Zero : Jurnal Sains, Matematika, dan Terapan
E-ISSN : 2580-5754
P-ISSN : 2580-569X
Vol. 6, No. 2, Desember 2022
pp. 133-141


# Decision Support System For Determining Levels of Crude Palm Oil Using Fuzzy MADM ( Multiple Attribute Decision Making ) Using The SAW (Simple Addtive Weighting) Method

**Mhd Furqan[1], Yusuf Ramadhan Nasution[2], Fauzan Irsyad[3]**
[1,3]Department of Computer Science, Universitas Islam Negeri Sumatera Utara, Medan, Indonesia

**Article Info**

***Article history:***

***Keywords:***

Crude oil content, *Fuzzy Multi Attribute Decision Making* Method and Simple Additive *Weighting,* Decision Support System

**ABSTRACT**

PT. UKINDO BLANKHAN – POM is one of many large oil palm plantations that produces crude palm oil. The quality requirements for palm oil used as a raw material in the food industry and the non-food industry are distinct. Consequently, authenticity, purity, freshness, and other aspects need to be given more thought. The crude palm oil content is still selected manually in the processing section. It is challenging to process this, and it does not completely rule out the possibility of assessment errors. Based on the assessment above, determining high-quality oil frequently presents challenges, particularly when it comes to valuing crude oil levels or aspects in accordance with quality and standards. In light of these issues, a system that can assist in determining the level and quality of raw oil is required. Consequently, developing a method for determining the content of crude palm oil using *Fuzzy MultiAttributeDecision Making* and *Simple Additive Weighting methods.* The *Fuzzy MultiAttribute Decision Making* method is used to find alternatives from a number of alternatives with predetermined criteria. While the *Simple Additive Weighting* method is used to rank the existing alternatives. The results of this study can be used as a tool in making decisions to get a good oil content.



***Corresponding Author:***

Fauzan Irsyad,
Department of Ilmu Computer,
Universitas Islam Negeri Sumatera Utara, Medan, Indonesia
Email: fauzanirsyad24@gmail.com

## 1. INTRODUCTION

Palm oil is a food ingredient that has two quality aspects. The first aspect relates to moisture content, dirt content, fatty acids, and color. While the second aspect relates to taste, aroma and purity as well as product purity [1]-[3]

PT.UKINDO BLANKHAN - POM is a private company that manages crude oil into crude oil in Blankahan Village, Langkat Regency. However, in determining the content of crude palm oil, companies still do it manually, namely by only analyzing the results of processed crude oil. So most likely the results obtained from the analysis will be inaccurate. Meanwhile, crude palm oil consists of several tubes of crude oil [4]-[8].

Along with the development of technology to determine the content of crude palm oil, a computerized decision-making system is needed that will support the decision-making process for the content of crude palm oil effectively, efficiently and easily [9]-[12].

In a decision support system for determining the oil content of crude palm oil, the authors apply fuzzy MADM (Multiple Attribute Decision Making) with the SAW (Simple Additive Weighting) method in a web-based application [13]-[15]. previous research, the authors have found several credit worthiness journals for Pinaaman at Bank Rakyat Indonesia Unit Segiri Samarinda with the fuzzy MADM (Multiple Attribute Decision) method [16].

## 2. RESEARCH METHODE

### 2.1. Understanding Fuzzy MADM (Multiple Attribute Decision Making)

Fuzzy logic is that it allows membership values between 0 and 1, gray level, also black and white, and in linguistic form. The advantage of fuzzy logic theory is the ability in the reasoning process so that the design does not require a mathematical equation of the object to be controlled (Furqan et al., 2020). Investigations in determining each member that depend on the fuzzy methodology are more effective in determining an outcome because they use membership numbers rather than just using estimation techniques (Furqan et al., 2021). Fuzzy Multiple Attribute Decision Making (FMADM) is a method used to find alternatives optimal of a number of alternatives with criteria. The essence of FMADM is to determine the weight value for each attribute, then proceed with a ranking process that selects the alternatives that have been given (Kusumadewi, Harjoko, and Wardoyo. 2006). In FMADM there are several common components used, namely:

In fuzzy MADM there are several common components used, namely:

a. Alternatives are objects that are distinct, but they all have the same chance of being selected by the decision maker.
b. Attributes are also referred to as components, decision criteria, and characteristics. Even though the majority of the criteria are all one level, it's possible that there are also related sub-criteria.
c. Contradictory criteria: Multiple criteria frequently clash with one another.
d. The decision weight (W) indicates the relative importance of each criterion.
e. Decision matrix, a decision matrix X with size m x n, contains elements xij, which represents the rating of alternative Ai (i=1,2,...,m) m is the number of alternatives, against criteria Cj(j=1,2, ..., n) n is the number of criteria (Kusumadewi, Harjoko, and Wardoyo. 2006).

