

Mathematical optimization for nutritional equity: A decision-making and transportation model for implementing SDG-10

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The Sustainable Development Goal 10 (SDG-10) aims to diminish inequalities within and among countries, including discrepancies in healthcare and nutrition. This study focuses on developing a mathematical model to assist in selecting the most nutritious food based on key health criteria – calcium, vitamins, carbohydrates, and proteins. With the application of multi-criteria decision-making (MCDM) techniques, the optimal food choice is determined to enhance health equity. Furthermore, the transportation problem is used to minimize the cost of distributing this nutritional knowledge and resources to a larger population. The integration of these mathematical approaches ensures that nutritious food choices are both effective and accessible, contributing to a reduction in health-related inequalities.

Keywords: Sustainable Development Goal 10 (SDG-10), health inequality, nutrition optimization.

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1. Introduction

In decision-making, individuals assess different alternatives and select the most suitable option based on evaluation most effective one to achieve specific goals and objectives. According to M. Haddad, D. Sanders, decision-making is influenced by various factors, such as available resources, constraints, preferences, and expected outcomes [1]. Because decision-making is a daily task in both professional and personal settings, the use of structured analytical tools is essential for improving decision quality.

One such structured approach is **Multi-Criteria Decision Making (MCDM)**, a multidimensional process designed to address decision-making problems across various disciplines. As noted by S.D. Pohekar and M. Ramachandran, MCDM enables decision-makers to evaluate complex scenarios systematically and select the most attractive alternative while considering multiple criteria [2]. This method enhances decision-making quality by making it more rational, structured, and efficient.

Several methods have been developed to apply MCDM principles in different fields. In recent years MCDM has seen significant growth and has been applied in:

- **Sustainable Energy** [2, 3];
- **Maintenance Management** [4, 5];

- **Construction Management** [6];
- **Tourism Management** [7];
- **Machine Selection** [8];
- **Material Selection** [9];
- **Supply Chain Management** [10];
- **Aviation** [11, 12];
- **Risk Management** [13].

These applications highlight the adaptability of MCDM in solving complex problems across multiple domains.

Nutritional Science: Macronutrients and Micronutrients

Nutritional science categorizes nutrients into two primary groups: **macronutrients** and **micronutrients**. According to EFSA, macronutrients are essential for building body tissues and providing energy, while micronutrients support vital biological functions [14].

Nutritional Deficiencies and Public Health Concerns

Malnutrition is a significant public health issue, particularly in low-income communities. Common deficiencies include:

- **Protein Energy Malnutrition (PEM)**;
- **Vitamin A Deficiency (VAD)**;
- **Iron Deficiency Anemia (IDA)**;
- **Iodine Deficiency Disorders (IDD)**;
- **Vitamin B Complex Deficiencies** [15].

To ensure balanced nutrition, U.S. Department of Health and Human Services and U.S. Department of Agriculture recommends the following macronutrient distribution for adults:

- **10% to 35%** of total Calories from Protein,
- **45% to 65%** from Carbohydrates,
- **20% to 35%** from Fats,
- **Less than 10%** of total Calories from Saturated Fat [16].

These guidelines help individuals maintain optimal health and prevent nutrition-related diseases.

Sustainable Development Goal 10 (SDG 10) focuses on **reducing inequalities** within and among countries by addressing disparities in income, opportunities, and access to essential services, including education and healthcare. One of the key challenges in rural communities is the **unequal access to nutritional knowledge**, which leads to malnutrition, poor health outcomes, and long-term socio-economic disadvantages [17]. Ensuring that all individuals, regardless of location or socio-economic status, have access to accurate and practical dietary knowledge is critical to achieving SDG 10.

In many rural areas a lack of awareness about **nutrient-rich foods** and the importance of a balanced diet results in **higher rates of under nutrition, stunting, and non-communicable diseases**. Despite the availability of various food options, people often make uninformed dietary choices due to limited knowledge. This **knowledge gap exacerbates health inequalities**, particularly affecting vulnerable populations such as children, pregnant women, and the elderly people [18].

To bridge this gap, an **efficient and structured approach** is required to disseminate nutritional knowledge to rural populations. This study proposes a **transportation model** that optimizes the delivery of **nutrition awareness programs** across multiple villages in the least amount of time. The model ensures that trainers and resources are distributed equitably, addressing the **disparity in knowledge access** and aligning with the objectives of SDG 10.

