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THE USE OF THE WEIGHTED PRODUCT METHOD IN A FOOD CHOICE DECISION SUPPORT SYSTEM FOR PATIENTS WITH TYPE 2 DIABETES MELLITUS

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Abstrak

Diabetes Mellitus adalah penyakit yang disebabkan oleh gangguan keseimbangan antara transpor glukosa ke dalam sel, yang disimpan di hati dan dikeluarkan oleh hati, sehingga mengakibatkan peningkatan kadar glukosa darah. Diabetes Mellitus yang juga merupakan penyebab kematian nomor 6 di dunia, perlu mendapat perhatian lebih. Perlunya pemilihan makanan bagi penderita Diabetes Mellitus Tipe 2, karena penderita Diabetes Mellitus harus bisa menjaga pola makan dan hanya bisa mengkonsumsi makanan yang rendah glukosa. Metode yang digunakan dalam penelitian ini adalah Weighted Product sebagai pilihan metode perhitungan multi kriteria dan studi literatur untuk pengumpulan data melalui penelitian sebelumnya. Hasil dari penelitian ini menggunakan perhitungan metode Weighted Product, menghasilkan ranking dengan nilai tertinggi 0,065 dan menjadi alternatif terbaik yaitu Singkong Kukus.

Kata Kunci: Sistem Pendukung Keputusan, Diabetes Mellitus, Weighted Product, Non-Insulin-Dependent, Alternatif

Abstract

Diabetes Mellitus is a disease caused by a disturbance in the balance between glucose transport into cells, which is stored in the liver and released by the liver, resulting in an increase in blood glucose levels. Diabetes Mellitus is listed as the top 6 cause of death in the world, so it should receive more attention. A person with Diabetes Mellitus must be able to maintain a diet and can only consume foods that are low in glucose, so the need for food selection for people with Type 2 Diabetes Mellitus is a must. The method used in this research is the Weighted Product as a choice of the multi-criteria calculation method and the research of literature for data collection through previous research. The results of this research using the calculation of the Weighted Product method, resulting in a ranking with the highest value of 0.065 and being the best alternative, namely Steamed Cassava.

Keywords: Decision Support System, Diabetes Mellitus, Weighted Product, Non-Insulin-Dependent, Alternative

1. Introduction

The decline in the level of health in the human body is caused by a lifestyle that does not pay attention to diet and daily activities. This is still done by many Indonesians who are a factor in causing obesity and even causing Diabetes Mellitus (DM). It is a disease caused by a disturbance in the balance between glucose transport into cells, which is stored in the liver and released by the liver, resulting in increased blood glucose levels is called Diabetes Mellitus [1]. The International Diabetes Federation (IDF) explains that the prevalence of diabetes mellitus in the world is 1.9% and has made DM as one of the seventh leading causes of death in the world and in 2013 the number of diabetes cases in the world was 382 million people where the proportion of DM cases type 2 is 95% of the world's population. The prevalence of type 2 diabetes mellitus is 85-90% [2].

DM is also a cause of amputation (which is not caused by trauma), disability, and death. Another impact of DM is to reduce life expectancy by 5-10 years. The life expectancy of people with Type 2 DM or non-insulin-dependent diabetes mellitus who suffer from serious mental illnesses, such as Schizophrenia, is even 20% lower than the general population [3]. Diabetes Mellitus is also the number 6 cause of death in the world, it should receive more attention [4].

Patients with diabetes need to be motivated on the importance of regularity and discipline of intake in terms of the number of meals, meal schedules and types of food, especially for those who use blood glucose-lowering drugs or insulin. The population with DM was the population with the lowest adherence (67.5%) to the recommended medical treatment compared to 16 other major diseases [5]. Patients with Diabetes Mellitus can be reduced by means of diet therapy, must make dietary arrangements and

arrange daily menus. Food must be measured according to need to be balanced. Preparing food menus for consumption can be done manually, but it takes a long time and is not necessarily accurate.

