Decision Making System for Determining the Hepatitis Food Criteria using Analytical Hierarchy Process Method

Ade Irma Wati1, Satria Abadi, M. Ilayaraja, Wahidah Hashim, Larisa N. Gorina

Abstract*: Hepatitis is a kind of inflammation which attacks the body's organ known as liver. Hepatitis itself is divided into commonly known types namely Hepatitis A, B, and C. however, there exist other types of hepatitis called D, E, G which are not familiar. The understanding of patients regarding hepatitis is an obstacle in healing. The thing that is needed is to regulate diet and avoid foods that are prohibited (high sodium, high saturated fat, high sugar, and high protein). Hepatitis sufferers must pay attention to food patterns, must control foods consumed daily, must consume food with low salt, low saturated fat, low in sugar, and low in protein to reduce the risk of not worsening the condition of people with hepatitis. The decision making system determines the hepatitis food criterion using 5 criteria's, namely the presence of high sodium, high saturated fat, high protein, high sugar, and high iron. While the Analytical Hierarchy Process (AHP) method is a decision making model which defines the multi-factor problems or complex multi criteria into a hierarchy. With hierarchy, a complex problem could be partitioned into smaller groups which are then ordered in a hierarchy to arrange the problem in a structural and systematic way.

Keywords: AHP, Decision making, hepatitis food.

I. INTRODUCTION

At present in the world there are an estimated 350 million sufferers (carier) HBsAg and 220 million (78%) of them are in Asia, including Indonesia. Based on HBsAg examination in the blood donor group in Indonesia the prevalence of Hepatitis ranges from 2.50 to 36.17%, it is necessary to have special treatment to stop the rate of spread of hepatitis. Efforts to reduce hepatitis sufferers need to be done by all layers in various ways. Because in addition to its high prevalence, hepatitis viruses can cause post-acute problems and can even occur cirroshis hepatitis and primary hepatocellular carcinoma. Ten percent of hepatitis virus infections will become chronic and 20% of patients with chronic hepatitis within 25 years of contracting will experience cirroshis hepatitis and hepatosellular carcinoma (hepatoma). The possibility of being chronic is higher if the infection occurs at the age of the toddler where the immune response has not developed fully. [1]

Hepatitis is a kind of inflammation which attacks the body's organ known as liver. Hepatitis itself is divided into commonly known types namely Hepatitis A, B, and C. however, there exist other types of hepatitis called D, E, G which are not familiar [2].

The understanding of patients regarding hepatitis is an obstacle in healing. The thing that is needed is to regulate diet and avoid prohibited (high sodium, high saturated fat, high sugar, and high protein). Hepatitis sufferers must pay attention to food patterns, it can control foods consumed daily, foods that are low salt, low saturated fat, low sugar, and low protein to reduce the risk of not worsening the condition of people with hepatitis [3].

Seeing these problems, this study was shown to solve the problem by making a decision making system to determine hepatitis food criterion using the analytical hierarchy process (AHP) method, it is applied to determine the right food criterion based on criteria and predetermined weight. This method was chosen because it was able to select the best alternative from all alternatives. So that from a food criterion decision making system is expected to help those with hepatitis.

II. LITERATURE REVIEW/THEORETICAL BASE

A. Healthy Food

Healthy food is food that contains balanced nutrition needed by human body by concocting various types of balanced foods, so that all nutritional need of the body is fulfilled and be able to be felt physically and mentally. (Mahardikaningtyas, Ali Nugroho, & Hartono, 2013). [4]

B. Hepatitis

Hepatitis is a liver disorder in the form of inflammation (cells) of the liver. This inflammation is characterized by increasing liver enzyme levels. This increase is caused by a disorder or damage to liver membrane. There are two factors that cause infection factors and non-infectious factors. Factors that cause infection include hepatitis viruses and bacteria. In addition to Hepatitis A, B, C, D, E, and G viruses there are still many other viruses that have the potential to cause hepatitis such as adenoviruses, CMV, Herpes simplex, HIV, rubella, varicella and others.

