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Decision Support System For Food Menu Selection For Boarding Students Using The Fuzzy AHP Method

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Abstract: This research aims to develop a decision support system specifically designed to help boarding school students choose a balanced food menu by considering nutritional aspects such as carbohydrates, protein and fat. The method used in this research is the Fuzzy Analytical Hierarchy Process (Fuzzy AHP), which aims to give weight to predetermined criteria and determine limits or thresholds for nutritional needs according to the condition of each student. This system is implemented in the form of a web-based application that makes it easier for students to determine food choices that suit their daily calorie and nutritional needs. The research results show that the system developed is able to provide optimal food menu recommendations, based on calculations of nutritional needs processed using the Fuzzy AHP method. Thus, it is hoped that this system can help boarding house students maintain a balanced nutritional intake and improve the quality of their health during the study period. Further implementation of this system is expected to be able to be integrated with users' food preferences to provide more personalized recommendations.

Keyword: Fuzzy AHP, Decision Support System, Food Menu Selection, Nutritional Needs, Boarding Students

INTRODUCTION

Students, as elements of society, play an essential role in the progress of the nation. Quality and sufficient food intake significantly influences students' optimal health. However, academic pressure often leads students to opt for fast food or unbalanced snacks, which negatively impact their health and nutritional status (Sabilla, 2022). Academic load can also affect their eating habits, with some students overeating to cope with stress, while others tend to reduce food intake, leading to negative effects on their nutritional status (Juliana et al., 2023). Studies have shown that individuals, including students, often make food-related decisions without considering the health impacts, and choosing unhealthy foods can lead to the formation of poor eating patterns (Angesti & Manikam, 2020).

In Indonesia, recommended dietary allowances are known as Angka Kecukupan Gizi (AKG). First established in 1968, the AKG has been updated through the National Workshop

on Food and Nutrition (WNPG). AKG is a value that indicates the average daily nutritional intake needed by almost all individuals with certain characteristics such as age, gender, height, and weight (Kementerian Kesehatan, 2019). However, there are challenges in uniformly applying the AKG across different populations, particularly due to physiological differences, lifestyle, and food access variations in various regions. Additionally, data collection processes for measuring actual nutritional intake require significant resources, including access to accurate food composition and consumption data. This can hinder effective assessment of nutritional adequacy, particularly in areas with limited food access or low education regarding nutrition.

Therefore, developing a food menu selection system is crucial to help students choose healthy and balanced meals, especially under academic pressures that often influence their eating patterns. This system allows students to easily obtain menu recommendations that align with their daily nutritional needs based on the Angka Kecukupan Gizi (AKG). Moreover, the system can prevent unhealthy eating habits, such as overeating or under-eating, which can negatively affect their health.

The Fuzzy Analytical Hierarchy Process (F-AHP) is a development of the AHP method in decision support systems. F-AHP is a multi-criteria method for decision-making that considers more subjective aspects. In F-AHP, the decision-making process involves using Triangular Fuzzy Numbers (TFN) in the fuzzification step, consisting of three key values to represent the importance of criteria: minimum, middle, and maximum values (Aflahin et al., 2023).

Research related to food menu selection, such as "Analysis of Factors Influencing Decisions in Choosing Food Menus in Nutrition Study Program Students of Semarang State University", shows that mood and personal taste preferences are dominant factors influencing menu selection among nutrition students (Ramadhani et al., 2024). Another study titled "The Effect of Academic Stress on Students' Diet and Nutritional Needs: A Case Study at the Faculty of Medicine, State University of Semarang" found that medical students tend to consume fast food during periods of academic stress, with factors such as ghrelin levels, emotional eating, and poor sleep quality affecting their eating habits (Nikarli et al., 2024).

It is hoped that the decision support system developed in this research can help boarding or overseas students who are far from their families in choosing food that suits their nutritional needs, taking into account optimal nutritional needs.

This research aims to develop a web-based food menu selection system using the Fuzzy AHP method. Fuzzy AHP can resolve issues in food menu selection by combining the strengths of the Analytic Hierarchy Process (AHP) in prioritizing criteria based on subjective judgment and the ability of Fuzzy Logic to handle uncertainty in the decision-making process. As a result, the system provides more accurate and suitable recommendations for students.

METHOD

This research uses the Fuzzy AHP approach to determine students' nutritional needs. There are three main criteria to consider when selecting a food menu: carbohydrates, protein and fat. These three criteria are weighted using AHP, and fuzzy logic is used to determine the limits or thresholds of these three criteria.