Selection and preparation of food menus for people with Diabetes Mellitus can use a Decision Support System specifically for selecting foods that can be consumed by people with Diabetes Mellitus. Before making the system, it is very necessary to make the design, so that it can create a quality system. The Design and Build of a Food Menu Selection Decision Support System for Patients with Type 2 Diabetes Mellitus is a mobile-based application. This application can be accessed anywhere and anytime online or offline. The preparation of a food menu using a system can make it easier for people with Diabetes Mellitus to arrange a food menu quickly and precisely according to the dose needed by the body.

A computerized system in digital form is needed to help facilitate the preparation of food menus and the calculation of precise doses. Calculations in this case can be done using the Weighted Product (WP) method. This method is one of the methods for solving complex problems and can produce structured calculations, and in some cases is known to be very fast in system performance [6]. The Weighted Product method is more efficient because of the time it takes to shorter calculations. This method was chosen because it can determine the weight value for each attribute, then followed by a ranking process that will result in the choice of the location of the burial ground that is in accordance with the criteria.

An alternative in taking action to determine a goal is to make a decision. A decision support system is very necessary and suitable to help decide the selection of food menus for people with Type 2 Diabetes Mellitus or non-insulin-dependent diabetes mellitus. This research uses a literature research method for data collection through journals or previous research articles with the same or almost the same research. The research of literature is a research technique carried out by researchers by collecting a number of books, magazines, leaflets related to the problem and research objectives [7] [8].

The point of this research is to design a Decision Support System for food selection for people with type 2 Diabetes Mellitus using the Weighted Product method and data collection is carried out at the Temon II Kulon Progo health center. The difference between this research and previous research is that the researchers took the case of Diabetes Mellitus Type 2 with the Weighted Product method and this research used 20 types of food as an alternative and in several previous studies that used the case of decision support systems using different methods from the current research. In addition to the different methods used, the case studies taken are also different, such as a food menu decision support system for typhoid, selection of baby porridge, and food for obesity. previous studies using different research methods, such as AHP, TOPSIS, Forward Chaining, Naive Bayes, Moora. The resulting output is in the form of a system and case research differs from the author, while the research conducted. The author uses the Weighted Product Method and gives the results in the form of ranking of food alternatives and the value of the accuracy of the calculation results manually and using excel.

2. Reseach Methods

2.1. Weighted Product (WP) Method

The Weighted Product method is a multi-criteria decision-making method. This method uses a multiplication technique to connect attribute ratings, in which the rating of each attribute must be raised first with the weight of the attribute in question or can be referred to as the normalization process. The steps for solving the problem using the WP method are as follows [9]:

a. Normalization or Repair of Weights

The following equation is used to normalize or improve the weights and determine the category of each criterion that is included in the benefit or cost criteria:

$$W_j = \frac{w_j}{\sum w_j} \quad (1)$$

Where w_j is attribute weight and $\sum W_j$ is summation of attribute weights. After calculation, the value of W will be between 0 to 1, and the total of all W is 1 [10],[11].

b. Determining the Vector S

Determine the vector S by multiplying all the criteria with the alternative results from the previous improvements.

$$S_i = \prod_{j=1}^{n} X_{ij}\, w_j \quad (2)$$

Where S_i is result of normalization of decision on alternative *i*, X_{ij} is alternative rating *i* per attribute *j*, and n is the number of criteria.

c. Determining the Vector V

Determine the vector V used for ranking from each number of vectors S with all vector values S. The largest V value is the best alternative.

$$V_i = \frac{\prod_{j=1}^{n} X_{ij}\, w_j}{\prod_{j=1}^{n} (X_{ij*}) w_j} \quad (3)$$

Where V_i is alternative preference result i, The asterisk (*) shows the number of criteria that have been assessed on vector S

2.2. Flowchart

Figure 1 shows the flowchart of the Food Selection Decision Support System for Type 2 Diabetes Mellitus Patients. Furthermore, after successful login the user can enter the weight of the criteria, then the weight of the criteria will be processed by the system and the system will provide an output in the form of ranking alternative foods.

Then after completion the user can do the re-calculation by entering the weight of the criteria again.

