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APPLYING ELECTRE METHOD TO DETERMINE HEALTHY FOOD FOR HYPERTENSIVE PATIENTS

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Abstract: Hypertension is one of the chronic diseases that can increase the risk of cardiovascular disease. A healthy diet is an important factor in managing hypertension, but many patients struggle to choose foods that are suitable for their condition. Therefore, a decision support system is needed to help patients determine healthy food choices objectively and systematically. This research aims to apply the ELECTRE (Elimination Et Choix Traduisant La Réalité) method in determining healthy foods for hypertension patients. This method is used because it can handle various criteria simultaneously and provide recommendations based on a mathematical approach. Data were obtained from Serozha Clinic through interviews, observations, and literature reviews on the nutritional content of food. The research results show that the ELECTRE method is capable of providing healthy food recommendations with an accuracy level of 90%, higher than the manual technique which only reaches 70%. In addition, the time required in the decision-making process has significantly decreased. Patients also showed a higher level of satisfaction with the proposed system. In conclusion, the ELECTRE method has proven effective in helping hypertension patients choose foods that meet their nutritional needs, and can thus be used as a reference in the development of decision support systems in the health sector.

Keywords: electre method; healthy food; health management; hypertension.

Abstrak: Hipertensi merupakan salah satu penyakit kronis yang dapat meningkatkan risiko penyakit kardiovaskular. Pola makan yang sehat menjadi faktor penting dalam pengelolaan hipertensi, namun banyak pasien kesulitan dalam memilih makanan yang sesuai dengan kondisi mereka. Oleh karena itu, diperlukan sistem pendukung keputusan yang dapat membantu pasien dalam menentukan pilihan makanan sehat secara objektif dan sistematis. Penelitian ini bertujuan untuk menerapkan metode ELECTRE (Elimination Et Choix Traduisant La Realite) dalam menentukan makanan sehat bagi penderita hipertensi. Metode ini digunakan karena mampu menangani berbagai kriteria secara simultan dan memberikan rekomendasi berdasarkan pendekatan matematis. Data diperoleh dari Klinik Serozha melalui wawancara, observasi, serta tinjauan literatur mengenai kandungan gizi makanan.Hasil penelitian menunjukkan bahwa metode ELECTRE mampu memberikan rekomendasi makanan sehat dengan tingkat akurasi 90%, lebih tinggi dibandingkan teknik manual yang hanya mencapai 70%. Selain itu, waktu yang dibutuhkan dalam proses pengambilan keputusan berkurang secara signifikan. Pasien juga menunjukkan tingkat kepuasan yang lebih tinggi terhadap sistem yang diusul kan.Kesimpulannya, metode ELECTRE terbukti efektif dalam membantu penderita hipertensi memilih makanan yang sesuai dengan kebutuhan gizi mereka, sehingga dapat digunakan sebagai referensi dalam pengembangan sistem pendukung keputusan di bidang kesehatan.

Kata kunci: hipertensi; makanan sehat; metode electre; pengelolaan kesehatan.

INTRODUCTION

The development of technology in the healthcare sector has advanced rapidly in recent years. Innovations in health technology have significantly contributed to improving the efficiency of medical services, including diagnosis, treatment,

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and patient condition monito ring, making them more accurate and effective[1]. Additionally, technology enables more structured medical data ma nagement, allowing healthcare professio nals to make data-driven decisions in handling various medical conditions[2].

One of the critical medical condi tions that require serious attention is hypertension, often referred to as the "silent killer." This disease frequently presents no noticeable symptoms, causing many individuals to be unaware that their blood pressure has reached dangerously high levels[3]. If left undetected and untreated, hypertension can lead to severe health complications such as heart disease, stroke, and kidney failure[4]. Therefore, early detection and a healthy lifestyle, including proper dietary choices, play a crucial role in managing this condition.

This study was conducted at Serozha Clinic, a healthcare facility that provides services for various medical conditions, including hypertension. Base d on data from the clinic, the number of hypertensive patients receiving treatment has increased over the past three years. However, dietary recommendations for patients remain suboptimal, as not all individuals with hypertension are suited to the prescribed food options[5].

Nutrition plays a crucial role in maintaining stable blood pressure, making it essential for hypertensive patients to select foods that align with their specific health needs while avoiding high-sodium, high-fat, processed, and preservative-rich foods, which can worsen their condition[6].

