Analysis of effective storage time to determine the quality of milk using simple additive weighting method

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Abstract. Milk is the result of livestock protein that is often consumed by the community, to produce quality milk and can be consumed by the community needed process of milk storage or pasteurization. The purpose of pasteurization is to kill the germs is in milk with as minimum possible loss of nutrients and maintain optimally physical properties and image of fresh milk, for that required decision-making techniques. Techniques used to analyze in a Simple Additive Weighting (SAW). The process of analyzing using Simple Additive Weighting (SAW) method is done by searching the weight value for each attribute, then doing the ranking process that will determine the optimal alternative in determining the quality of milk content based on the criteria used. The final result from the results of analysis conducted by simple additive weight method states that the milk is still feasible consumed by the community based on the old storage process is 21 hours. At room temperature 27.50 °C and milk is heated at 65 °C for 30 minutes.

Keyword : Quality of Milk, Criteria, Alternative, Weight Value and Simple Additive Weighting Method

1. PRELIMINARY
1.1 Basic Problems

The livestock sector is a sub-sector that is highly regarded by the government, the reason for making this subsector one of the attention by the government because this sector has a huge opportunity to be developed as a business in the future. The community's need for livestock products will increase every year. Livestock as a provider of protein, energy, vitamins, and minerals is increasing as the public awareness of nutritional needs in order to improve the quality of life and meet the nutritional needs of the community, especially the source of animal protein.

Milk is one of the animal protein products consumed by all societies without limit the age limit because milk is a product that is easy to eat, in addition to all the nutrients present in the milk needed by the body. Milk is also one of the food products that are easily damaged, damage to milk is caused by microbial content in milk, especially bacterial microbes.

The growth of various microbes present in milk can change the quality of milk itself, this can be characterized by changes in taste, aroma, color and appearance that causes the milk to become damaged [1]. Milk damage can be suppressed either by heat treatment technique or by pasteurization method then the product is known as pasteurized milk [2].

The pasteurization process is intended to kill some of the pathogenic germs present in the milk, with the minimum possible loss of nutrients and maintain as much physical properties and taste as the fresh milk [3]. So that the nutritional content of milk does not suffer damage caused by the microbial content in milk. The author will perform the process of analyzing the quality of milk nutritional
content by comparing the length of the process of storing milk by using the method of Simple Additive Weighting.

Simple Additive Weighting (SAW) method is often also known as weighted summing method. The basic concept of the SAW method is to find the weighted sum of performance ratings on each alternative of all attributes. The SAW method requires the process of normalizing the decision matrix (X) to a scale comparable to all existing alternative ratings [4]. In this study the authors do the process of analyzing the length of milk storage process to determine the quality of milk is good for consumption by the community so that the nutrient content in milk is still feasible dikonsumi by people using Simple Additive Weighting.

1.2 Problem Formulation
The description that has been explained in the background can be formulated about how the analysis process influence the duration of storage time to the milk content and how to solve the criteria used by Simple Additive Weighting method.

1.3 Limitations of Research
In order for this study is not too broad then the authors provide limits of research:
1. The method used to determine the quality of milk using Simple Additive Weighting method.
2. Only analyze the length of time the milk storage to determine the feasibility of milk content consumed by the community.
3. The process of storing milk begins from 0, 3, 6, 9, 12, 15, 18, and 21 hours. Just analyze the length of time the milk storage to determine the feasibility of milk content consumed by the community.
4. Storage carried out at room temperature (27.5°C) with replicate 3 times.
5. Milk is heated at 65 °C for 30 minutes.
6. The calculation result of each criterion is in the form of calculation of regression result.

1.4 Research Objectives
The purpose of this study is:

a. To analyze how long the process of milk storage is good, so the milk content to be consumed by the community remains met without being contaminated by microbes.

b. Completed the criteria of the alternatives that have been determined to determine the quality of milk using the Simple Additive Weighting (SAW) method.

c. Knowing the weighting process for each criterion and continuing the weighting analysis with Simple Additive Weighting (SAW) method.