Stages of Fuzzy Madm (Multiple Attribute Decision Making), The process of FMADM is carried out in three stages, specifically:

a. At the stage of assembling the situation components, an estimation table that identifies alternatives and specifies objectives, criteria, and attributes will be created.
b. The analysis stage consists of two steps:
    - Provides estimates of the probabilities, uncertainties, and potential magnitudes of each alternative's effects.
    - Decide whether you prefer to make decisions based on each value or to ignore any potential risks.
c. And then the information synthesis stage is carried out.

The SAW (Simple Additive Weighting) method is a method used to find optimal alternatives from a number of alternatives with certain criteria. The basic concept of this method is to find the weighted sum of each performance on each alternative to all attributes (criteria).

### 2.2. SimplelAdditive Weightingl(SAW)iMethod

The SAW (Simple Additive Weighting) method is a method used to find optimal alternatives from a number of alternatives with certain criteria. The basic concept of this method is to find the weighted sum of each performance on each alternative to all attributes (criteria). Where the value of the decision matrix (X) must be normalized to a scale that can be compared with all existing alternative ratings. The completion steps in using the SAW method are:

a. Determine alternatives (candidates), namely AI. Determine the criteria that will be used as a reference in decision making, namely Ci.
b. Provide a match value for each alternative on each criterion.
c. Determine the preference weight or level of importance (W), forleach criterion. Make a table of the order of suitability of each alternative for each criterion.
d. Make a decision matrix X which is formed from the match order table of each alternative. The X

value of each alternative (Ai) on each predetermined criterion (Cj), where i=1,2,....m and j=1,2,...n

$$X = \begin{bmatrix} x_{11} & \cdots & x_{1j} \\ \vdots & \ddots & \vdots \\ x_{i1} & \cdots & x_{ij} \end{bmatrix}$$

e. Normalize the x decision matrix by calculating the normalized performance value (rij) of alternative Ai on the criterion C rij = xij/Max xij if j = profit (benefit) attribute Min xij / xij if j = cost (cost) attribute
Information:
rij= normalized performance rating of alternative Ail on criterion Cj ( il= 1, i2, ..., ml and jl = 1, 12, ..., n).
xij=X matrix value of alternatives Ai in C Max criteria xi= argest value of matrix
Min Xij = smallest value of matrix
Benefit = if the greatest value is the best
Costt = if the smallest value is the best

f. The results of the normalized performance value (rij) form the normalized matrix (R)

$$R = \begin{bmatrix} r_{11} & \cdots & r_{1j} \\ \vdots & \ddots & \vdots \\ r_{i1} & \cdots & r_{ij} \end{bmatrix}$$

g. The final result of the preference value (Vi) is the sum of the preference weights (W), which correspond to the matrix column elements, and the normalized matrix row components (R) (W).

$$Vi = \sum_{j=1}^{n} w_j r_{ij}$$

The results of calculating a larger Vi value indicate that alternative Ai is the best alternative (Lismardiana: 2018). The assessment of the standard criterion value is carried out based on the fuzzy numbers as shown in Figure 1.

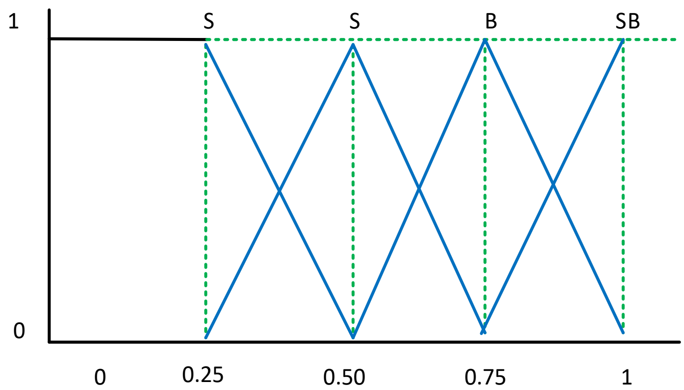



Figure 1. Criterion Value Carried Out Based On The Fuzzy Numbers

Information :

SB = Very Bad C = Fair SB = Very Good
B = Bad B = Good

## 3. RESULT AND ANALYSIS

### 2.1. Determination of criteria

The selection test criteria data used in the decision support system using fuzzy multilattribute decision making (FMADM) and simple additive weighting (SAW) in the decision support system for determining the quality of palm oil types total 4 criteria, namely.