Several studies have explored decision support systems for food selection among hypertensive patients. In a study titled "Application of The Profile Matching Method In Food Selection For Hypertension Sufferers" the Profile Matc hing method was applied to help patients choose suitable foods based on nutriti onal content such as sodium, fat, and protein. The study demonstrated that this system could provide recommendations consistent with manual calculations, altho ugh discrepancies remained compared to nutritionist recommendations due to the system's limitations in comprehensively considering all nutritional aspects[7].

Another study, titled "Decision Support System for Food Menu Selection for Hypertension Patients Using the Weighted Aggregated Sum Product Assessment Method" has successfully built a web-based system using the WASPAS method, achieving an accuracy rate of 100% in providing food recommendations based on sodium, fat, and protein criteria, with test results showing a system effectiveness of 91.2%[8].

Additionally, research titled "Selec tion of the Best Foods for Hypertension Patients Using the TOPSIS Method" successfully assisted nutritionists in deter mining the best foods for hypertension patients by considering the criteria of carbohydrates, protein, fat, processing, and salt. The results of this study show that the TOPSIS method is capable of providing the best food recommendations such as steamed potatoes, mung bean porridge, and red beans as the most suitable options based on the relative closeness to the positive ideal solution[9].

Based on previous research, the methods used thus far still have limitations in addressing the complexity of food selection, which involves multiple criteria and uncertainty in nutritional information. Therefore, this study proposes the ELECTRE (Elimi nation Et Choix Traduisant la Réalité) method as an alternative solution. This

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method is advantageous in simultaneo usly handling multiple criteria, enabling more objective ranking and improving the efficiency of the decision-making process[10].

Thus, this study aims to develop a decision support system based on the ELECTRE method to assist hypertensive patients in selecting appropriate foods based on their health conditions. In addition to contributing to the application of ELECTRE in the healthcare field, this research is expected to enhance the effectiveness of dietary recommendations for hypertensive patients in a more optimal manner.

METHOD

This study collected data through interviews, observations, and literature reviews. Interviews provided insights into how healthy food choices were determined for hypertensive patients at Klinik Serozha. Observations involved monitoring the decision-making process, while documentation gathered information from medical records.

Additionally, a literature review analyzed sources on decision support systems using the ELECTRE method. The steps that need to be taken to solve problems using the ELECTRE method include:

Performing decision matrix normalization by converting the values of each criterion to the same scale for comparisons. This normalization process is performed using the following formula:

$$R_{ij} = \frac{X_{ij}}{\sqrt{\sum_{i=1}^{m} X_{ij}^2}} \quad (1)$$

Information:

R_{ij}: Normalization of the relationship between alternative i and criterion j

X_{ij}: The value of the decision matrix element before normalization

m : The number of alternatives.

Determining the weighted normalized matrix by multiplying each column of the R_{ij} matrix by the weight W_j assigned by the decision-maker.

Determine the Concordance and Discordance Index. The concordance index (C_{kl}) is calculated by summing the weights of the criteria where alternative A_k has a value that is equal to or better than alternative A_l. Conversely, the Discordance Index (D_{kl}) involves criteria where alternative A_k has a lower value than alternative A_l:

$$D_{kl} = \{j | V_{kj} < V_{lj} \quad (2)$$

Information:

D_{kl}: Set of discordance index

V_{kj}: Value of the weighted normalized matrix of alternative k on criterion j

V_{lj}: Value of the weighted normalized matrix of alternative l on criterion j.

Each value in the concordance matrix is determined by adding up the weights of the criteria that belong to the concordance set.

For the discordance matrix, each element is determined by dividing the total difference in criterion values within the discordance set by the total difference in all criteria values:

$$D_{kl} = \frac{\max \{|V_{kj} - V_{lj}|\}_{j \in D_{kl}}}{\max \{|V_{kj} - V_{lj}|\}_{\forall j}} \quad (3)$$

Information :

D_{kl} : Element of the discordance matrix

$\max_{\{|Vkj - Vlj|\} j \in Dkl}$: The maximum difference of criteria included in the discordance set

$\max_{\{|Vkj - Vlj|\} \forall j}$: The maximum difference of values across all available criteria

The Dominant Concordance Matrix is formed using a threshold value τ,

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which is calculated as follows:

$$C = \frac{\sum_{k=1}^{m} \sum_{l=1}^{m} c_{kl}}{m(m-1)} \qquad (4)$$

Information:
C : Concordance threshold value
Ckl : Element of the concordance matrix
m : Alternative

This threshold value is used to evaluate each element of the matrix, where alternative A_k is considered dominant over alternative A_l if the concordance index satisfies $C_{kl} \geq$. The components of the dominant concordance matrix F are identified using the following criteria.