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While the bacteria that cause hepatitis include, for example, Salmonella typhi, Salmonella paratyphi, tuberculosis, leptosvera. Non-infectious factors for example because of drugs. Certain Obet can interfere with liver function and cause hepatitis (Dalimartha, 2008). [5]

C. Decision Support System

It has the capability to offer problem solving and communication skills for problems with semi-structured and unstructured conditions. It can be employed to take decisions in semi-structured scenarios and unstructured scenarios, where there is no information related to decision making (Kusrini, 2007). [6]

D. Analytical Hierarchy Process

AHP is a kind of decision making methods introduced by Dr. Thomas L. Satty, a mathematician from the University of Pittsburg, United States in the early 1970s. The basic thinking of the AHP method is the process of forming a numerical score which ranks every decision alternatives depending upon how the alternative should be matched with the criterion of decision makers (Saaty, 1999). [7]

E. Fuzzy Multiple Attibute Decision Making

According to [8-12], Fuzzy Multiple Attribute Decision Making (FMADM) is a method utilized to identify the optimum alternatives from total criteria. The core of Fuzzy MADM is to identify the weights for every criterion, which will then be a ranking process that will choose alternatives.

There are some methods used to solve MADM :

1) Simple Additive Weight (SAW)
2) Weighted Product (WP)
3) Analytical Heirarchy Process (AHP)
4) Technique for order preference by similitary to ideal solution (TOPSIS)
5) Elimination et choix tradujisant la realite (ELECTRE) [13]

III. RESEARCH METHODOLOGY

A. Research Flowchart

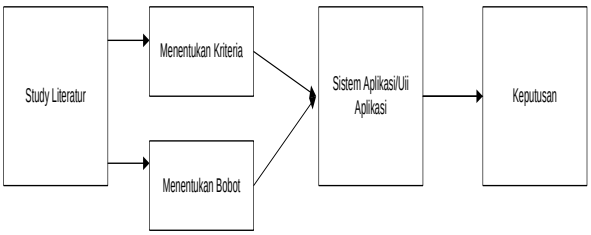

Fig. 1.Flowchart

- Literature Study : In this stage, it was collected 18 papers and information about hepatitis food criteria
- Determining criterion: In this stage, determining selected criterion to find criterion score in selecting weight score.
- Determining Weight Score: In this stage, determining weight score is searching criterion score.
- Application System/Application Test: In this stage it was performed application test to determine a decision.

B. AHP Method

Basically, procedure or stages in AHP method consists of :

a. Define problem and determine expected solution
b. Determine element priority
c. Synthesis
d. Measure consistency
e. Measure Consistency index (CI) with formula : $CI=(\lambda_{max}-k)/k-1$

Where k represents the number of elements

f. Measure Consistency Ratio (CR) with formula : $CR = CI / RI$

where CI and RC represents the Consistency Index and Consistency Consistency respectively [14].

Table-I: Quantitative Scale in AHP Method

Interest intensity	Definition	Explanation
1	Every element is essential	both elements have same influence to the purpose
3	An element is somewhat highly essential compared to others	Experience and judgment support one element instead of other
5	An element is essential compared to others	Experience and assessment strongly support one element compared to others
7	An element is highly essential compared to others	One strong element is supported and the domain is seen in practice
9	One element is absolutely important than the other elements	Evidence that supports one element to another element holds higher degree of affirmation that might strengthen
2,3,4,6	Scores between 2 consideration are close	This score is given if there is a compromise between 2 choices
Opposite	If activity 1 receives a number compared to activity J, then J has the opposite score compared to I	

1) Research criterion

As for some criteria in this research are :

C1 = high natrium
C2 = high saturated fat
C3 = high protein
C4 = high sugar
C5 = high iron

2) Weight criterion

In this research, there are weight criteria in determining hepatitis food namely.