Table 1. Assessment Criteria

| Test Criteria | | | |
|---|---|---|---|
| Code | Name | Weight | W |
| C1 | Fatty acid | 50% | 0.5 |
| C2 | Water content | 50% | 0.5 |
| C3 | Impurity Level | 50% | 0.5 |
| 2C4 | Color | 50% | 0.5 |

Based on the table above is the acquisition value of the Fatty Acid criteria (C1). Where the value of the variable Fatty Acid is looking for is summarized by fuzzy numbers.

Table 2. Fatty Acid Criteria

| Range | Weight | Score |
|---|---|---|
| >4 | Very good | 0.5 |
| 3.1 – 4 | Good | 0.4 |
| 2.1 – 3 | Enough | 0.3 |
| 1.1 – 2 | Not good | 0.2 |
| < 1 | Not good | 0.1 |

a. Determination of the criterion value of Moisture Content (C2)
   The variable value of the Moisture Content criteria is converted to the ifuzzy number below the line.

Table 3. Criteria for Moisture Content

| Range | Weight | Score |
|---|---|---|
| > 0.4 | Very good | 0.5 |
| 0.31 - 0 .4 | good | 0.4 |
| 0.21 - 0.30 | Enough | 0.3 |
| 0.11 - 0.20 | Not good | 0.2 |
| < 0.10 | Not good | 0.1 |

b. Determination of value of impurities content criteria (C3)
   The variable value of the Impurity Content criteria is converted with the fuzzy numbers below.

Table 4. Criteria for dirt content

| Range | Weight | Score |
|---|---|---|
| > 0.4 | Very good | 0.5 |
| 0.31 - 0 .4 | Good | 0.4 |
| 0.21 - 0.30 | Enough | 0.3 |
| 0.11 - 0.20 | Not good | 0.2 |
| < 0.10 | Not good | 0.1 |

c. Determination of the value of the Color criterion (C4)
   The color criterion value variable is converted to the fuzzy numbers below.

Table 5. Color Criteria

| Range | Weight | Score |
|---|---|---|
| Clear Yellow | Very good | 0.5 |
| Yellow | Good | 0.4 |
| Reddish yellow | Enough | 0.3 |

- Case examples like the table below

Table 6. Alternative data

| Alternative | Fatty acid (C1) | Water content (C2) | Impurity Level (C3) | Color (C4) |
|---|---|---|---|---|
| Tank 1 | Very good | Good | Enough | Very good |
| Tank 2 | Good | Not good | Very good | Good |
| Tank 3 | Very good | Enough | Not good | Good |
| Tank 4 | Very good | Good | Enough | Good |
| Tank 5 | Very good | Enough | Enough | Good |

### 2.2. Matrix Normalization

By normalizing the matrix based on the equation as attached in chapter II, the normalized matrix values for each alternative are:

a. Normalization of Fatty Acid Criteria

$$r1.1 = \frac{0.5}{0.5} = 1$$
$$r2.1 = \frac{0.4}{0.5} = 0.8$$
$$r3.1 = \frac{0.5}{0.5} = 1$$
$$r4.1 = \frac{0.5}{0.5} = 1$$
$$r5.1 = \frac{0.5}{0.5} = 1$$

b. Normalization of Moisture Content Criteria

$$r1.2 = \frac{0.4}{0.4} = 1$$
$$r2.2 = \frac{0.2}{0.4} = 0.5$$
$$r3.2 = \frac{0.3}{0.4} = 0.75$$