Using the **transportation problem**, a special case of **Linear Programming (LP)**, this study develops an **optimized allocation strategy** for deploying nutrition trainers to different rural locations. By minimizing transportation time and ensuring **maximum outreach**, the model contributes to reducing knowledge inequality, promoting **sustainable health improvements**, and supporting the broader vision of SDG 10 [22]. A numerical example is provided to illustrate the effectiveness of this method in ensuring **fair and**

efficient dissemination of nutritional awareness.

2. Preliminaries

2.1. Alternatives

Alternatives are the “different possible courses of action”.

2.2. Criteria

Criteria are defined as “tools for evaluating and comparing alternatives from the view point of the consequences of their selection”.

2.3. Decision

Decision-making differs according to the problem type, which can encompass choice, ranking, and sorting issues.

2.4. Survey Method

Survey Research is a quantitative research method used for collecting data from a set of respondents. It has been among the most frequently utilized techniques in the industry for several years due to the multiple benefits and advantages it offers when collecting and analyzing data.

2.5. Macronutrients

Macronutrients constitute the primary energy source for the human body and include:

- Carbohydrates,
- Proteins,
- Lipids (Fats).

These nutrients form the basis of caloric intake and are crucial for maintaining overall health [19].

2.6. Micronutrients

Micronutrients are essential in small amounts. They include vitamins and minerals. Micronutrients, though required in smaller amounts, are vital for biochemical processes and include:

- vitamins (fat-soluble and water-soluble),
- minerals.

While they do not contribute significantly to caloric intake, micronutrients are essential for immune function, growth, and disease prevention [20].

2.7. Transportation problem

The transportation problem is an optimization model used to minimize transportation costs or time by allocating resources efficiently from multiple supply points to multiple demand points.

2.8. Supply points (origins)

Supply points refer to locations where resources are available. In this study supply points represent training centers from which trainers are dispatched to rural areas.

2.9. Demand points (destinations) [23]

Demand points are locations where resources are needed. In this study, they represent villages requiring nutrition awareness programs.

2.10. Cost (or time) Matrix

A cost (or time) matrix represents the transportation cost (or time) from connecting supply points to demand points while minimizing the total cost or time involved in transportation.

3. Proposed method

In this section an advanced decision-making approach is used, with its structure illustrated in Table 1. For a particular MCDM problem, ‘m’ alternatives ($F_1, F_2, F_3, \dots, F_m$) are involved, each being distinct.

In this section advanced decision-making approach is used, with its structure illustrated in Table 1. For a given MCDM problem there are ‘m’ alternatives ($F_1, F_2, F_3, \dots, F_m$) are involved, each being distinct which contains Carbs, Proteins, Calcium and Vitamins and ‘n’ criteria ($C_1, C_2, C_3, \dots, C_n$). Here we applied the advanced proposed method to find the best daily Nutrition intake for our healthy life.

3.1. Mathematical form of MCDM problem

In a mathematical form, an MCDM problem is defined as follows $A = \{B_i | i = 1, 2, 3, \dots, m\}$, where B is a distinct and finite set of alternatives, and m represents the number of them. $C = \{C_j | j = 1, 2, 3, \dots, n\}$ where C represents a set of specific criteria used to evaluate B , and n denotes their number. The alternatives are generally homogeneous; however, this is not a strict requirement for the criteria. In other words, the criteria may have different units, lack direct relationships, and pursue different, often

conflicting, objectives – with some requiring minimization and others maximization $W = \{W_j | j = 1, 2, 3, \dots, n\}$ where W is a set of normalized weights assigning to each criterion based on their importance.

3.2. Matrix form of MCDM

Tab. 1. Matrix form

Alternatives/ Criteria	C_1	C_2	C_n
B_1	x_{11}	x_{12}	x_{1n}
B_2	x_{21}	x_{22}	x_{2n}
....
B_m	x_{m1}	x_{m2}	x_{mn}

In this matrix x_{ij} represents the value of B_i related to C_j , and the matrix (M) and the weights’ vector $W = \{w_1, w_2, \dots, w_n\}$ are the basic inputs for the MCDM problems.

In fact, MCDM scores the alternatives and orders them based on the best to the worst.

3.3. Algorithm of proposed method

Step 1: Calculate the Mean:

$$\bar{X} = \frac{\sum_{i=1}^n X_i}{n}$$

Step 2: Calculate: $|x - \bar{x}|$.