Eight Criterion Table

criterion	Weight criterion
C1	25
C2	35
C3	20
C4	20
	100

Tested Alternative

A1 = fruit
A2 = vegetable
A3 = meat
A4 = peanut

IV. DISCUSSION

A. Manual Test

Decision support system determines hepatitis food criterion using 5 criteria's namely: high sodium, high saturated fat, high protein, high sugar, high iron. The stages in the AHP method are:

1. Define problem and determine expected solution.
2. Make hierarchy structure began with general purpose, scored criterion and alternative

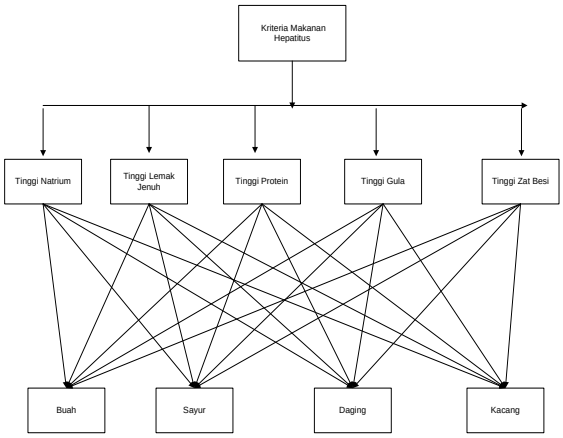

Fig. 2.AHP Hierarchy Structure

After performing this, after making the AHP hierarchy structure, the subsequent level of application development is to determine alternate weights by compiling a paired matrix for alternative of every criterion.

Alternative weight for criterion Input recommended criterion data in paired form.

Table-II: Paired comparison matrix criterion

Criterion	C1	C2	C3	C4	C5
A1	2	3	4	5	6
A2	2/3	2	3	4	5
A3	2/4	3/4	2	3	4
A4	2/5	3/5	4/5	2	3
A5	2/6	3/6	4/6	5/6	2

The above matrix data is modified from fraction to decimal form.

Table-III: Results of Paired comparison of semi-criterion paired weighting

criterion	C1	C2	C3	C4	C5
C1	2	3	4	5	6
C2	0,67	2	3	4	5
C3	0,5	0,75	2	3	4
C4	0,4	0,6	0,8	2	3
C5	0,3	0,5	0,67	0,83	2
Total	3,87	6,85	10,47	14,83	20

After determining temporary total values / weights, every individual element present in the above cell is divided by the individual column totals, for instance, to fill the second column and the second row was (C 1: Σ weight C1) ⟶ (1.00: 2.45) = 0.4082 (utilize the similar approach to fill remaining columns) to obtain equivalent results.

Table-IV: Comparison Results of semi-criterion paired weighting alternative

Criterion	C1	C2	C3	C4	C5	TOTAL
C1	2,2 988	0,4 379	0,3 820	0,3 371	0,3 -	3,5 558
C2	0,1 731	0,2 919	0,2 865	0,2 697	0,25 -	0,95 212
C3	0,1 291	0,1 094	0,1 910	0,2 022	0,2 -	0,7 317
C4	0,1 0,33	0,0 875	0,0 764	0,1 348	0,15 -	0,35 020
C5	0,0 775	0,0 729	0,0 639	0,0 559	0,1 -	0,1 702

After the total results of each row were known, then calculate the alternative priority score to average criterion score with the formula of Total results of the comparison divided by the number of alternatives. The example to fill priority criterion C1 was (Σ the result of the comparison: Σ criterion) ⟶ (3,55558 / 5) = 0.71116 (use the same method to fill in the other columns) so that results are found in the table below.

Table-V: Priority results based on criterion

Criterion	Criterion priority	Ranking
C1	0,71116	II
C2	0,190424	I
C3	0,14634	III
C4	0,07004	IV
C5	0,03404	V

After determining criterion priority has been completed, the next step is to determine the priority of each alternative, namely by inputting the comparison value of each alternative.