$$r4.2 = \frac{0.4}{0.4} = 1$$

$$r5.2 = \frac{0.3}{0.4} = 0.75$$

c. Normalization of Impurities Content Criteria

$$r1.3 = \frac{0.3}{0.4} = 0.75$$

$$r2.3 = \frac{0.4}{0.4} = 1$$

$$r3.3 = \frac{0.2}{0.4} = 0.5$$

$$r4.3 = \frac{0.3}{0.4} = 0.75$$

$$r5.3 = \frac{0.3}{0.4} = 0.75$$

d. Color Criteria Normalization

$$r1.4 = \frac{0.5}{0.5} = 1$$

$$r2.4 = \frac{0.5}{0.5} = 1$$

$$r3.4 = \frac{0.4}{0.5} = 0.8$$

$$r4.4 = \frac{0.4}{0.5} = 0.8$$

$$r5.4 = \frac{0.4}{0.5} = 0.8$$

### 2.3. Ranking

The last step is to calculate the final result. The preferential value (Vi) is obtained from the addition of the multiplication of normalized matrix elements (R) with the reference weight (W). The weights used are as follows: lW = [0.5 0.5 0.5 0.5]. The formula used is Vi = w * r for each alternative.

The Following Are The Results Of Decision Support System For Determining The Content Of Palm Oil Using The Fuzzy Madm (Multiple Attribute Decision Making) Method Using The Saw (Simple Additive Weighting) Method

Figure 2. Login

Login PageThis is the first page accessed by visitors.


Figure 3. Home

Home page Is the home page that will appear if the login is successful.

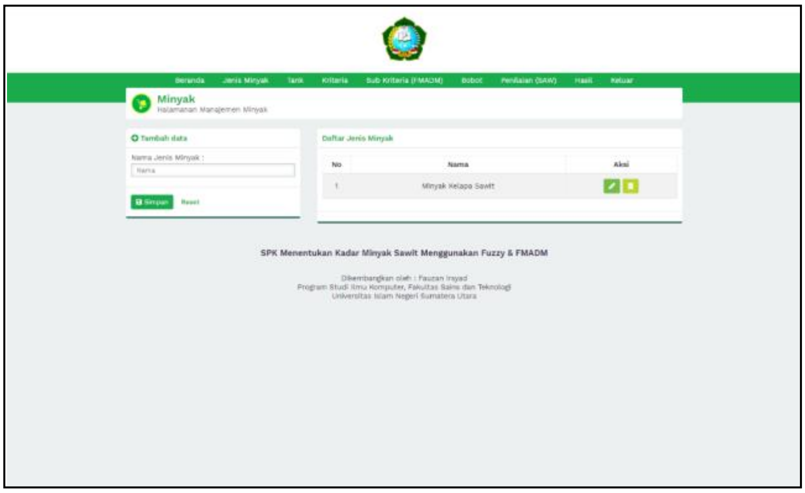



Figure 4 Oil Type Data

Oil type data page Is a page that displays the type of oil

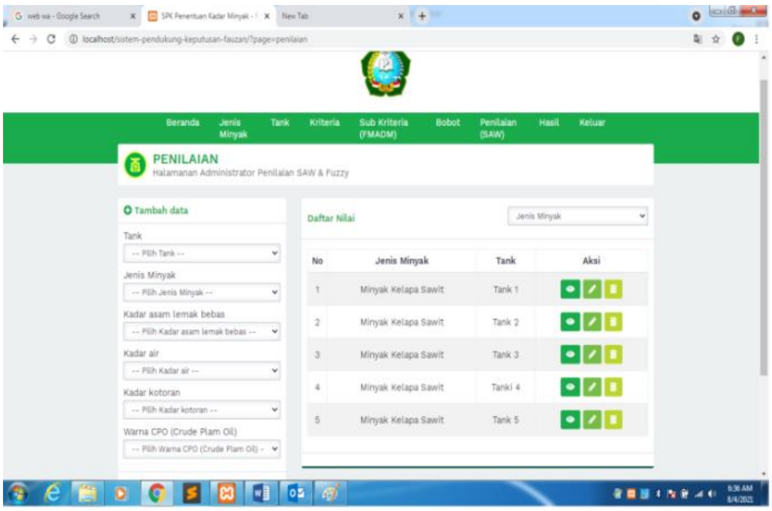
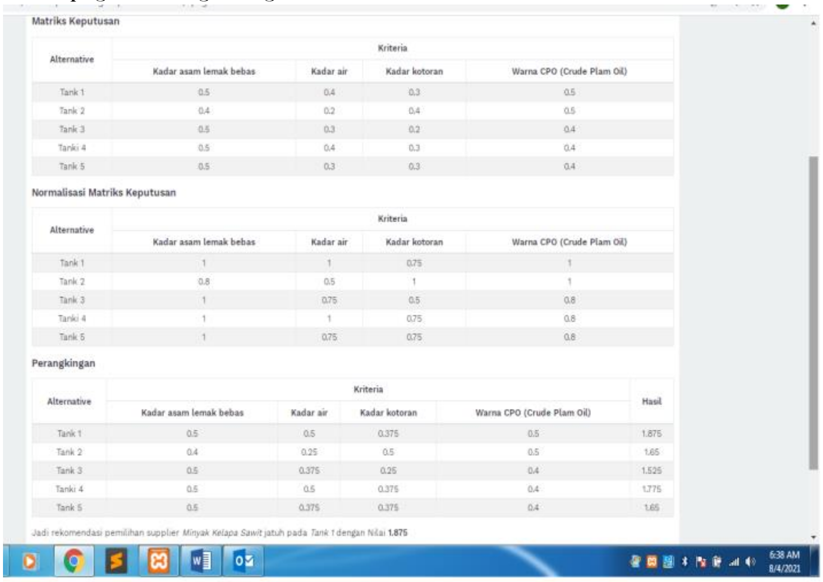