Step 3: Assign weightage for each criteria using any one of the existing method.

Step 4: Allot best rank for the smallest deviation.

Step 5: Calculating weightage: $x_{ij} = x_{ij}$ corresponding weight.

Step 6: Find the optimal solution.

4. The advanced Best Alternative Technique for the Optimal Solution (BATOS) method for Multi-Criteria Decision Making (MCDM)

The Advanced Best Alternative Technique for Optimal Solution (BATOS) sounds like a promising method for multi-criteria-based decision-making. Its emphasis on simplicity and accessibility could make it particularly attractive for researchers and decision-makers who prefer straightforward approaches. Using elementary calculations like mean, weight, and ranking

systems can indeed streamline the decision-making process, making it more manageable and less prone to complications. By focusing on these fundamental calculations, Advanced BATOS provide a clear framework for evaluating alternatives and selecting the best course of action. Overall, the Advanced BATOS method appears to offer a practical and user-friendly approach to decision-making, which could be beneficial across various domains and disciplines.

Weights mean how much a given factor should be taken into consideration (default weight = 1 for all factors).

Impact means that a given factor has positive or negative impact. Like we want quality to be great (beneficial or favorable) as possible but the price to be less (non-beneficial) as possible, so I will assign '+' weight to the quality, and '-' weight to the price.

In this paper I have taken four types nutrients in that two from macronutrient (Carbohydrate and Protein) and two from micronutrient (Calcium and Vitamin A).

4.1. Carbohydrates (Carbs)

As a primary energy source, carbohydrates provide fuel for various bodily activities, including physical exercise and cognitive functions. Additionally, carbohydrates play a crucial role in regulating blood glucose levels and insulin metabolism, which are vital for maintaining stable energy levels and preventing conditions like diabetes. Carbohydrates are also involved in cholesterol and triglyceride metabolism, affecting cardiovascular health. Moreover, certain types of carbohydrates, such as dietary fiber, aid in digestion and promote gut health through fermentation by beneficial gut bacteria. Overall, carbohydrates are indispensable for maintaining overall health and well-being [22].

4.2. Proteins

Proteins are composed of amino acids, which are often referred to as the building blocks of life, because they form long chains to create various types of proteins. These proteins play crucial roles in the body, serving as structural components, enzymes, hormones, antibodies, and more. Since the body cannot produce all the necessary amino acids on its own, it relies on dietary sources to obtain them. Hence, proteins are categorized as macronutrients, along with carbohydrates and fats, because they are required in relatively large quantities to support various

physiological functions and maintain overall health.

“It is important for individuals to consume protein every day. Daily protein intake plays a role in keeping your cells in good shape and should be part of your daily health maintenance plan”.

4.3. Calcium

Calcium is an important mineral for maintaining overall health. Its primary role lies in building and maintaining strong bones and teeth, where the majority of the body's calcium is stored. Beyond skeletal health, calcium is involved in numerous physiological processes. It supports muscle function, including the contraction and relaxation of muscles, and aids in the transmission of nerve impulses throughout the body, facilitating communication between the brain and various body parts. Moreover, calcium plays a role in the movement of blood through blood vessels and contributes to the release of hormones that regulate various bodily functions. Overall, adequate calcium intake is essential for maintaining optimal health and functioning.

4.4. Vitamin A

Vitamin A is indeed crucial for various bodily functions. It plays a vital role in maintaining healthy vision, particularly in low-light conditions. It also supports the immune system, aiding in the body's defense against infections. Additionally, vitamin A is involved in cell growth and differentiation, making it essential for reproduction and development. Furthermore, it contributes to the proper functioning of organs like the heart and lungs, highlighting its significance for overall health.

In this paper I have taken four different criteria's like Carbs, Proteins, Calcium, Vitamin and four Alternatives like Food 1, Food 2, Food 3, Food 4. Each alternatives contains the Nutrient component of Carbs, Proteins, Calcium, Vitamin.

Here I have taken data from Nutritional goals for each age/sex group used in assessing adequacy of USDA Food Patterns at various Calorie levels from the RDA (Recommended Dietary Allowance).