The Dominant Discordance Matrix is established using the threshold value ⊒, which is determined using the following formula:

$$f_{k_l} = \begin{cases} 1, \text{jika } C_{kl} \geq \square \\ 0, \text{jika } C_{kl} < \square \end{cases} \qquad (5)$$

The dominant discordance matrix is established following this rule: The aggregate dominance matrix is determined using the following equation:

$$e_{kl} = \{f_{kl} \cdot g_{kl}\} \qquad (6)$$

e_{kl} : Element of the dominant E matrix
f_{kl} : The dominant concord ance matrix
g_{kl} : Element of the dominant discordance matrix

An alternative A_k that has more values of 1 in matrix eee is considered the best alternative. Conversely, an alternative with fewer e_{kl} values is regarded as the worst alternative and can be removed from consideration.

RESULT AND DISCUSSION

The results obtained from the application of the ELECTRE method provide a deep understanding and can be described as follows.

Table 1. Criteria

No	Criteria Code	Criteria Name	Weight
1	K01	Carbohydrate	2
2	K02	Salt	5
3	K03	Fat	2
4	K04	Protein	1

Table 2. Alternatives

No	Alternative Code	Alternative Name
1	AG	Ayam Goreng
2	TD	Telur Dadar
3	PT	Pepes Teri
4	TB	Tumis Buncis
5	UG	Udang Goreng
6	TG	IkanTongkol Goreng
7	KR	Kacang Rebus
8	GA	Gulai Ayam
9	TK	Tumis Kangkung
10	SA	Sop Ayam

After weighting is applied, each food item is assigned a weight based on the rating scale for each criterion in this table.

Table 3. Decision Matrix

Alternative	Criteria			
	K01	K02	K03	K04
AG	2	4	2	1
TD	1	4	2	1
PT	2	5	1	1
TB	2	4	1	1
UG	3	2	2	1
TG	2	4	2	1
KR	2	2	3	2
GA	2	3	4	1
TK	2	3	2	1
SA	2	3	1	1

Table 4. Normalized Matrix

Alternative	Criteria			
	K01	K02	K03	K04
AG	0.3086	0.3592	0.2887	0.2774
TD	0.1543	0.3592	0.2887	0.2774
PT	0.3086	0.449	0.1443	0.2774
TB	0.3086	0.3592	0.1443	0.2774
UG	0.4629	0.1796	0.2887	0.2774
TG	0.3086	0.3592	0.2887	0.2774
KR	0.3086	0.1796	0.433	0.5547
GA	0.3086	0.2694	0.5774	0.2774
TK	0.3086	0.2694	0.2887	0.2774
SA	0.3086	0.2694	0.1443	0.2774
Wj	6.4807	11.136	6.9282	3.6056

Table 5. Weighted Decision Matrix

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Alternative	Criteria			
	K01	K02	K03	K04
AG	0.6172	1.7961	0.866	0.2774
TD	0.3086	1.7961	0.866	0.2774
PT	0.6172	2.2451	0.433	0.2774
TB	0.6172	1.7961	0.433	0.2774
UG	0.9258	0.898	0.866	0.2774
TG	0.6172	1.7961	0.866	0.2774
KR	0.6172	0.898	1.299	0.5547
GA	0.6172	1.347	1.7321	0.2774
TK	0.6172	1.347	0.866	0.2774
SA	0.6172	1.347	0.433	0.2774
Wj	0.6172	1.7961	0.866	0.2774

Table 6. Concordance Matrix

Concordance	AG	TD	PT	TB	UG	TG	KR	GA	TK	SA
AG	-	11	6	11	9	11	7	8	11	11
TD	9	-	4	9	9	9	5	6	9	9
PT	8	8	-	11	6	8	7	8	8	11
TB	8	8	6	-	6	8	7	8	8	11
UG	6	6	6	6	-	6	7	3	6	6
TG	11	11	6	11	9	-	7	8	11	11
KR	6	6	6	6	9	6	-	3	6	6
GA	6	6	6	6	9	6	10	-	11	11
TK	6	6	6	6	9	6	7	8	-	11
SA	3	3	6	6	6	3	7	8	8	-