1.5 Research Benefits
The benefits provided are:

a. Can help to determine how long it takes to make the process of storing milk so that the milk content in it is suitable for consumption by the community.

b. Can know the criteria suitable to determine the quality of milk that is consumed by the community based on the length of storage.

c. Can know the process of weighting each criterion.

2. LITERATURE REVIEW
2.1 Decision Support System
According to Raymond McLeod (1998), Decision Support System is a specific information-generating system aimed at solving a particular problem that managers must solve at various levels[5]. According Little, Decision Support System is a computer-based information system that produces various alternative decisions to assist management in handling various problems that are structured by using data and models [6].

The fundamentals of the decision (Azhar, 2003), are:
1. Intuition, ie decisions are taken based on the feelings and thoughts of the decision maker.
2. Experience, ie decisions are taken based on events that had been experienced before by the decision maker.
3. Facts, ie decisions are taken based on data and information that has been collected.
4. Authority, ie decisions are taken by those with higher powers and powers.
5. Rational, ie the decisions taken must be logical or acceptable common sense[7].

Decision-making is the process of choosing action (among alternatives) to achieve a particular goal. Decision-making involves a process of thinking about the problem as data needs and problem modeling leading to the interpretation and application of knowledge. Changes in the decision-making environment can occur thus affecting the quality of decisions [8]. Decision-making is the result of a selection process from a variety of alternative actions that may be chosen by a particular mechanism, with the aim of producing the best decision. Where the decision process is gradual, systematic, consistent, and in every step from the beginning has included all parties, will give good results [9].

The purpose of making decision support system that is [10]:
1. Help managers make decisions to solve structured and unstructured problems.
2. Supports managers’ appraisals instead of trying to replace them. Decision support systems are not meant to replace managers. Computers can be applied in solving structured problems. For an unstructured problem, managers are responsible for applying judgments, and conducting analyzes. computers and managers work together as problem-solving teams to solve problems in semi-structured areas.
3. Improve the effectiveness of managers' decisions rather than their efficiency. The main purpose of a decision support system is not as efficient as possible, but as effective as possible.

2.2 Simple Additive Weighting Method (SAW)
Simple Additive Weighting (SAW) is a weighted sum method. The basic concept of the SAW method is to find the weighted sum of performance ratings on each alternative on all criteria [10]. The SAW method requires the process of normalizing the decision matrix (X) to a scale comparable to all existing alternative ratings. SAW method recognizes the existence of 2 (two) attributes namely benefit criteria (benefit) and cost criteria (cost). The fundamental difference between the two criteria is in the selection of criteria when making decisions.

The completion step in using it is:
1. Determine the alternative, ie \( A_i \).
2. Determine the criteria that will be used as a reference in decision making, namely \( C_j \).
3. Provide an alternative match rating rating on each criterion.
4. Determine the weight of preference or importance level (W) of each criterion.
   \[ W = [W_1, W_2, W_3, \ldots, W_J]. \]
5. Create a match rating table of each alternative on each criteria.
6. Create a decision matrix (X) formed from the match rating table of each alternative on each criterion. The value of X of each alternative (Ai) on each criterion (Cj) has been determined, where, \( i = 1,2, \ldots, m \) and \( j = 1,2, \ldots, n \).
   \[ X = \begin{bmatrix} x_{11} & \cdots & x_{ij} \\ \vdots & \ddots & \vdots \\ x_{11} & \cdots & x_{jj} \end{bmatrix}. \]
7. Perform normalization of decision matrix by calculating the value of performance rating ternomalisasi \( (r_{ij}) \) from alternative \( A_i \) in each criterion \( C_o \).
Information:

a. A profit criterion if the value provides benefits to the decision maker, otherwise the cost criterion if it raises costs for the decision maker.
b. If it is a profit criterion then the value is divided by the value of each column, whereas for the cost criterion, the value of each column is divided by the value.