Calculating the number of calories needed by students can be done based on the student's gender, body weight, maximum body weight and age. Here's how to calculate calorie needs:

1. Requirements for men: 66,5 + (13,75 x body weight in kilograms) + (5,003 x height in cm) – (6,75 x age).
2. Requirements for women: 655,1 + (9,563 x body weight in kilograms) + (1,850 x height in cm) – (4,676 x age) Halodoc, (2024).

After obtaining the student's calorie needs, nutritional needs can be calculated based on the number of calories that have a certain percentage. Here's how to calculate the percentage of nutritional needs:

1. Carbohydrate requirements are 60% - 75% of calories, 1 gram is equivalent to 4 calories.
2. Protein requirements are 10% - 15% of calories, 1 gram is equivalent to 4 calories.
3. Fat requirements are 10% - 25% of calories, 1 gram is equivalent to 9 calories HelloSehat, (2024).

The percentage of nutritional needs is needed to determine the limit or threshold in Fuzzy Logic. In Fuzzy Logic, there are 3 limits, namely minimum, medium and maximum limits. The following is an explanation of the minimum limits. medium, and maximum of the criteria:

Table 1. Criteria Limitations in Fuzzy Logic

Criteria	Minimum Limit	Medium Limit	Maximum Limit
Carbohydrate	< 60%	60% - 75%	>75%
Proteins	<10%	10% - 15%	>15%
Fat	<10%	10% - 25%	>25%

Therefore, the medium limit is an appropriate limit when viewed from the nutritional needs of the total calories needed by students.

Looking at the percentage of nutritional needs, it is found that carbohydrates rank first in terms of weight criteria needed in calculating AHP, followed by protein as second, and fat as third. Before weighting the criteria, a pairwise comparison matrix is carried out first, followed by a normalization matrix, and finally the weighting of the criteria, as follows:

Table 2. AHP Pairwise Comparison Matrix

Criteria	Carbohydrate	Proteins	Fat
Carbohydrate	1.0000	2.0000	3.0000
Proteins	0.5000	1.0000	2.0000
Fat	0.3333	0.5000	1.0000
Total	1.8333	3.5000	6.0000

Table 3. Normalization Matrix and AHP Criteria Weights

Criteria	Carbohydrate	Proteins	Fat	Criteria Weight
Carbohydrate	0.5455	0.5714	0.5000	0.5390
Proteins	0.2727	0.2857	0.3333	0.2973
Fat	0.1818	0.1429	0.1667	0.1638

In a food menu selection system, an application is needed that can display food menu selections. Website-based applications are very suitable for food menu selection systems because there is no need to download or download memory-consuming applications, and can be run on all devices. The following is the program flow for a web-based food menu selection system for boarding school students:

1. Users enter gender, weight, height and age first so that the application can display the user's total calorie, carbohydrate, protein and fat needs.
2. The application will display the overall results starting from calculating the Fuzzy value, Fuzzy AHP value, and ranking of each criterion.
3. The application will display the 3 best food menu sequences based on each criterion and display the Fuzzy value and Fuzzy x AHP value as a reference. Aflahin et al., (2023).

Calorie data from food ingredients or processed foods is obtained based on the Indonesian food composition table issued by the Ministry of Health of the Republic of Indonesia in 2018. This table contains the nutritional composition of food per 100 grams.

RESULTS AND DISCUSSION

This research has produced a web-based system that can be used to calculate students' nutritional needs based on the input provided (gender, weight, height and age). The results of calculating calorie and nutritional needs are displayed in the form of tables and graphs, and recommendations for the best food menu are given based on the criteria of carbohydrates, protein and fat.

The author first performs manual calculations using Excel, as follows:

Table 4. Determining Calorie Needs

Gender	Weight	Height	Age	Total Calories
Man	60	160	20	1557

Table 5. Determining the Lower and Upper Limits for Each Criteria

Min K Limit	Max K Limit	Min P Limit	Max P Limit	Min L Limit	Max L Limit
234	292	39	58	17	43

Table 6. Fuzzy AHP Values and Carbohydrate Rankings

Food	*Threshold*	*Fuzzy Value*	*Fuzzy AHP Value*	Ranking
Rice	In accordance	1.4138	0.7620	1
Ketupat	In accordance	1.3103	0.7062	2
Steamed Cassava	In accordance	1.1207	0.6040	3
Corn on the Cob	In accordance	0.5948	0.3206	4
Egg Tofu	In accordance	0.1034	0.0558	5