Table 2. RDA Data

Age Group	Carbs (g)	Proteins (g)	Calcium (g)	Vitamin (g)	Calories
Female (31–50)	130	46	1	0.7	1800
Male (31–50)	130	56	1	0.9	2200
Female (51+)	130	46	1.2	0.7	1600
Male (51+)	130	56	1.2	0.9	2000
Average (\bar{X})	130	51	1.1	0.8	1900

4.5. Numerical analysis

To solve the problem of selecting the best diet for daily intake for a healthy life from the four varieties of foods based on the daily requirement of calorie intake recommended by RDA (Recommended Dietary Allowance), we need to consider factors such as carbohydrates, proteins, calcium, and minerals. Given data values for a particular factor is to be considered as standard units.

Tab. 3. Problem

Food	Carbs (g)	Proteins (g)	Calcium (g)	Vitamin A (g)
F ₁	120	45	0.7	0.8
F ₂	135	50	1.0	0.7
F ₃	125	55	0.8	0.4
F ₄	130	40	1.3	0.9
Avg from RDA	130	51	1.1	0.8

4.6. Solution

Step 1. Survey Method to calculate weightage for each criteria.

Tab. 4. Weightage Calculation

Factory/criteria	F ₁	F ₂	F ₃	–	–	F ₃₀
Carbs (X ₁)	0.55	0.6	0.63	–	–	0.54
Proteins (X ₂)	0.15	0.2	0.17	–	–	0.24
Calcium (X ₃)	0.2	0.15	0.12	–	–	0.18
Vitamins A (X ₄)	0.1	0.5	0.8	–	–	0.4

Using Arithmetic Mean Calculate the weight.

Weight for Carbs:

$$\bar{X}_1 = \frac{\sum_{i=1}^{30} X_i}{n} = \frac{0.55+0.6+0.63+*****+0.54}{30} = 0.6$$

Weight for Proteins:

$$\bar{X}_2 = \frac{\sum_{i=1}^{30} X_i}{n} = \frac{0.15+0.2+0.17+*****+0.24}{30} = 0.2$$

Weight for Calcium

$$\bar{X}_3 = \frac{\sum_{i=1}^{30} X_i}{n} = \frac{0.2+0.15+0.12+*****+0.18}{30} = 0.15$$

Weight for Vitamin A:

$$\bar{X}_4 = \frac{\sum_{i=1}^{30} X_i}{n} = \frac{0.1+0.5+0.8+*****+0.4}{30} = 0.05$$

Step 2. Assigning Weight to Criteria.

Tab. 5. MCDM Formulation

Food	Carbs (g)	Proteins (g)	Calcium (g)	Vitamin A (g)
Weight	0.6	0.2	0.15	0.05
F ₁	120	45	0.7	0.8
F ₂	135	50	1.0	0.7
F ₃	125	55	0.8	0.4
F ₄	130	40	1.3	0.9
Avg from RDA	130	51	1.1	0.8

Step 3. Deviation from the average $|x - \bar{x}|$.

Tab. 6. Deviation table

Food	Carbs (g)	Proteins (g)	Calcium (g)	Vitamin A (g)
Weight	0.6	0.2	0.15	0.05
F ₁	10	6	0.4	0
F ₂	5	1	0.1	0.1
F ₃	5	4	0.3	0.4
F ₄	10	11	0.2	0.1

Step 4. Assigning Rank for each criteria.

Tab. 7. Rank Table
(Smallest value should be given the best rank)

Food	Carbs (g)	Proteins (g)	Calcium (g)	Vitamin A(g)
Weight	0.6	0.2	0.15	0.05
F ₁	10-2	6-3	0.4-4	0-1
F ₂	5-1	1-1	0.1-1	0.1-2
F ₃	5-1	4-2	0.3-3	0.4-3
F ₄	10-2	11-4	0.2-2	0.1-2

Step 5. Find the optimal solution.

Tab. 8. Optimal Solution

Food	Carbs (g)	Proteins (g)	Calcium (g)	Vitamin (g)	Total	Rank
F ₁	1.2	0.6	0.6	0.05	2.45	4
F ₂	0.6	0.2	0.15	0.1	1.05	1
F ₃	0.6	0.4	0.45	0.15	1.6	2
F ₄	1.2	0.8	0.3	0.1	2.4	3

From the mathematical model we can conclude that F₂ contains the best daily required Nutrition Contents since it has the minimum deviation from the daily requirement recommended by RDA (Recommended Dietary Allowance).

Now I would like to spread this knowledge to the rural people to reduce the inequality in the knowledge of taking nutrient food and how to choose the best food among the different varieties of food. For that I am using the proposed transportation problem to spread this knowledge to most of the villages with minimum time period.

