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Determining the Formulation of Mosquito Repellent Production Raw Materials Using Simple Additive Weighting (SAW)

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Abstract: Fumakilla Nomos is committed to manufacturing domestic insecticides, namely insect repellents. The raw materials used include various materials where the material is taken from nature. Because of that, the obstacles are the unstable quality of raw materials, the availability of raw materials is uncertain, and the distance between the suppliers of raw materials is quite far. So we need a decision support system for selecting raw materials using the Simple Additive Weighting (SAW) algorithm to find the best alternative formulations in choosing raw materials. This method is used to rank the alternatives of each raw material that can be used, where the highest value will be the best alternative result. The results of manual and application calculations show that the best alternative is alternative 1 with a value of 1.360, the highest value of the five alternative formulas. This application is expected to help the effectiveness and efficiency of companies in determining raw materials that are experiencing problems by making several alternatives for each raw material.

Keywords: *Decision Support System, Simple Additive Weighting (SAW), Selection of Raw Materials*

1. Introduction

As technology develops in this modern era, all must follow developments, including companies (Grewal et al., 2020). Many companies now prefer to spend large sums on an intelligent machine that can increase productivity and reduce the level of risk that exists, as well as lower production costs (Saiz-Rubio & Rovira-Más, 2020). In a company engaged in the manufacturing industry, to make a product, they need the primary material or often referred to as raw materials. Raw materials in the manufacturing industry are the company's core because, without raw materials, the company will not run. Therefore, the selection of raw materials becomes essential to be used as a basis for determining the quality of the product and the achievement of production results. The company Fumakilla Nomos is engaged in manufacturing insecticides or insect repellents (mosquito coils). The raw materials used include various materials where these materials are obtained from nature so that they have specific criteria to be used as a mosquito repellent product. The company has standards for assessing suitable raw materials to maintain product quality. These standards are an essential reference for selecting raw materials to be used in product formulations in the production process. Because raw materials are obtained from nature, the problems that often occur regarding these raw materials include unstable quality of raw materials, uncertain availability of raw materials and relatively far distance suppliers of raw materials. From these problems, we need a decision support system for selecting suitable raw materials according to the standard formulation of mosquito coils to improve the quality and production of the company (Ayunda et al., 2021). Using the SAW simple additive weighting algorithm, it is assumed that the best alternative is to find the best formulation ranking of each raw material criterion according to the standard (Gündoğdu & Yörükoğlu, 2021). With this decision support system, it is hoped that it can assist companies in finding alternative raw material formulations so that they are more efficient and effective.

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2. Method

The research stage is a series of research stages, from the beginning of the research to the implementation stage. Figure 1 shows the settings of the research. The following are the stages of the research:

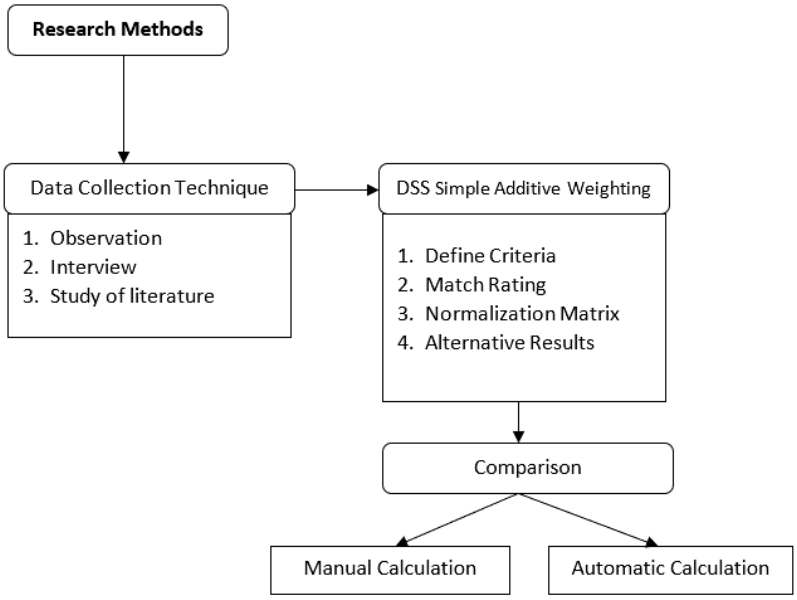


Fig 1. Research Stage

1. Simple Additive Weighting

The decision support system for selecting raw materials to determine the best formulation according to the standard uses six criteria: WP, CP, JP, TW, KL, and CO. The following is an analysis of the decision support system for selecting raw materials to determine the best formulation using the Simple Additive Weighting (SAW) method. (Rusito, 2017), (Syamila et al., 2021):

a. Defining Criteria

Determine the criteria that will be used as a reference in making decisions. The criteria used are the raw materials used to determine the best formulation. Each standard has a different weight; this weight will be used to determine the best alternative to this method (Senthil Kumar & Malathi, 2018).

b. Alternative Match Ratings

Determine the suitability rating for each alternative on each criterion or alternative value. The alternative suitability rating value or the value of each standard in one alternative (Senthil Kumar & Malathi, 2018). This value is obtained from existing data in the company, where the data has been used as a raw material formulation.

c. Alternative Normalization

Making alternative normalization with a matrix (Manek et al., 2018). The formula used to normalize the alternatives is as follows:

$$r_{ij} = \begin{cases} \frac{X_{ij}}{Max\, X_{ij}} & if\ j\ is\ the\ profit\ attribute\ (benefit\ ) \\ \frac{Min\, X_{ij}}{X_{ij}} & if\ j\ is\ the\ cost\ attribute\ (cost\ ) \end{cases} \quad (1)$$

Explanation:

Rij = normalized performance rating of each criterion alternative
Xij = attribute value owned by each criterion
Maxij = the greatest value of each criterion *i*
Minij = the smallest value of each criterion *i*

d. Alternative Results

The alternative results are obtained from the sum of the normalized multiplication matrices with the weight of each criterion so that the most outstanding value will be accepted, which will be selected as the best alternative as a solution (Wulandari & Nugroho, 2015). The following formula is used to determine the best alternative results:

$$V_i = \sum_{j=1}^{n} W_j\, r_{ij} \quad (2)$$

Explanation:

Vi = ranking for each alternative

Wj = the weighted value of each criterion

Rij = normalized rating value

A large *Vi* value indicates that the alternative is chosen. The weight of each alternative is converted to a decimal (Septian et al., 2021).

2. Comparison

At the comparison stage, a comparison of the results of the Simple Additive Weighting calculation is carried out to determine the raw material for mosquito repellent (Yoon et al., 2015), from the results of manual calculations with automatic calculations (Ristiani et al., 2018). Automatic calculation results are obtained from the DSS software. So that these results can be presented for making decisions (Hananto, Priyatna, et al., 2021) (Naibaho, 2021).

3. Current Raw Material Selection Procedures

Analysis of the ongoing system to find out problems and obtain problem-solving. Analysis obtained from interviews and field observations regarding raw materials and formulas with department heads. The following in Figure 2 describes the flow of the raw material selection system until the raw materials are ready for use.