Table 7. Fuzzy AHP Values and Protein Rankings

Food	*Threshold*	*Fuzzy Value*	*Fuzzy AHP Value*	Ranking
Fried Mujahir Fish	In accordance	1.4421	0.4287	1
Fried Chicken Intestines	In accordance	1.3526	0.4021	2
Salted fish	In accordance	1.1842	0.3520	3
Fried Squid	In accordance	1.1105	0.3301	4
Fried Chicken Wings	In accordance	0.8632	0.2566	5

Table 8. Fuzzy AHP Value and Fat Rating

Food	*Threshold*	*Fuzzy Value*	*Fuzzy AHP Value*	Ranking
Ceplok Chicken Eggs	In accordance	0.9385	0.1537	1
Presto Milkfish	In accordance	0.4538	0.0743	2
Omeleted Chicken Eggs	In accordance	0.4192	0.0687	3
Salted Duck Eggs	In accordance	0.1846	0.0302	4

After calculating using Excel, a test will be carried out through the system, as follows:

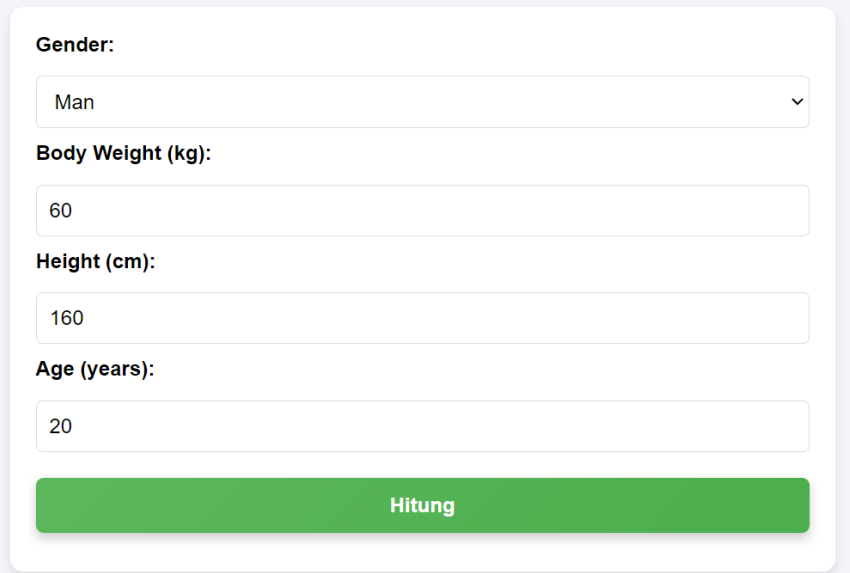


Figure 1. Nutritional Needs Check Form

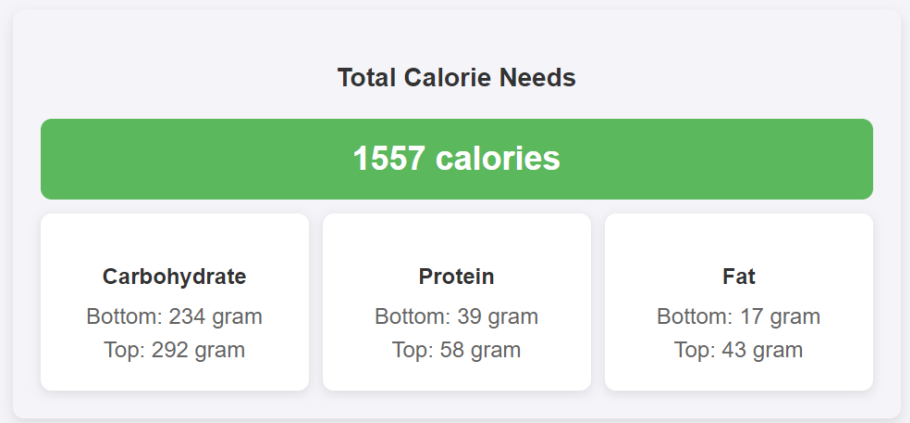
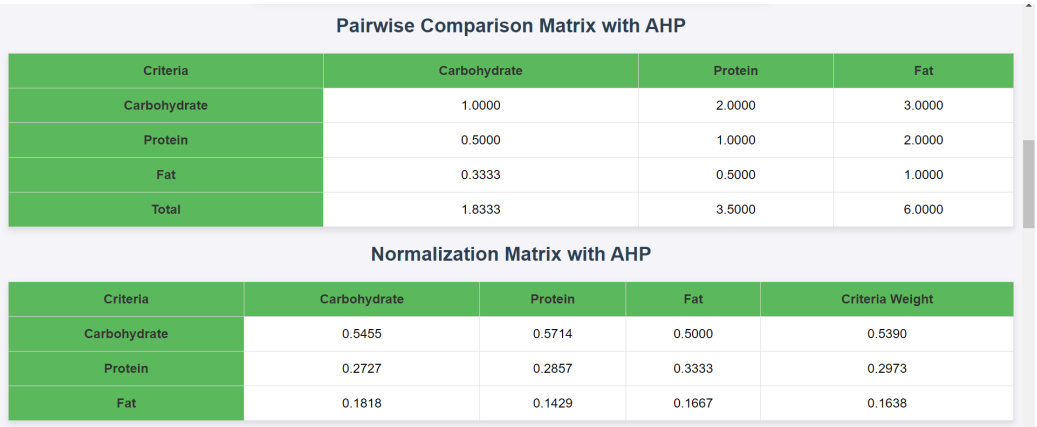