Table-VI: Comparison of high natrium paired criterion (C1)

C1	A1	A2	A3	A4
A1	2	0,5	3	0,33
A2	4	2	6	0,66
A3	0,67	0,16	2	0,11
A4	6	1,51	9,09	2
Total	12,67	3,81	20,09	3,1

Next, create a normalization table for high sodium criterion by dividing the score of each matrix box by the total column.

Table-VII: Normalization of high natrium criterion

C1	A1	A2	A3	A4	TOTAL
A1	0,15	0,15	0,15	0,15	0,60
A2	0,31	0,31	0,31	0,31	1.24
A3	0,05	0,05	0,05	0,05	0,2
A4	0,47	0,47	0,47	0,47	1,88

Then, calculate the total rows to be divided by alternatives to find priority scores. The results of the calculation of high sodium priority are as follows.

Table-VIII: The results of the calculation of high sodium priority are as follows

Alternative	Criterion priority	Ranking
A1	0,15	III
A2	0,31	II
A3	0,05	IV
A4	0,47	I

Table-IX: Paired comparison of high saturated fat criterion (C2)

C2	A1	A2	A3	A4
A1	2	0,33	3	0,25
A2	6	2	9	0,75
A3	0,66	0,11	2	0,08
A4	8	1.32	12	2
Total	16,66	3,76	26	3,08

Then, a normalization table is created for high saturated fat criterion by dividing the value of every matrix box by the total column.

Table-X: Normalization of high saturated criterion

C2	A1	A2	A3	A4	TOTAL
A1	0,12	0,12	0,12	0,12	0,48
A2	0,36	0,36	0.36	0,36	1,44
A3	0,03	0,03	0,03	0,03	0,12
A4	0,48	0,48	0,48	0,48	1,92

Then, calculate the total rows to be divided by alternatives to determine the priority score. The results of the calculation of high saturated fat priority are as follows

Table-XI: Priority of high saturated fat

Alternative	Criterion priority	Ranking
A1	0,12	III
A2	0,36	II
A3	0,03	IV
A4	0,48	I

Table-XII: Paired comparison of high protein (C3).

C3	A1	A2	A3	A4
A1	2	3	4	0,5
A2	0,66	2	1,33	0,16
A3	0,5	0,75	2	0,12
A4	4	6	8	2
Total	7,16	11,75	15,33	2,78

Then, a normalization table is created for high protein criterion by dividing the value of every matrix box by the total column.

Table-XIII: Normalization of high protein criterion

C3	A1	A2	A3	A4	TOTAL
A1	0,27	0,27	0,27	0,27	1,08
A2	0,09	0,09	0,09	0,09	0,36
A3	0,06	0,06	0,06	0,06	0,24
A4	0,55	0,55	0,55	0,55	2,2

Then, calculate the total rows to be divided by alternatives to find priority values. The results of high protein priority calculations are as follows

Table-XIV: High protein priority

Alternative	Criterion priority	Ranking
A1	0,27	II
A2	0,09	III
A3	0,06	IV
A4	0,55	I

Table-XV: Paired comparison of high sugar criterion (C4).

C4	A1	A2	A3	A4
A1	2	4	0,2	5
A2	0,5	2	0,05	1,25
A3	10	20	2	25
A4	0,4	0,8	0,04	2
Total	12,9	26,8	2,29	33,25

Then, a normalization table is created high sugar criterion by dividing the value of every matrix box by the total column.

Table-XVI: Normalization of high sugar

C4	A1	A2	A3	A4	TOTAL
A1	0,15	0,15	0.15	0,15	0,6
A2	0.03	0,03	0,03	0,03	0,12
A3	0.77	0,77	0,77	0,77	3,08
A4	0,03	0,03	0,03	0,03	0,12

Then, calculate the total rows to be divided by alternatives to determine the priority values. The results of the calculation of high sugar priority are as follows

Table-XVII: Priority of high sugar

Alternative	Criterion priority	Rangking
A1	0,15	II
A2	0,03	III
A3	0,77	I
A4	0,03	IV

Table-XVIII: Paired comparison of high iron criterion (C5).