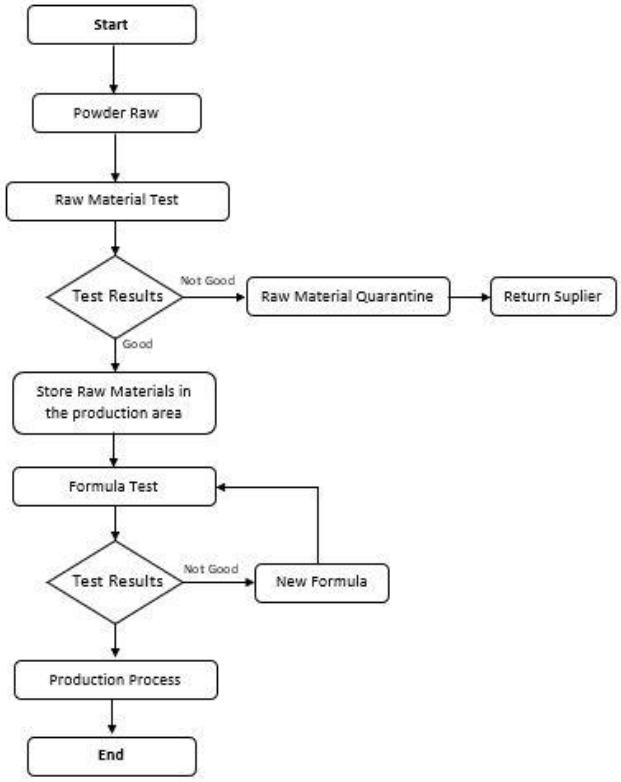


Fig 2. Previous Raw Material Selection Procedure

a. Raw materials that come from suppliers will be taken samples for testing of raw materials whether they are following production standards.

b. The next process, namely reblending, follows raw materials that have passed the raw material testing. Meanwhile, raw materials that do not pass or NG (Not Good) testing of raw materials will be quarantined and separated from the production area and given a special label to be returned to the supplier.

c. From the Redland process, product testing or raw material testing will be made specifically to the product to determine product quality. If the product testing passes, the raw materials will be sent to the next production. Meanwhile, if there is a discrepancy with the results of product testing, and analysis of the cause of the problem will be carried out and create a new formulation or formula that is different from the previous one (Hananto, Assiroj, et al., 2021).

4. The proposed raw material selection procedure

Solutions to problems faced in selecting raw materials to obtain the best alternative formula

for raw materials (Proag, 2021). The following in Figure 3 is a proposed solution:

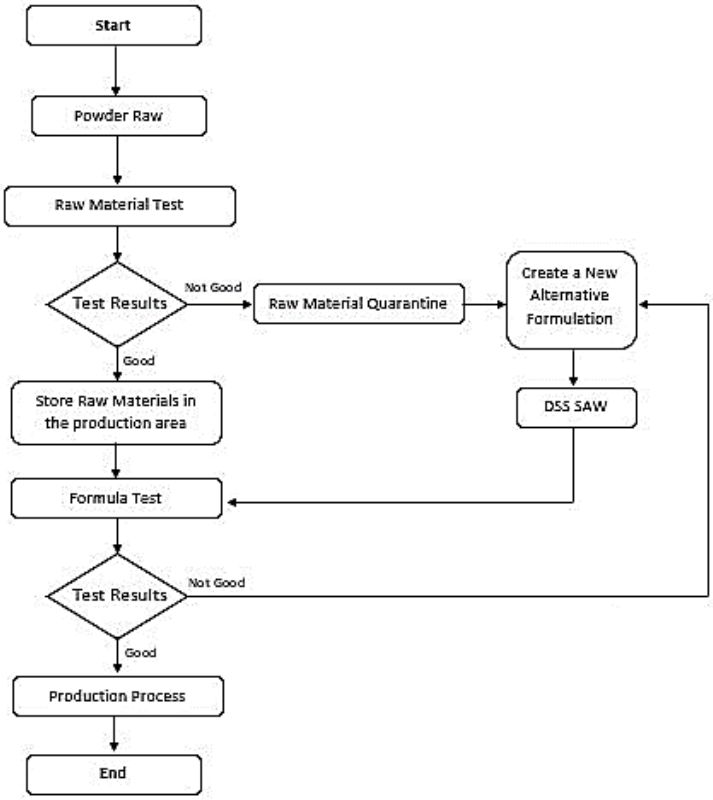


Fig 3. The proposed raw material selection procedure

a. Raw materials with NG status with limited stock conditions will be used for production with various considerations from a management.
b. The raw material is made of several possible alternative formulas for raw materials following the existing problem conditions, namely limited stock.
c. Alternative raw material formulas will go through the SPK-SAW process to determine the best ranking.
d. Product tests will be carried out in order of ranking from first to last.
e. If it fails, several alternative raw material formulas will be regenerated with different values from the previous ones and the existing values.