5. Mathematical Structure of the Problem

The transportation model for optimizing nutrition awareness sessions in rural areas can be formulated as a Linear Programming (LP) problem. The objective is to minimize the total transportation time while ensuring that all villages receive the required number of training sessions.

5.1. Algorithm for the proposed method

Step 1. Balance the transportation problem.

Step 2. For each row in the cost table, subtract the row mean from each element in the row.

Step 3. For each column, subtract the column mean from each element in the column.

Step 4. For minimization: start allocating as much as possible to the least cost value cell.

Step 5. For maximization: start allocating as much as possible to the highest cost value cell.

Step 6. Proceed to step 4/5 until all allocations are complete.

5.2. Problem Formulation

Decision Variable

Let x_{ij} represent the number of training sessions transported from training center i to village j , where:

$i = 1, 2, 3$ (Centers: A, B, C),
 $j = 1, 2, 3, 4$ (Villages: V1, V2, V3, V4).

Objective function

The goal is to minimize the total transportation time, given by:

$$\min Z = \sum_{i=1}^3 \sum_{j=1}^4 c_{ij} x_{ij}$$

where:

- c_{ij} represent the transportation time in hours from centre i to village j ,
- x_{ij} is the number of session transported from centre i to village j .

Constraints:

(i) Supply Constraints (Trainers availability at centers).

Each center has a limited number of trainers available, which imposes a supply constraint:

$$\sum_{j=1}^4 x_{ij} \leq S_i, \forall i = 1, 2, 3$$

where:

S_i represents the total number of training sessions available at center i .

For the given data:

- Center A: $S_1 = 10$,
- Center B: $S_2 = 12$,
- Center C: $S_3 = 8$.

Thus, the supply constraints are:

$$\begin{aligned} X_{A1} + X_{A2} + X_{A3} + X_{A4} &\leq 10 \\ X_{B1} + X_{B2} + X_{B3} + X_{B4} &\leq 12 \\ X_{C1} + X_{C2} + X_{C3} + X_{C4} &\leq 08 \end{aligned}$$

Demand Constraints (Sessions required at Villages)

Each village requires a certain number of training sessions, which must be met:

$$\sum_{i=1}^3 x_{ij} \leq D_j, \forall j = 1, 2, 3, 4$$

where:

D_j represents the total number of training sessions required at village j .

For the given data:

- Village V1: $D_1 = 6$,
- Village V2: $D_2 = 5$,
- Village V3: $D_3 = 7$,
- Village V4: $D_4 = 6$.

Thus, the demand constraints are:

$$\begin{aligned} X_{A1} + X_{B1} + X_{C1} &\leq 6 \\ X_{A2} + X_{B2} + X_{C2} &\leq 5 \\ X_{A3} + X_{B3} + X_{C3} &\leq 7 \\ X_{A4} + X_{B4} + X_{C4} &\leq 6 \end{aligned}$$

Non negativity constraints

Since the number of training sessions cannot be negative, we impose:

$$X_{ij} \geq 0, \forall i, j.$$

Transportation cost (time) Matrix

The transportation time (in hours) from each centre to each village is given by:

Tab. 9

Centre/Village	V1	V2	V3	V4	Supply
A	4	3	5	6	10
B	2	6	4	5	12
C	3	5	2	4	8
Demand	6	5	7	6	

Solution

Step 1. Balance the transportation problem. Since total supply ($10 + 12 + 8 = 30$) is greater than total demand ($6 + 5 + 7 + 6 = 24$), this is an unbalanced transportation problem. To balance it, a dummy village (V5) can be introduced with demand = 6 sessions and transportation time $c_{i5} = 0$ for all centers.

Now Row total and Column total are equal, i.e.

$$\sum_{i=1}^m a_{ij} = \sum_{i=1}^m b_{ij} = 30, \text{ therefore given problem is balanced.}$$

Tab. 10. Balanced data

	V1	V2	V3	V4	V5	Supply
A	4	3	5	6	0	10
B	2	6	4	5	0	12
C	3	5	2	4	0	8
Demand	6	5	7	6	6	

Step 2. Find the mean for each row $\bar{s}_i = \frac{\sum_{j=1}^n c_{ij}}{N}$, where N is the number of elements of each row.

Step 3. Find the Cost Deviation from the row mean. (i.e) $\widetilde{C}_{ij} = C_{ij} - \bar{s}_i$.

Tab. 11.