C5	A1	A2	A3	A4
A1	2	1	0,5	0,33
A2	2	2	0,5	0,33
A3	4	2	2	0,66
A4	6	3	1,51	2
Total	14	8	4,51	3,32

Then, a normalization table is created for high iron criterion by dividing the value of every matrix box by the total column.

Table-XIX: Normalization of high iron

C5	A1	A2	A3	A4	TOTAL
A1	0,14	0,14	0,14	0,14	0,56
A2	0,14	0,14	0,14	0,14	0,56
A3	0,28	0,28	0,28	0,28	1,12
A4	0,42	0,42	0,42	0,42	1,68

Then, calculate the total rows to be divided by alternatives to determine priority score. The results of the calculation of high iron priority are as follows

Table-XX: High iron priority

Alternative	Criterion priority	Ranking
A1	0,14	IV
A2	0,14	III
A3	0,28	II
A4	0,42	I

And the final stage is to compute the best alternative in the decision-making system to determine hepatitis food criteria and the final calculation results as follows.

Table-XXI: Final Result of Calculation

Criterion/ Alternative	C1	C2	C3	C4	C5
Weight	0,2	0,2	0,2	0,15	0,15
A1	0,15	0,12	0,27	0,15	0,14
A2	0,31	0,36	0,09	0,03	0,14
A3	0,05	0,03	0,06	0,77	0,28
A4	0,47	0,48	0,55	0,03	0,42

B. Calculation Results

The final results are calculated by determining the weight score multiplied by alternative priorities.

A1 = (0,2*0,15) + (0,2*0,12) + (0,2*0,27) + (0,15*0,15) + (0,15*0,14)
= 0,03 + 0,024 + 0,054 + 0,0225 + 0,021
= 0,1515
= 15%

A2 = (0,2*0,31) + (0,2*0,36) + (0,2*0,09) + (0,15*0,03) + (0,15*0,14)
= 0,062 + 0,072 + 0,018 + 0,0045 + 0,021
= 0,1775
= 18%

A3 = (0,2*0,05) + (0,2*0,03) + (0,2*0,06) + (0,15*0,77) + (0,15*0,28)
= 0,01 + 0,006 + 0,012 + 0,1155 + 0,042
=0,1855
=19%

A4 = (0,2*0,47) + (0,2*0,48) + (0,2*0,55) + (0,15*0,03) + (0,15*0,42)
=0,094 + 0,096 + 0,11 + 0,0045 + 0,063
=0,3675
=37%

Table-XXII: Calculation result

Criterion	C1	C2	C3	C4	C5
Weight	0.2	0.2	0.2	0.15	0.15
A1	0.15	0.12	0.27	0.15	0.14
A2	0.31	0.36	0.09	0.03	0.14
A3	0.05	0.03	0.06	0.77	0.28
A4	0.47	0.48	0.55	0.03	0.42

Table-XXIII: Alternative score and criterion

Criterion	C1	C2	C3	C4	C5	result
A1	0.03	0.024	0.054	0.0225	0.021	0.1515
A2	0.062	0.072	0.018	0.0045	0.021	0.1775
A3	0.01	0.006	0.012	0.1155	0.042	0.1855
A4	0.094	0.096	0.11	0.0045	0.063	0.3675

Table-XXIV: The results of criterion calculation and weight score.

Alternative		Hasil	Rangking
A1	0.1515	16%	4
A2	0.1775	18%	3
A3	0.1855	19%	2
A4	0.3675	37%	1

C. Analysis

By observing the computation results takes place and supported by predetermined criterion, it is known that the alternative determining of the most superior hepatitis criterion was A4 with the highest value of 0.3675 or 37% so that it can be said that A4 (beans) was an option which should not be given to hepatitis.