8. The result of a normalized performance rating value \( r_{ij} \) forms a normalized matrix \( R \).

\[
R = \begin{bmatrix}
r_{11} & \cdots & r_{ij} \\
\vdots & \ddots & \vdots \\
r_{m1} & \cdots & r_{mj}
\end{bmatrix}
\] .........................................................(4)

9. The final result of the preference value \( V_i \) is derived from the sum of the matrix elements of the normalized matrix row \( R \) with the corresponding weight of preference \( W \) of the matrix column element \( W \).

\[
V_i = \sum_{j=1}^{m} W_j r_{ij} \] .................................................................(5)

Greater \( V_i \) calculation results indicate that the alternative \( A_i \) is the best alternative [4].

3. ANALYSIS AND DISCUSSION

3.1 Process of Analyzing With Simple Additive Weight Method

The results of regression calculations obtained in milk, put into the matrix for the calculation by using SAW method, as for the calculation process as follows:

a. In this study the alternative length of storage process assessed is marked with \( A_1 \) through \( A_8 \), with the description as follows:

- \( A_1 = \) Hour 0
- \( A_2 = \) Hour 3
- \( A_3 = \) Hour 6
- \( A_4 = \) Hour 9
- \( A_5 = \) Hour 12
- \( A_6 = \) Hour 15
- \( A_7 = \) Hour 18
- \( A_8 = \) Hour 21

b. The criterion indicator is indicated by \( C_1 \) to \( C_4 \) with the following details:

- \( C_1 = \) Water content
- \( C_2 = \) Fats Content
- \( C_3 = \) Protein content
- \( C_4 = \) Number of Microbes

c. Determining the likert scale or importance of each indicator with value:

- Very less = 1
- Less = 2
- Simply = 3
- Good = 4
- Very good = 5

The weight of preferences or the importance of each indicator is given with the same value on each indicator \((1,1,1,1)\), where the determination of preference or importance level is taken from agreement on manual calculation. The calculation is done by simple additive weight method after
done assessment of milk based on the calculation of regression value, can be seen in the calculation process as follows:

Table 1. Alternate and criteria values

| No | Hour | C1    | C2    | C3    | C4 |
|----|------|-------|-------|-------|----|
| 1  | A1   | 86.94 | 3.7667| 3.6333| 35 |
| 2  | A2   | 86.66 | 3.7667| 3.7   | 56.33 |
| 3  | A3   | 86.08 | 3.7333| 3.6667| 56 |
| 4  | A4   | 86.32 | 3.6333| 3.5667| 85 |
| 5  | A5   | 87.19 | 4.0667| 3.9333| 95 |
| 6  | A6   | 86.79 | 4.1   | 3.8   | 216.67 |
| 7  | A7   | 86.57 | 3.7   | 5.1667| 300 |
| 8  | A8   | 86.79 | 3.7667| 5.3667| 300 |

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d. Create a Matrix from the table of alternative values and criteria

\[
\begin{align*}
R_{ij} &= \frac{A_i}{\max(A_j)} \quad (i=1,2,...,n; j=1,2,...,4) \\
\end{align*}
\]

e. Perform Matrix Normalization Process \( (R_{ij}) \) by using formula

\[
R_{ij} = \frac{A_i}{\max(A_j)} \quad (i=1,2,...,n; j=1,2,...,4) \\
\]

Before putting into the formula first sought the highest value of each criterion

C1 = 87.19
C2 = 4.1
C3 = 5.3667
C4 = 300

f. Perform normalization process matrix (Rij)