Figure 5. Assessment

Rating page This is a page showing ratings.



**Matriks Keputusan**

| Alternative | Kriteria | | | |
|---|---|---|---|---|
| | Kadar asam lemak bebas | Kadar air | Kadar kotoran | Warna CPO (Crude Plam Oil) |
| Tank 1 | 0.5 | 0.4 | 0.3 | 0.5 |
| Tank 2 | 0.4 | 0.2 | 0.4 | 0.5 |
| Tank 3 | 0.5 | 0.3 | 0.2 | 0.4 |
| Tanki 4 | 0.5 | 0.4 | 0.3 | 0.4 |
| Tank 5 | 0.5 | 0.3 | 0.3 | 0.4 |

**Normalisasi Matriks Keputusan**

| Alternative | Kriteria | | | |
|---|---|---|---|---|
| | Kadar asam lemak bebas | Kadar air | Kadar kotoran | Warna CPO (Crude Plam Oil) |
| Tank 1 | 1 | 1 | 0.75 | 1 |
| Tank 2 | 0.8 | 0.5 | 1 | 1 |
| Tank 3 | 1 | 0.75 | 0.5 | 0.8 |
| Tanki 4 | 1 | 1 | 0.75 | 0.8 |
| Tank 5 | 1 | 0.75 | 0.75 | 0.8 |

**Perangkingan**

| Alternative | Kriteria | | | | Hasil |
|---|---|---|---|---|---|
| | Kadar asam lemak bebas | Kadar air | Kadar kotoran | Warna CPO (Crude Plam Oil) | |
| Tank 1 | 0.5 | 0.5 | 0.375 | 0.5 | 1.875 |
| Tank 2 | 0.4 | 0.25 | 0.5 | 0.5 | 1.65 |
| Tank 3 | 0.5 | 0.375 | 0.25 | 0.4 | 1.525 |
| Tanki 4 | 0.5 | 0.5 | 0.375 | 0.4 | 1.775 |
| Tank 5 | 0.5 | 0.375 | 0.375 | 0.4 | 1.65 |

Jadi rekomendasi pemilihan supplier *Minyak Kelapa Sawit* jatuh pada *Tank 1* dengan Nilai **1.875**

Figure 6. Assessment Results

Assessment results page is a page that displays the results of the assessment.

## 4. CONCLUSIOON

From the results of manual calculations and calculations using fuzzy multilattribute decision making systems (FMADM) and simple additive weighting (SAW) on the system of increasing crude oil content using palm oil, the final value is the same, and the calculation of the decision support system has a higher advantage than manual calculations.

## REFERENCES


[1] J. Manajemen, S. Informasi, N. Y. Fitri, P. Studi, and M. Sistem, "GURU DENGAN MENGGUNAKAN METODE SIMPLE ADDITIVE WEIGHTING ( SAW ) PADA SMK," vol. 2, no. 1, pp. 318–326, 2017.

[2] Z. Ritonga, Y. Sepriani, and D. Suhendra, "Analisis Persentase Indeks Kadar CPO ( Crude Palm Oil ) di PTPN III Aek Nabara Kecamatan Bilah Hulu," vol. 1, pp. 14–20, 2020.

[3] S. Utara, "METODE BAYES DALAM MENDIAGNOSIS PERILAKU," vol. 6, no. 3, 2022.