Figure 2. Results of Total Calorie Requirements



Pairwise Comparison Matrix with AHP

Criteria	Carbohydrate	Protein	Fat
Carbohydrate	1.0000	2.0000	3.0000
Protein	0.5000	1.0000	2.0000
Fat	0.3333	0.5000	1.0000
Total	1.8333	3.5000	6.0000

Normalization Matrix with AHP

Criteria	Carbohydrate	Protein	Fat	Criteria Weight
Carbohydrate	0.5455	0.5714	0.5000	0.5390
Protein	0.2727	0.2857	0.3333	0.2973
Fat	0.1818	0.1429	0.1667	0.1638

Figure 3. Pairwise Comparison Matrix and AHP Normalization

Fuzzy AHP Value and Protein Ratings

Food	Threshold	Fuzzy Value	Fuzzy AHP Value	Peringkat
Fried Mujahir Fish	Sesuai	1.8688	0.5555	1
Fried Chicken Intestines	Sesuai	1.7625	0.5239	2
Salted Fish	Sesuai	1.5625	0.4645	3
Fried Squid	Sesuai	1.4750	0.4385	4
Fried Chicken Wings	Sesuai	1.1813	0.3511	5

Figure 4. Fuzzy AHP Value and Carbohydrate Ranking

Fuzzy AHP Value and Protein Ratings

Food	Threshold	Fuzzy Value	Fuzzy AHP Value	Peringkat
Fried Mujahir Fish	In accordance	1.4421	0.4287	1
Fried Chicken Intestines	In accordance	1.3526	0.4021	2
Salted Fish	In accordance	1.1842	0.3520	3
Fried Squid	In accordance	1.1105	0.3301	4
Fried Chicken Wings	In accordance	0.8632	0.2566	5

Figure 5. Fuzzy AHP Value and Protein Ranking

Fuzzy AHP Value and Fat Ratings

Food	Threshold	Fuzzy Value	Fuzzy AHP Value	Rating
Ceplok Chicken Eggs	In accordance	0.9385	0.1537	1
Presto Milkfish	In accordance	0.4538	0.0743	2
Omeleted Chicken Eggs	In accordance	0.4192	0.0687	3
Salted Duck Eggs	In accordance	0.1846	0.0302	4

Figure 6. Fuzzy AHP Value and Fat Rating

3 Best Menus Based on Rankings

Number	Carbohydrate	Protein	Fat
1	Rice	Fried Mujahir Fish	Ceplok Chicken Eggs
2	Ketupat	Fried Chicken Intestines	Presto Milkfish
3	Steamed Cassava	Salted Fish	Omeleted Chicken Eggs

Figure 7. Best Food Menus Based on Rankings

CONCLUSION

This research has succeeded in producing a decision support system based on the Fuzzy AHP method, which is designed to provide food menu recommendations that suit the nutritional needs of boarding house students. This system prioritizes carbohydrates as the main factor in meeting nutritional needs, followed by protein and fat. By using the Fuzzy AHP approach, the system is able to combine student preferences and daily nutritional needs, so that it can provide balanced food menu recommendations. The top 3 food items recommended by the system, based on Fuzzy AHP calculations, are:

1. Rice (carbohydrate) with a Fuzzy AHP value of 0.7620.
2. Fried Mujair Fish (protein) with a Fuzzy AHP value of 0.4287.
3. Ceplok Chicken Eggs (fat) with a Fuzzy AHP value of 0.1537.

The system also has the potential to be further integrated with individual food preferences and specific health conditions, to increase the accuracy and personalization of recommendations. Therefore, further development of this system could make it a more effective tool in promoting healthy eating patterns among boarding house students.

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