	V1	V2	V3	V4	V5	Supply
A	0	-1	1	2	-4	10
B	-1	3	1	2	-3	12
C	0	2	-1	1	-3	8
Demand	6	5	7	6	6	

Step 4. Find the column mean and Cost Deviation from the Column mean.

$$(i.e) \widetilde{C}_{ij} = C_{ij} - \bar{s}_i - \bar{t}_j.$$

Tab. 12. Column Deviation

	V1	V2	V3	V4	V5	Supply
A	0	-2	1	0	-1	10
B	-1	2	1	0	0	12
C	0	1	-1	-1	0	8
Demand	6	5	7	6	6	

Step 5. If there are multiple cells with the same lowest value in the resultant table, start the allocation decision by selecting the cell with the maximum allocation is possible.

Tab. 13. Optimal Solution

	V1	V2	V3	V4	V5	Supply
A	0	5	1	0	5	10
B	6	2	1	5	1	12
C	0	1	7	1	0	8
Demand	6	5	7	6	6	

Now there is no allocation left out. Also $m + n - 1 = 7 =$ the number of allocation.

i.e. The total minimum transportation time is $= (3 \times 5) + (0 \times 5) + (2 \times 6) + (5 \times 5) + (0 \times 1) + (2 \times 7) + (4 \times 1) = 70$ hours.

6. Results

The proposed mathematical model effectively identifies the most nutritious food option based on key criteria – calcium, vitamins, carbohydrates, and proteins – using Multi-Criteria Decision-Making (MCDM) techniques such as the Advanced Best Alternative Optimal Solution method. The results indicate that food items with a balanced nutritional profile rank higher in the selection process. This structured approach ensures that dietary decisions prioritize nutrition while minimizing costs.

In the second phase, the transportation model optimizes the cost-effective distribution of nutritional awareness and food supply using minimal resources. By reducing transportation expenses and maximizing outreach to underprivileged populations, the model contributes to reducing health inequalities in alignment with SDG-10.

The findings emphasize the significance of mathematical optimization techniques in addressing health equity. The integration of MCDM for food selection and the transportation model for efficient dissemination offers a robust approach to minimizing nutritional disparities and promoting accessible, cost-effective nutrition solutions.

7. Future work

The model holds promise for applications beyond the health sector, particularly in business management across various industries. Future developments will focus on enhancing the model's adaptability for different fields, such as supply chain management, marketing strategies,

and resource allocation. Efforts will also be directed towards improving its scalability for large-scale implementations, refining its decision-making capabilities for both planning and execution. Additionally, real-time data integration and AI-driven optimization techniques will be explored to further enhance the model's accuracy and efficiency.

8. Conclusion

This study identifies F2 as the optimal choice for meeting daily nutritional needs based on minimal deviation from RDA recommendations. Additionally, an optimized transportation model was developed to efficiently distribute nutritional awareness sessions across rural villages, ensuring broader outreach with minimal travel time. This approach supports SDG 10 by promoting equal access to nutritional education and reducing knowledge disparities. Future research can enhance efficiency through real-time traffic data, multi-modal transport, different food combinations with nutritional values, and dynamic scheduling.

9. Bibliography

- [1] Haddad M., Sanders D., "Selection of discrete multiple criteria decision making methods in the presence of risk and uncertainty", *Operations Research Perspectives*, 5, 357–370 (2018).
- [2] Pohekar S.D., Ramachandran M., "Application of multi-criteria decision making to sustainable energy planning – A review", *Renewable and Sustainable Energy Reviews*, 8(4), 365–381 (2004).
- [3] Siksnyte I., Zavadskas E.K., Streimikiene D., Sharma D., "An overview of multi-criteria decision-making methods in dealing with sustainable energy development issues", *Energies*, 11(10), 2754 (2018).

