did not incorporate the role of experts in assessing the importance of the criteria. To survey expert opinions on the relative significance of these criteria, future research could employ subjective weighting methods, such as Simple Weight Calculation (SIWEC) [30] and the R (ranking the alternatives based on their performance data related to the attributes) method [31]. Furthermore, this study did not include product cost as a criterion. To facilitate product selection that not only ensures adequate nutrition, but also aligns with consumers' financial situations, future research should consider incorporating price as a factor under specific conditions, such as timeframe.

REFERENCES

- [1] I. Badi, M. B. Bouraima, and C. K. Kiptum, "Integrating Cultural Norms and Behavioral Risk Factors into Traffic Accident Mitigation: A Hybrid MCDM Approach for Libya," *Mechatronics and Intelligent Transportation Systems*, vol. 4, no. 1, Mar. 2025, <https://doi.org/10.56578/mits040104>.
- [2] B. Yildirim and E. Ayyildiz, "Selecting the most suitable 3D printing technology for custom manufacturing using fuzzy decision-making methodology," *International Journal on Interactive Design and Manufacturing (IJIDeM)*, Mar. 2025, <https://doi.org/10.1007/s12008-025-02258-x>.
- [3] M. Baydaş, T. Eren, Ž. Stević, V. Starčević, and R. Parlakkaya, "Proposal for an objective binary benchmarking framework that validates each other for comparing MCDM methods through data analytics," *PeerJ Computer Science*, vol. 9, Apr. 2023, Art. no. e1350, <https://doi.org/10.7717/peerj-cs.1350>.
- [4] D. D. Trung, B. Dudić, N.-T. Nguyen, and A. Ašonja, "Data Normalization for Root Assessment Methodology," *International Journal of Industrial Engineering and Management*, vol. 15, no. 2, pp. 156 – 168, Jun. 2024, <http://doi.org/10.24867/IJIEEM-2024-2-354>.
- [5] S. H. Mian, E. Abouel Nasr, K. Moiduddin, M. Saleh, M. H. Abidi, and H. Alkhalefah, "Assessment of consolidative multi-criteria decision making (C-MCDM) algorithms for optimal mapping of polymer materials in additive manufacturing: A case study of orthotic application," *Heliyon*, vol. 10, no. 10, May 2024, Art. no. e30867, <https://doi.org/10.1016/j.heliyon.2024.e30867>.
- [6] K. Ogrodnik, "Application of MCDM/MCDA methods in city rankings - review and comparative analysis," *Economics and Environment*, vol. 86, no. 3, pp. 132–151, Dec. 2023, <https://doi.org/10.34659/eis.2023.86.3.689>.
- [7] J.-J. Wang, Y.-Y. Jing, C.-F. Zhang, and J.-H. Zhao, "Review on multi-criteria decision analysis aid in sustainable energy decision-making," *Renewable and Sustainable Energy Reviews*, vol. 13, no. 9, pp. 2263–2278, Dec. 2009, <https://doi.org/10.1016/j.rser.2009.06.021>.