\[
\begin{align*}
R_{11} &= \frac{86.94}{\max(86.94,86.66,86.08,86.32,87.19,86.79,86.57,86.79)} = 0.997132699 \\
R_{12} &= \frac{86.66}{\max(86.94,86.66,86.08,86.32,87.19,86.79,86.57,86.79)} = 0.993921321 \\
R_{18} &= \frac{86.79}{\max(86.94,86.66,86.08,86.32,87.19,86.79,86.57,86.79)} = 0.995412318 \\
R_{21} &= \frac{86.32}{\max(3.7667,3.7667,3.7333,3.6333,4.0667,4.1,3.7,3.7667)} = 0.918707317 \\
R_{22} &= \frac{3.7667}{\max(3.7667,3.7667,3.7333,3.6333,4.0667,4.1,3.7,3.7667)} = 0.918707317 \\
R_{28} &= \frac{3.7667}{\max(3.7667,3.7667,3.7333,3.6333,4.0667,4.1,3.7,3.7667)} = 0.918707317 \\
R_{31} &= \frac{3.6333}{\max(3.6333,3.7,3.6667,3.5667,3.9333,3.85,5.1667,5.3667)} = 0.677008217 \\
R_{32} &= \frac{3.7}{\max(3.6333,3.7,3.6667,3.5667,3.9333,3.85,5.1667,5.3667)} = 0.689436712 \\
R_{38} &= \frac{5.3667}{\max(3.7667,3.7667,3.7333,3.6333,4.0667,4.1,3.7,3.7667)} = 0.116666667 \\
\end{align*}
\]
\[ R_{42} = \frac{56}{\text{Max}(35;56;33;5;68;59;216;67;300;300)} = 0.187766667 \]

\[ R_{48} = \frac{300}{\text{Max}(35;56;33;5;68;59;216;67;300;300)} = 1 \]

g. Creating a Matrix is normalized:

\[
\begin{array}{cccc}
0.997132699 & 0.918707317 & 0.677008217 & 0.116666667 \\
0.993921321 & 0.918707317 & 0.689436712 & 0.187766667 \\
0.987269182 & 0.910560976 & 0.910560976 & 0.186666667 \\
0.990021791 & 0.886170732 & 0.886170732 & 0.283333333 \\
\end{array}
\]

\[ \begin{array}{cccc}
1 & 0.991878049 & 0.991878049 & 0.316666667 \\
0.995412318 & 1 & 1 & 0.722233333 \\
0.992889093 & 0.902439024 & 0.902439024 & 0.962733151 \\
0.995412318 & 1 & 1 & 1 \\
\end{array} \]

h. Ranking process using the weight determined by the decision maker:

\[ A_1 = \{(1)(0.997132699) + (1)(0.918707317) + (1)(0.677008217) + (1)(0.116666667) \} = 2.7095149 \]

\[ A_2 = \{(1)(0.993921321) + (1)(0.918707317) + (1)(0.689436712) + (1)(0.187766667) \} = 2.789832017 \]

\[ A_3 = \{(1)(0.987269182) + (1)(0.910560976) + (1)(0.683231781) + (1)(0.186666667) \} = 2.767728606 \]

\[ A_4 = \{(1)(0.990021791) + (1)(0.886170732) + (1)(0.664958357) + (1)(0.283333333) \} = 2.824124213 \]

\[ A_5 = \{(1)(1) + (1)(0.991878049) + (1)(0.732908491) + (1)(0.722233333) \} = 3.041453207 \]

\[ A_6 = \{(1)(0.995412318) + (1)(1) + (1)(0.708070136) + (1)(0.722233333) \} = 3.425715787 \]

\[ A_7 = \{(1)(0.992889093) + (1)(0.902439024) + (1)(0.962733151) + (1)(0.962733151) \} = 3.858061268 \]

\[ A_8 = \{(1)(0.995412318) + (1)(1) + (1)(1) + (1)(1) \} = 3.995412318 \]

The biggest alternative is on A8 that is 3.995412318 so A8 is an old alternative process of milk storage which is still good used for consumption by society.

4. Conclusion

1. The process of analyzing is done by using simple additive weight method using 4 (four) fruit criteria that is fat content, water content, protein content and microbial quantity while alternative based on milk storage process consist of 8 (eight) alternative hours of milk storage starting from 0, 3, 6, 9, 12, 15, 18, and 21 hours.

2. From the results of analysis conducted by simple additive weight method states that the milk is still feasible consumed by the community based on the old storage process is 21 hours. At room temperature 27.50 °C and milk is heated at 65 °C for 30 minutes.

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