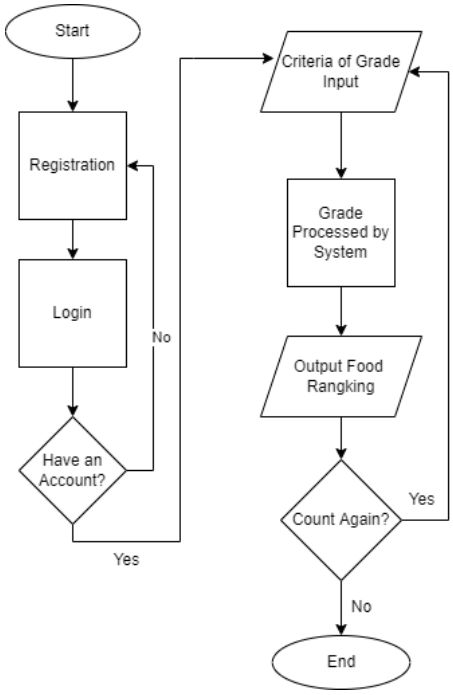

Figure 1. System Flow's Flowchart

2.3. Use Case Diagram

Use case diagrams have a purpose, namely to visualize the interaction between the user and the system in a simple way, so that the boundaries of the system can be seen.

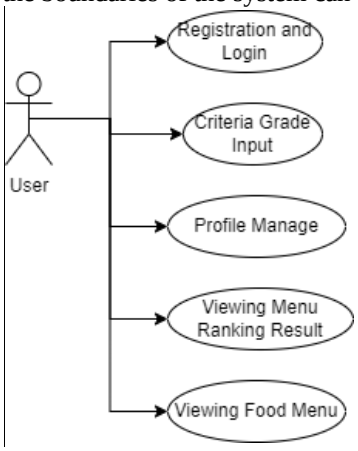

Figure 2. Use Case Diagram

Use case diagrams have a purpose to visualize the interaction between the user and the system in a simple way, so that the boundaries of the system can be seen. The Use Case Diagram in Figure 2 reveals that the user can use the system by registering and logging in first, then after successful login the user can input the Criteria Weight, then the user can also Manage Profiles on the system account and the user also has the right to be able to view the results. Menu Ranking, and view Food Menu.

3. Result and Discussion

3.1. Data Flow Diagram

Data Flow Diagram (DFD) is a tool that describes the flow of data until a system is complete, and work or processes are carried out in the system [12].

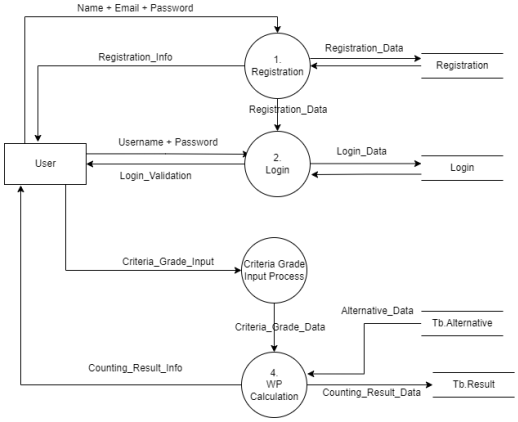

Figure 3. DFD Level 1

The Data Flow Diagram in Figure 3 has the following details:

a) Registration Process
   In this process the user is asked to enter his full name, email, and password, to get an account.
b) Login Process
   In this process, the user inputs his username and password to verify his identity, so that he can enter the system.
c) Criteria Weighting Input Process
   This process is an input process of criteria weights performed by the user. The weight of the criteria will be used for the calculation of the data.
d) Weighted Product Calculation Process
   This process is a calculation process using the WP Method algorithm with the output in the form of normalization values, alternative values, and calculation results. This process takes data from weighted input data and takes alternative data from alternative tables or alternative databases, so as to produce calculated data.