D. Application System/ Application Test

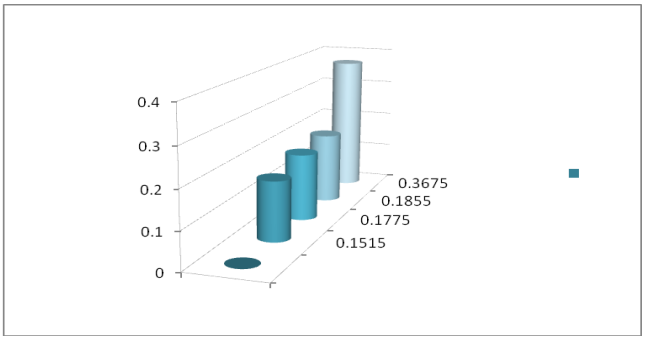

Fig. 3.Final Results Graphic

Fig. 4.Input Data

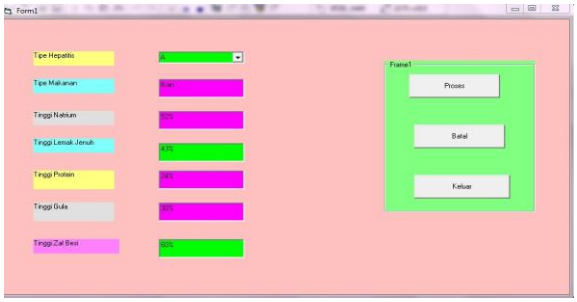

Fig. 5.Output Data 1

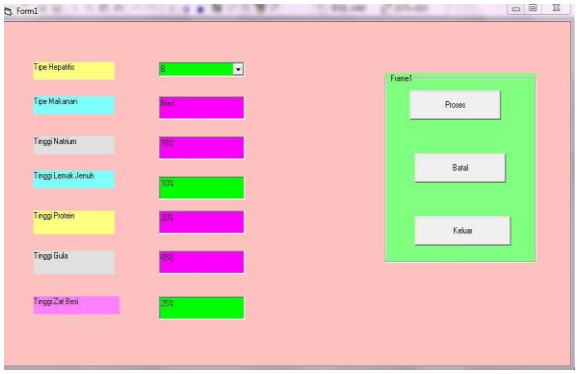

Fig. 6.Output Data 2

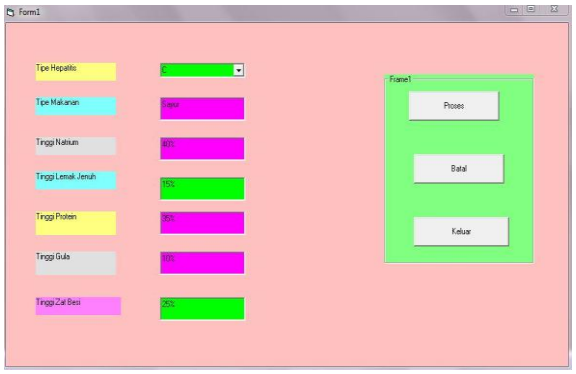

Fig. 7.Output Data 2

V. CONCLUSION AND SUGGESTIONS

A. Conclusion

From the results of testing the system developed using the Analytical Hierarchy Process model it can be concluded that the decision making system by the use of FMADM determines hepatitis food criterion was A1 = 15% A2 = 18% A3 = 19% A4 = 37%. From the results of the calculation of the following alternative score , the highest value was A4 = 37%.

Decision Making System Model Determined Food Criteria Hepatitis used 5 criteria, namely food with high sodium, high saturated fat, high protein, high sugar, and high iron.

B. Suggestion

As a part of future work, the presented model can be extended to a web based application which will be useful for real time analysis.

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