[4] W. Saputro *et al.*, "Implementasi sistem pendeteksi banjir di Kp.Kojan RW 06 Kalideres Jakarta Barat berbasis internet of things," *PUNDIMASKOT Publ. Abdimas Komput. dan Teknol.*, vol. 1, no. 1, pp. 55–58, 2022, [Online]. Available: http://journal.binainternusa.ac.id/index.php/maskot

[5] M. Furqan, Sriani, A. H. Hasugian, and M. S. Hsb, "Penentuan Kualitas Bibit Padi Menggunakan Metode Fuzzy Mamdani," *J. Sains Komput. Inform.*, vol. 5, no. September, pp. 529–539, 2021.

[6] E. Nasri and A. S. AW, "Aplikasi Seleksi Penentuan Nasabah Untuk Penjualan Barang Secara Kredit Dengan Algoritma K-Nearest Neighbor," *J. Ilm. Sains Dan Teknol.*, vol. 4, no. 1, pp. 1–11, 2020.

[7] D. K. Hakim and M. S. Rohman, "Sistem Informasi Penyebaran Virus Corona di Wilayah Brebes Berbasis Android," vol. 15, no. 1, pp. 43–61, 2021.

[8] N. Y. Fitri and Nurhadi, "Analisis Dan Perancangan Sistem Pendukung Keputusan Penilaian Kinerja Guru Dengan Menggunakan Metode Simple Additive Weighting (Saw) Pada Smk Yadika Jambi," *J. Manaj. Sist. Inf.*, vol. 2, no. 1, pp. 318–326, 2017.

[9] A. L. Adewale, A. F. Jumoke, M. Adegboye, and A. Ismail, "An Embedded Fuzzy Logic Based Application for Density Traffic Control System," *Int. J. Artif. Intell. Res.*, vol. 2, no. 1, p. 6, 2018, doi: 10.29099/ijair.v2i1.44.

[10] B. V. Christioko, H. Indriyawati, and N. Hidayati, "Fuzzy Multi-Atribute Decision Making (Fuzzy Madm) Dengan Metode Saw Untuk Pemilihan Mahasiswa Berprestasi," *J. Transform.*, vol. 14, no. 2, p. 82, 2017, doi: 10.26623/transformatika.v14i2.441.

[11] M. Nur and S. Wahyuni, "Analisis Kualitas Crude Palm Oil ( CPO ) Di PT . Inti Indo Sawit PMKS Subur Buatan 1 Siak Metode Pengumpulan Data Metode Pengolahan Data," *J. Teknol. Ind. Pertan.*, vol. 1, no. 1, pp. 1–6, 2015.

[12] Irawan Beni, "Sistem Pendukung Keputusan Pemilihan Bibit Kelapa Sawit Dengan Metode Simple Additive Weighting ( Saw )," *Sist. Pendukung Keputusan Pemilihan Bibit Kelapa Sawit Dengan Metod. Simple Addit. Weight. ( Saw )*, pp. 1–8, 2013, [Online]. Available: http://mahasiswa.dinus.ac.id/docs/skripsi/jurnal/12181.pdf

[13] I. I. Sinon and A. F. Rozi, "Sistem Pendukung Keputusan Dalam Pemilihan Biji Kelapa Sawit Menggunakan Metode MOORA," *J. Teknol. Dan Sist. Inf. Bisnis*, vol. 3, no. 2, pp. 425–430, 2021, doi: 10.47233/jteksis.v3i2.301.

[14] Fatoni, Kurniawan, and W. Munandar, "Metode Fuzzy Multiple Attribute Decision Making ( FMADM ) sistem penilaian calon penerima manfaat," *J. Ilm. MATRIK*, vol. 16, no. 1, pp. 45–58, 2014.

[15] D. Prayetno *et al.*, "Sistem Pendukung Keputusan Menentukan Kadar Minyak Mentah Kelapa Sawit Dengan Metode Topsis," *Sensitek 2018*, vol. 2, no. juli, pp. 704–709, 2018.

[16] F. Sembiring, M. T. Fauzi, S. Khalifah, A. K. Khotimah, and Y. Rubiati, "Sistem Pendukung Keputusan Penerima Bantuan Covid 19 menggunakan Metode Simple Additive Weighting (SAW) (Studi Kasus : Desa Sundawenang)," *Explor. Sist. Inf. dan Telemat.*, vol. 11, no. 2, p. 97, 2020, doi: 10.36448/jsit.v11i2.1563.