3.2. Weighted Product Calculation

The calculation uses the weighted product method to determine food choices for people with Type 2 DM as follows:

a. Determine the types of food to be used as alternatives. In this research using the criteria of fat, protein, carbohydrates, and vitamins.

b. Determine the weight for each criterion by giving a value of 1 to 5, using a weighting scale from the Likert Scale [13] and [14], namely:
1= Very Unimportant
2= Not Important
3= Doubtful
4= Important
5= Very Important
Giving weight to each criterion is a code to determine the level of the lower and higher criteria. Table 1 weights criteria used for calculations in decision support systems, this table is made for knowledge, in order to clarify the value of the weights used.

Table 1. Criteria Grading

Criteria	Grade
Protein	4
Fat	4
Carbohydrate	5
Vitamin	2

c. This research uses 20 types of food as an alternative. The alternatives shown in the table below are used as a reference or knowledge of the type of food and nutrition used as an alternative that will be calculated along with the weight of the criteria. The types of food are shown in Table 2:

Table 2. Food List

No	Type of Food	Portion	Nutrition Per 100 Gram				Symbol
			Pro (g)	Fat (g)	Carb (g)	Vita (mg)	
1.	Brown Rice	100 g	2.8	0.4	32.5	0	A
2.	Soy Milk	100 g	3.5	2.5	5.0	2	B
3.	Chicken Breast	100 g	35.2	20.6	0.4	0	C
4.	Boiled Tempe	100 g	20.8	8.8	13.5	0	D
5.	Ambon Banana	1 pc	1.0	0.8	24.3	9	E
6.	Potato	85 g	2.1	0.2	13.5	21	F
7.	Smoked Salmon	100 g	18.28	4.32	0	2	G
8.	Avocado	61 g	0.9	6.5	7.7	13	H
9.	Boiled Egg	100 g	16.3	19.4	1.4	0	I
10.	Oatmeal	100 g	2	2	12	0	J
11.	White Sweet Potato	100 g	0.4	0.4	20.6	36	K
12.	Boiled Corn	100 g	5.0	0.7	30.3	-	L
13.	Mung Beans	100 g	8.7	0.5	18.3	3	M
14.	Sardine	100 g	19.9	1.8	3.4	-	N
15.	Yogurt	100 g	3.3	2.5	4.0	0	O
16.	Fish Cork	100 g	16.2	0.5	2.6	-	P
17.	Steamed Cassava	100 g	1.2	0.3	36.4	20	Q
18.	Steamed Taro Bogor	100 g	1.5	0.3	28.2	2	R
19.	Mustard	87 g	2.3	0.3	4.0	10.2	S
20.	Macaroni	100 g	5.76	0.92	30.68	0	T

d. Doing weighting on each type of food. The weighting of the alternatives is carried out to facilitate the calculation of the decision support system, the table below is used as a reference for the authors, so that the authors can easily see the weights for each alternative. The weighting of the types of food is shown in Table 3.

Table 3. Grading Criteria for Each Food

Criteria	Alternatives									
	A	B	C	D	E	F	G	H	I	J
Protein	4	4	5	5	2	2	5	1	4	2
Fat	2	2	4	2	1	1	4	4	5	2
Carbohydrate	5	5	2	4	5	4	1	4	2	5
Vitamin	1	1	1	1	4	5	2	5	1	1

Criteria	Alternatives									
	K	L	M	N	O	P	Q	R	S	T
Protein	1	4	4	5	4	5	4	2	2	4
Fat	1	2	1	2	2	2	2	1	1	2
Carbohydrate	4	5	5	4	5	4	5	5	4	5
Vitamin	5	1	2	1	1	1	4	4	5	1

e. The user enters the weight for each criteria. The weight entered by the user is on a scale of 1-5. An example of user input weights is shown in Table 4.