In determining the alternative formulation of raw material for mosquito repellent, the company collects raw materials classified as Not Good (NG). After that, according to the flow of the proposed Raw Material Selection Procedure in Figure 3, criteria and weights are needed in carrying out the calculations to obtain the best alternative results for the following raw materials with alternative formulations determined using the Simple Additive Weighting method, here is a discussion of the results of the study:

1. Determine Criteria

Determine the criteria that will be used as a reference in making decisions. The following is in Table 1 the criteria used in selecting raw materials to determine the best formulation:

Table 1. Criteria table (C) and Criteria weight value

Critria Industry	Criteria	Weight	Explanation
WP	C1	0,35	*Benefit*
CP	C2	0,33	*Benefit*
JP	C3	0,07	*Benefit*
TW	C4	0,23	*Benefit*

KL	C5	0,02	*Benefit*
CO	C6	0,50	*Cost*

2. Alternative Match Ratings

Determine the suitability rating for each alternative on each criterion or alternative value. The following in Table 2 is an alternative value for each criterion:

Table 2. Alternative suitability rating values

	C1	C2	C3	C4	C5	C6
Alternative 1	475	400	50	337	50	211.733
Alternative 2	450	300	50	348	75	200.437
Alternative 3	350	350	50	398	75	204.465
Alternative 4	350	0	50	348	75	186.407
Alternative 5	100	100	100	348	100	197.702

3. Alternative Normalization

We are making alternative normalization with a matrix. The following is the normalization of the alternative match rating values:

Normalisasi C1

R11 = 475 / Max {475, 450, 350, 350, 100} = 475 / 475 = 1
R21 = 450 / Max {475, 450, 350, 350, 100} = 450 / 475 = 0.95
R31 = 350 / Max {475, 450, 350, 350, 100} = 350 / 475 = 0.74
R41 = 350 / Max {475, 450, 350, 350, 100} = 350 / 475 = 0.74
R51 = 100 / Max {475, 450, 350, 350, 100} = 100 / 475 = 0.21

Normalisasi C2

R12 = 400 / Max {400, 300, 350, 0, 200,} = 400 / 400 = 1
R22 = 300 / Max {400, 300, 350, 0, 200,} = 300 / 400 = 0.75
R32 = 350 / Max {400, 300, 350, 0, 200,} = 350 / 400 = 0.88
R42 = 0 / Max {400, 300, 350, 0, 200,} = 0 / 400 = 0
R52 = 200 / Max {400, 300, 350, 0, 200,} = 200 / 400 = 0.50

Normalisasi C3

R13 = 50 / Max {50, 50, 50, 50, 100} = 50 / 100 = 0.50
R23 = 50 / Max {50, 50, 50, 50, 100} = 50 / 100 = 0.50
R33 = 50 / Max {50, 50, 50, 50, 100} = 50 / 100 = 0.50
R43 = 50 / Max {50, 50, 50, 50, 100} = 50 / 100 = 0.50
R53 = 100 / Max {50, 50, 50, 50, 100} = 100 / 100 = 1

Normalisasi C4

R14 = 337 / Max {337, 348, 398, 348, 348} = 337 / 398 = 0.85
R24 = 348 / Max {337, 348, 398, 348, 348} = 348 / 398 = 0.87
R34 = 398 / Max {337, 348, 398, 348, 348} = 398 / 398 = 1
R44 = 348 / Max {337, 348, 398, 348, 348} = 348 / 398 = 0.87
R54 = 348 / Max {337, 348, 398, 348, 348} = 348 / 398 = 0.87

Normalisasi C5

R15 = 50 / Max {50, 75, 75, 75, 100} = 50 / 100 = 0.50
R25 = 75 / Max {50, 75, 75, 75, 100} = 75 / 100 = 0.75
R35 = 75 / Max {50, 75, 75, 75, 100} = 75 / 100 = 0.75

R45 = 75 / Max {50, 75, 75, 75, 100} = 75 / 100 = 0.75
R55 = 100 / Max {50, 75, 75, 75, 100} = 100 / 100 = 1