- [8] T. V. Dua, "PSI-SAW and PSI-MARCOS Hybrid MCDM Methods," *Engineering, Technology & Applied Science Research*, vol. 14, no. 4, pp. 15963–15968, Aug. 2024, <https://doi.org/10.48084/etasr.7992>.
- [9] M. Azadfallah, "Incorporating Negative Values into the Simple Additive Weighting (SAW) Under Uncertain Conditions: An Applications in Project Manager Selection Problem," in *International Program and Project Management — Best Practices in Selected Industries*, vol. 31, K. D. Strang and N. R. Vajjhala, Eds. Cham: Springer Nature Switzerland, 2025, pp. 277–296.
- [10] V. Hiremani, R. M. Devadas, P. Gujjar, S. Johar, and S. R., "Ranking of Institutes Using MCDM SAW Method Under Uncertainty," in *2024 5th International Conference for Emerging Technology (INCET)*, Belgaum, India, May 2024, pp. 1–4, <https://doi.org/10.1109/INCET61516.2024.10593015>.
- [11] H. Taherdoost, "Analysis of Simple Additive Weighting Method (SAW) as a MultiAttribute Decision-Making Technique: A Step-by-Step Guide," *Journal of Management Science & Engineering Research*, vol. 6, no. 1, pp. 21–24, Feb. 2023, <https://doi.org/10.30564/jmser.v6i1.5400>.
- [12] T. Do, "Application of TOPSIS an PIV Methods for Multi - Criteria Decision Making in Hard Turning Process," *Journal of Machine Engineering*, vol. 21, no. 4, pp. 57–71, Dec. 2021, <https://doi.org/10.36897/jme/142599>.
- [13] Y. Çelikbilek and F. Tüysüz, "An in-depth review of theory of the TOPSIS method: An experimental analysis," *Journal of Management Analytics*, vol. 7, no. 2, pp. 281–300, Apr. 2020, <https://doi.org/10.1080/23270012.2020.1748528>.
- [14] D. Duc Trung, "A combination method for multi-criteria decision making problem in turning process," *Manufacturing Review*, vol. 8, 2021, Art. no. 26, <https://doi.org/10.1051/mfreview/2021024>.
- [15] A. Sotoudeh-Anvari, "Root Assessment Method (RAM): A novel multi-criteria decision making method and its applications in sustainability challenges," *Journal of Cleaner Production*, vol. 423, Oct. 2023, Art. no. 138695, <https://doi.org/10.1016/j.jclepro.2023.138695>.
- [16] D. D. Trung, "Using RAM method for optimal selection of flame retardant nanocomposite material fabrication solution," *EPJ Applied Metamaterials*, vol. 11, 2024, Art. no. 4, <https://doi.org/10.1051/epjam/2024005>.
- [17] D. Trung, D. Duc, N. Bao, and D. Thuy, "Using the root assessment method to choose the optimal solution for mushroom cultivation," *Yugoslav Journal of Operations Research*, no. 00, pp. 7–7, 2024, <https://doi.org/10.2298/YJOR240115007T>.
- [18] D. D. Trung, B. Dudić, H. T. Dung, and N. X. Truong, "Innovation in Financial Health Assessment: Applying MCDM Techniques to Banks in Vietnam," *ECONOMICS*, vol. 12, no. 2, pp. 21–33, Aug. 2024, <https://doi.org/10.2478/eoik-2024-0011>.
- [19] "Fundamental for preserving good health," *Vinmec International Healthcare System*. <https://www.vinmec.com/vie>.
- [20] N. N. A. Dao and N. A. Dao, "A Review of Soluble and Insoluble Fiber in Food," *Journal of Industry and Trade*, vol. 9, pp. 430–435, 2023.
- [21] N. M. Thuy, *Textbook of Human Nutrition*. Can Tho University, 2005.
- [22] "Commonly employed for evaluating the nutritional composition of nut-based foods," Medlatec Medical service, *Medlatec Medical service*. <https://medlatec.vn/>.
- [23] "Nut-based foods," Vinmec International Healthcare System, <https://www.vinmec.com/vie/bai-viet/cac-loai-hat-va-loi-ich-suc-khoe-voi-tre-em-vi>.
- [24] "Food categories that contain significant amounts of nutrients," vnexpress international, <https://vnexpress.net/8-loai-hat-giup-tang-tuoi-tho-4657561.html>.
- [25] F. Ciardiello and A. Genovese, "A comparison between TOPSIS and SAW methods," *Annals of Operations Research*, vol. 325, no. 2, pp. 967–994, Jun. 2023, <https://doi.org/10.1007/s10479-023-05339-w>.
- [26] S. Chakraborty, "TOPSIS and Modified TOPSIS: A comparative analysis," *Decision Analytics Journal*, vol. 2, Mar. 2022, Art. no. 100021, <https://doi.org/10.1016/j.dajour.2021.100021>.
- [27] "Nutritional values for eight commonly consumed nut varieties," Vietnamese macadamia seed production and distribution company, <https://maccavip.com/vi/gia-tri-dinh-duong-cua-hat-macca>.
- [28] S. H. Mian, E. Abouel Nasr, K. Moiduddin, M. Saleh, M. H. Abidi, and H. Alkhalefah, "Assessment of consolidative multi-criteria decision making (C-MCDM) algorithms for optimal mapping of polymer materials in additive manufacturing: A case study of orthotic application," *Heliyon*, vol. 10, no. 10, May 2024, Art. no. e30867, <https://doi.org/10.1016/j.heliyon.2024.e30867>.
- [29] K. Ogrodnik, "Application of MCDM/MCDA methods in city rankings - review and comparative analysis," *Economics and Environment*, vol. 86, no. 3, pp. 132–151, Dec. 2023, <https://doi.org/10.34659/eis.2023.86.3.689>.
- [30] A. Puška, M. Nedeljković, D. Pamučar, D. Božanić, and V. Simić, "Application of the new simple weight calculation (SIWEC) method in the case study in the sales channels of agricultural products," *MethodsX*, vol. 13, Dec. 2024, Art. no. 102930, <https://doi.org/10.1016/j.mex.2024.102930>.
- [31] R. V. Rao, and J. Lakshmi, "R-method: A simple ranking method for multi-attribute decision-making in the industrial environment," *Journal of Project Management*, vol. 6, pp. 223–230, May. 2021, <https://doi.org/10.5267/j.jpm.2021.5.001>.