Table 4. User Input Grade

Criteria	User Input Grade
Protein	4
Fat	4
Carbohydrate	5
Vitamin	2

f. Normalizing or improving the weights, with the initial weight W= (4, 4, 5, 2) will be normalized or corrected so that the total weight must meet the equation $\sum W_j = 1$ ($W_1 + W_2 + W_3 + W_4 = 1$) where W is the weight of each criterion entered by the user. Normalization or improvement of the criteria weights using equation 1 as follows:

$$W_1 = \frac{4}{4+4+5+2} = 0.27$$
$$W_3 = \frac{5}{4+4+5+2} = 0.33$$
$$W_2 = \frac{4}{4+4+5+2} = 0.27$$
$$W_4 = \frac{2}{4+4+5+2} = 0.13$$
$$\sum W_j = 0.27 + 0.27 + 0.33 + 0.13 = 1$$

g. The results of weight improvement or normalization from user input are shown in Table 5.

Table 5. Grade Fix/Grade Normalization from Use Input

Criteria	User Grade Input	Grade Normalization
Protein	4	0,27
Fat	4	0,27
Carbohydrate	5	0,33
Vitamin	2	0,13

h. Next is to calculate the vector S (the value of each alternative). Calculations are carried out using equation 2, for example:

$$S_1(option\ A) = (4^{0.27})(2^{0.27})(5^{0.33})(1^{0.13}) = 2.982$$

i. Next, rank food alternatives by dividing the value of V (vector value used for ranking) for alternatives by the total value of all S vector values. The following is the calculation of the value of V using equation 3

j. The results of the calculation of vector V obtained the largest or highest value being the best alternative. The ranking table is shown in Table 6.

Table 6. Alternative Ranking Results

Ranking	Type of Food	Alternative	Result
1	Steamed Cassava	Q	0,065
2	Boiled Tempe	D	0,054
3	Sardine	N	0,054
4	Fish Cork	P	0,054
5	Red rice	A	0,054
6	Soy milk	B	0,054
7	Boiled corn	L	0,054
8	Yogurt	O	0,054
9	Macaroni	T	0,054
10	Avocado	H	0,052
11	Chicken breast	C	0,051
12	Boiled eggs	I	0,051
13	Mung beans	M	0,049
14	Smoked Salmon	G	0,045
15	Ambon banana	E	0,045
16	Oatmeal	J	0,045
17	Steamed Taro Bogor	R	0,045
18	Potato	F	0,043
19	Mustard	S	0,043
20	White Sweet Potato	K	0,035

k. The results of calculations using the Weighted Product method shown in Table 6 produce a ranking or ranking on alternative food and the rank with the highest value is used as the best alternative. Steamed Cassava is the best suggestion for users because it has the highest score and ranks first. The second best suggestion is Boiled Tempe, third is Sardines, fourth is Cork Fish, fifth is Brown Rice, sixth is Soy Milk, seventh is Boiled Corn, eighth is Yogurt, ninth is Macaroni, tenth is Avocado, eleventh is Chicken Breast, the twelfth is Boiled Egg, thirteenth is Green Beans, fourteenth is Smoked Salmon, fifteenth is Ambon Banana, sixteenth is Oatmeal, seventeenth is Steamed Bogor Taro, eighteenth is Potato, nineteenth is Mustard, and twentieth is White Sweet Potato.

l. This Weighted Products (WP) method calculates all criteria, not only criteria that according to the user are important. This method takes the largest or highest value from the calculation and is used as the best alternative. The number of alternatives available Users are recommended to take 3 alternatives with the highest value as a combination of foods that can be consumed and if there are the same values, the user can exchange them according to their needs. The results of the calculation of the V vector show the same number of values because there are equal weights for each alternative. In the ranking above, there are several alternatives that have the same value, to sort the ranking of each alternative the author uses an algorithm, namely by comparing the value of each criterion that has the highest to lowest criterion weight. The example above in the alternative Boiled Tempe and Red Rice, each alternative has a criterion weight on protein 5 and 4, so that Boiled Tempe has a higher weight value than Red Rice, so the order of Boiled Tempe is above Red Rice and so are the others [15].

4. Conclusion

By using the proposed decision support system, people with Type 2 Diabetes Mellitus can easily compile a food menu for consumption. The food selection decision support system is based on the Weighted Product method calculation, by entering the weight of the criteria and will produce a ranking or ranking of alternatives and results. Vector V calculation produces the highest value with a value of 0.065 and the boiled cassava food types is found as the best alternative.

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