Table 7. Discordance Matrix

Discordance	AG	TD	PT	TB	UG	TG	KR	GA	TK	SA
AG	-	0	1	0	0.3436	0	0.4822	1	0	0
TD	1	-	1	0.7127	0.6873	1	0.4822	1	0.6873	0.6873
PT	0.9644	0.9644	-	0	0.3215	0.9644	0.6429	1	0.4822	0
TB	1	1	1	-	0.4822	1	0.9644	1	0.9644	0
UG	1	1	1	1	-	1	1	1	1	1
TG	0	0	1	0	0.3436	-	0.4822	1	0	0
KR	1	1	1	1	0.7127	1	-	1	1	0.5185
GA	0.5185	0.5185	0.6913	0.3457	0.3563	0.5185	0.6177	-	0	0
TK	1	1	1	1	0.6873	1	0.9644	1	-	0
SA	1	1	1	1	0.9644	1	1	1	1	-

Table 8. Dominant Concordance Matrix (F)

Matriks Dominan *Concordance* (F)										
F	AG	TD	PT	TB	UG	TG	KR	GA	TK	SA
AG	-	1	0	1	1	1	0	1	1	1
TD	1	-	0	1	1	1	0	0	1	1
PT	1	1	-	1	0	1	0	1	1	1
TB	1	1	0	-	0	1	0	1	1	1
UG	0	0	0	0	-	0	0	0	0	0
TG	1	1	0	1	1	-	0	1	1	1
KR	0	0	0	0	1	0	-	0	0	0
GA	0	0	0	0	1	0	1	-	1	1
TK	0	0	0	0	1	0	0	1	-	1
SA	0	0	0	0	0	0	0	1	1	-

Table 9. Dominant Discordance Matrix (G)

Dominant Discordance Matrix (G)

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G	AG	TD	PT	TB	UG	TG	KR	GA	TK	SA
AG	-	0	1	0	0	0	0	1	0	0
TD	1	-	1	1	0	1	0	1	0	0
PT	1	1	-	0	0	1	0	1	0	0
TB	1	1	1	-	0	1	1	1	1	0
UG	1	1	1	1	-	1	1	1	1	1
TG	0	0	1	0	0	-	0	1	0	0
KR	1	1	1	1	1	1	-	1	1	0
GA	0	0	0	0	0	0	0	-	0	0
TK	1	1	1	1	0	1	1	1	-	0
SA	1	1	1	1	1	1	1	1	1	-

Table 10. Aggregate Dominant Matrix (E)

Dominant Discordance Matrix (E)												
G	AG	TD	PT	TB	UG	TG	KR	GA	TK	SA	Total	Ranking
AG	-	0	0	0	0	0	0	1	0	0	1	5
TD	1	-	0	1	0	1	0	0	0	0	3	3
PT	1	1	-	0	0	1	0	1	0	0	4	2
TB	1	1	0	-	0	1	0	1	1	0	5	1
UG	0	0	0	0	-	0	0	0	0	0	0	9
TG	0	0	0	0	0	-	0	1	0	0	1	6
KR	0	0	0	0	1	0	-	0	0	0	1	7
GA	0	0	0	0	0	0	0	-	0	0	0	10
TK	0	0	0	0	0	0	0	1	-	0	1	8
SA	0	0	0	0	0	0	0	1	1	-	2	4

A study is conducted where 10 cases of food recommendations are analyzed using both Manual Technique and the ELECTRE Method.

Table 11. Accuracy Test

Regarding	Manual Technique	By Implementing ELECTRE Method
Time required	Takes longer as each case is evaluated manually. Estimated time: 5 minutes per case → 10 cases = 50 minutes.	Faster as it uses an algorithm. Estimated time: 1 minute per case → 10 cases = 10 minutes.
The efficiency of the decision	Based on subjective judgment. Errors may occur due to human inconsistency. Correct recommendations is 70% from 10 cases	More systematic and data-driven. Higher accuracy. Correct recommendations is 90% from 10 cases
Conformity of results to patients	Varies depending on the evaluator's knowledge. Some recommendations may not align with patient preferences. Satisfaction score: 65%	More reliable as it uses objective criteria. Ensures better alignment with patient needs. Satisfaction score: 85%
Patient satisfaction with the system	Lower due to long waiting time and inconsistent results. Satisfaction level: 60%	Higher due to quick, accurate, and consistent recommendations. Satisfaction level: 90%

Main Page

The main page is the first interface that appears when opening the decision-making system for selecting healthy food for hypertensive patients using the ELECTRE method at Serozha Clinic.

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This page is accessible to all users, including administrators, patients, and doctors.