- [4] Al-Najjar B., Alsyof I., “Selecting the most efficient maintenance approach using fuzzy multiple criteria decision making”, *International Journal of Production Economics*, 84(1), 85–100 (2003).
- [5] Shafiee M., “Maintenance strategy selection problem: An MCDM overview”, *Journal of Quality in Maintenance Engineering*, 21(4), 378–402 (2015).
- [6] Jato-Espino D., Castillo-Lopez E., Rodriguez-Hernandez J., Canteras-Jordana J.C., “A review of application of multi-criteria decision making methods in construction”, *Automation in Construction*, 45, 151–162 (2014).
- [7] Akincilar A., Dagdeviren M., “A hybrid multi-criteria decision making model to evaluate hotel websites”, *International Journal of Hospitality Management*, 36, 263–271 (2014).
- [8] Ho W., Xu X., Dey P.K., “Multi-criteria decision making approaches for supplier evaluation and selection: A literature review”, *European Journal of Operation Research*, 202(1), 16–24 (2010).
- [9] Mousavi-Nasab S.H., Sotoudeh-Anvari A., “A comprehensive MCDM-based approach using TOPSIS, COPRAS and DEA as an auxiliary tool for material selection problems”, *Materials and Design*, 121, 237–253 (2017).
- [10] Wansink B., Sobal J., “Mindless eating: The 200 daily food decisions we overlook”, *Environ Behav*, 39(1), 106–23 (2007).
- [11] Janic M., Reggiani A., “An application of the multiple criteria decision making (MCDM) analysis to the selection of a new Hub Airport”, *European Journal of Transport Infrastructure Research*, 2(2/3), 3692 (2002).
- [12] Gudiel Pineda P.J., Liou J.J.H., Hsu C.C., Chuang Y.C., “An integrated MCDM model for improving airline operational and financial performance”, *Journal of Air Transport Management*, 68(C), 103–117 (2018).
- [13] Ilangkumaran M., Karthikeyan M., Ramachandran T., Boopathiraja M., Kirubakaran B., “Risk analysis and warning rate of hot environment for foundry industry using hybrid MCDM technique”, *Safety Science*, 72, 133–143 (2015).
- [14] EFSA, “Dietary Reference Values for nutrients. Summary report”, *EFSA Journal*, 2017, 10.2903/sp.efsa.2017.e1512.
- [15] *Dietary Guidelines for Indians*, National Institute Of Nutrition, India, 2024.
- [16] USDA, *Dietary Guidelines for Americans, 2020–2025*, Ninth Edition, USA, https://healthcare.utah.edu/sites/g/files/zrelqx136/files/media/documents/2023/Dietary_Guidelines_for_Americans_2020-2025-compressed_1.pdf.
- [17] United Nations, *The Sustainable Development Goals Report 2021*, United Nations Department of Economic and Social Affairs, p. 45, <https://unstats.un.org/sdgs/report/2021/The-Sustainable-Development-Goals-Report-2021.pdf>.
- [18] FAO, *2021 The State of Food Security and Nutrition in the World*, Food and Agriculture Organization of the United Nations, p. 23, Rome, 2021, <https://openknowledge.fao.org/server/api/core/bitstreams/1c38676f-f5f7-47cf-81b3-f4c9794eba8a/content>.
- [19] Carreiro A.L., Dhillon J., Gordon S., Higgins K.A., Jacobs A.G., McArthur B.M., et al., “The Macronutrients, Appetite, and Energy Intake”, *Annual Review of Nutrition*, 17:36, 73–103 (2016).
- [20] Shergill-Bonner R., “Micronutrients”, *Symposium Nutrition*, 27(8), 357–62 (2017).

Matematyczna optymalizacja dla równości żywieniowej: model podejmowania decyzji i transportu do wdrażania SDG-10

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Cel Zrównoważonego Rozwoju 10 (SDG-10) dąży do zmniejszenia nierówności w obrębie krajów, w tym rozbieżności w opiece zdrowotnej i żywieniu. Niniejsze badanie koncentruje się na opracowaniu modelu matematycznego, który pomoże w wyborze najbardziej wydajnej strategii żywieniowej na podstawie kluczowych kryteriów zdrowotnych w zakresie zawartości: wapnia, witamin, węglowodanów i białek. Dzięki zastosowaniu technik podejmowania decyzji wielokryterialnych (MCDM) określany jest optymalny wybór struktury odżywiania w celu zwiększenia równości zdrowotnej społeczeństwa. Dodatkowo w pracy uwzględniono problem transportu żywności, który jest wykorzystywany w celu zminimalizowania kosztów dystrybucji zasobów żywieniowych do większej populacji. Integracja tych podejść zapewnia, że wybory w zakresie struktury żywieniowej są zarówno skuteczne, jak i dostępne, przyczyniając się do zmniejszenia nierówności związanych ze zdrowiem.

Słowa kluczowe: Cel Zrównoważonego Rozwoju 10 (SDG-10), nierówności w ochronie zdrowia, optymalizacja, struktura odżywiania.