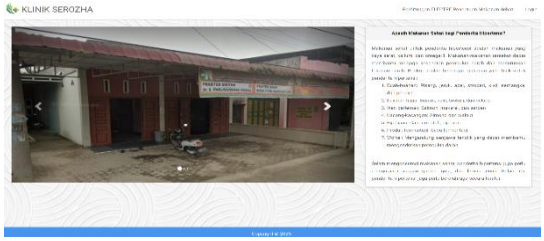


Image 1. Main Page Interface

Criteria Page

The criteria page appears when selecting the "Master Criteria" menu and clicks on the "Criteria" submenu on main page

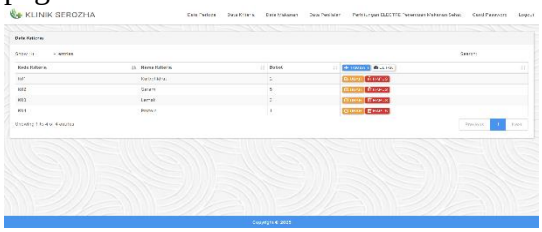


Image 2. Criteria Data Page Interface

Food Data Page

The food data page appears when selecting the "Master Food" menu and clicks on the "Food" submenu on main page.

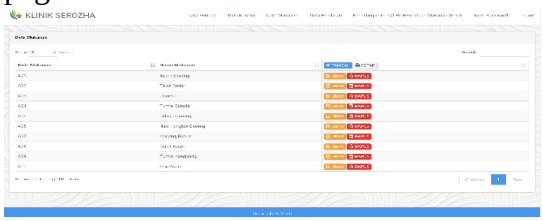


Image 3. Food Data Page Interface

Assessment Data Page

The assessment data page appears when selecting the "Assessment Data" menu on main page.

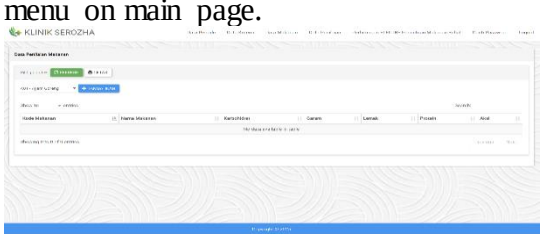


Image 4. Assessment Data Page Interface

ELECTRE Calculation Page

The ELECTRE calculation page is displayed when clicking on the "ELECTRE Calculation" menu for determining healthy food on main page.

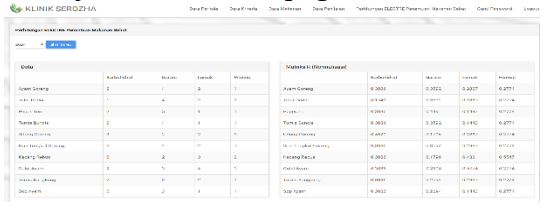
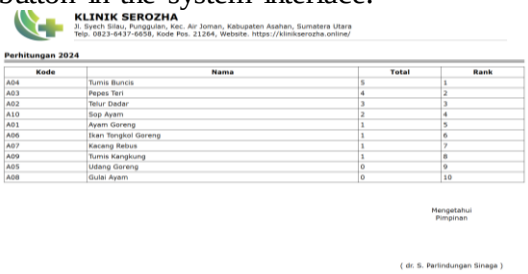


Image 5. ELECTRE Calculation Page Interface

Report Page

The report page is displayed when the user selects and presses the "Print" button in the system interface.



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Telp. 0823-6437-6658, Kode Pos. 21264, Website. https://klinikserozha.online/

Perhitungan 2024

Kode	Nama	Total	Rank
A04	Tumis Buncis	5	1
A03	Pepes Tiri	4	2
A02	Telur Dadar	3	3
A10	Sop Ayam	2	4
A01	Ayam Goreng	1	5
A06	Ikan Tongkol Goreng	1	6
A07	Kacang Rebus	1	7
A09	Tumis Kangkung	1	8
A05	Udang Goreng	0	9
A08	Gulai Ayam	0	10

Mengetahui
Pimpinan

(dr. S. Perlindungan Sinaga)

Image 6. Report Page

CONCLUSION

The ELECTRE method helps individuals with hypertension choose foods that meet dietary needs by evaluating factors like nutrients, salt content, and health impact. This approach provides objective, data-driven recommendations for better health management. Developed with PHP and MySQL, the system ensures efficient data handling, and its calculations are easy for medical professionals to understand.

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