Normalisasi C6

R16 = Min {211.733, 200.437, 204.465, 186.407, 197.702} / 211.733 = 186.407/211.733 = 0.88
R26 = Min {211.733, 200.437, 204.465, 186.407, 197.702} / 200.437 = 186.407 / 200.437 = 0.93
R36 = Min {211.733, 200.437, 204.465, 186.407, 197.702} / 204.465 = 186.407 / 204.465 = 0.91
R46 = Min {211.733, 200.437, 204.465, 186.407, 197.702} / 186.407 = 186.407 / 186.407 = 1
R56 = Min {211.733, 200.437, 204.465, 186.407, 197.702} / 197.702 = 186.407 / 197.702 = 0.94

After the calculation is complete, the normalization value is obtained, shown in Table 4 below.:

Table 3. Matrix normalization results

	C1	C2	C3	C4	C5	C6
Alternative 1	1.00	1.00	0.50	0.85	0.50	0.88
Alternative 2	0.95	0.75	0.50	0.87	0.75	0.93
Alternative 3	0.74	0.88	0.50	1.00	0.75	0.93
Alternative 4	0.74	-	0.50	0.78	0.75	1.00
Alternative 5	0.21	0.50	1.00	0.87	1.00	0.94

4. Alternative Results

The alternative results are obtained from the sum of the normalized multiplication matrices with the weight of each criterion so that the greatest value will be obtained, which will be selected as the best alternative as a solution. (Astuti & Sagala, 2021). A large Vi value indicates that the alternative is chosen. The following in Table 5 is the result of calculating the ranking of each alternative:

Table 4. Results of the preventive matrix

	C1	C2	C3	C4	C5	C6	V_i
Alternative 1	0,35	0,33	0,04	0,19	0,01	0,44	1,360
Alternative 2	0,33	0,25	0,04	0,20	0,02	0,47	1,295
Alternative 3	0,26	0,29	0,04	0,23	0,02	0,46	1,282
Alternative 4	0,26	-	0,04	0,20	0,02	0,50	1,009
Alternative 5	0,07	0,17	0,07	0,20	0,02	0,47	1,001

So, according to the calculation, the largest value is found in Vi or in Alternative one, which is 1.36, so it can be recommended as the best choice of raw materials for mosquito repellent formulations. Following is Table 6 the ranking results of each alternative:

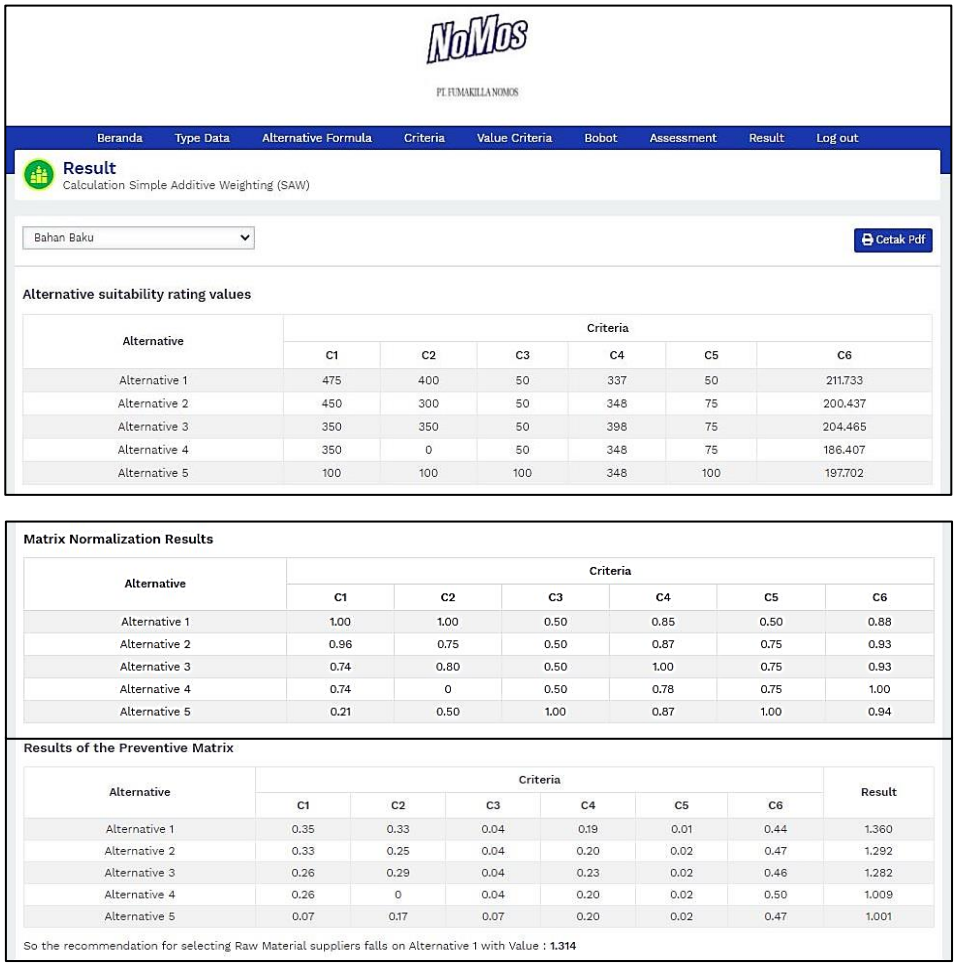
Table 5. Alternative ranking results

	V_i	Ranking
Alternative 1	1.36	1
Alternative 2	1.30	2
Alternative 3	1.28	3
Alternative 4	1.01	4
Alternative 5	1.00	5

5. Decision Support System Software for SAW

In the SAW DSS Software, calculations are carried out automatically as follows:

By selecting the type of data to be processed, the results of the matrix normalization process will come out, and the results of the best alternative prevention in the selection of raw materials. The display of the results of the DSS SAW software can be seen in Figure 4:



NoMos

PT. FUMAKILLA NOMOS

Beranda | Type Data | Alternative Formula | Criteria | Value Criteria | Bobot | Assessment | Result | Log out

Result
Calculation Simple Additive Weighting (SAW)

Bahan Baku

Cetak Pdf

Alternative suitability rating values

Alternative	Criteria					
	C1	C2	C3	C4	C5	C6
Alternative 1	475	400	50	337	50	211.733
Alternative 2	450	300	50	348	75	200.437
Alternative 3	350	350	50	398	75	204.465
Alternative 4	350	0	50	348	75	186.407
Alternative 5	100	100	100	348	100	197.702

Matrix Normalization Results

Alternative	Criteria					
	C1	C2	C3	C4	C5	C6
Alternative 1	1.00	1.00	0.50	0.85	0.50	0.88
Alternative 2	0.96	0.75	0.50	0.87	0.75	0.93
Alternative 3	0.74	0.80	0.50	1.00	0.75	0.93
Alternative 4	0.74	0	0.50	0.78	0.75	1.00
Alternative 5	0.21	0.50	1.00	0.87	1.00	0.94

Results of the Preventive Matrix

Alternative	Criteria						Result
	C1	C2	C3	C4	C5	C6	
Alternative 1	0.35	0.33	0.04	0.19	0.01	0.44	1.360
Alternative 2	0.33	0.25	0.04	0.20	0.02	0.47	1.292
Alternative 3	0.26	0.29	0.04	0.23	0.02	0.46	1.282
Alternative 4	0.26	0	0.04	0.20	0.02	0.50	1.009
Alternative 5	0.07	0.17	0.07	0.20	0.02	0.47	1.001

So the recommendation for selecting Raw Material suppliers falls on Alternative 1 with Value : 1.314

Fig 4. Results of the preventive matrix using DSS SAW Software

6. Comparison

At this stage, the comparison of the calculation results of the Simple Additive Weighting Manual with Automatic calculations. The results of manual calculations are shown in Table 5, and automatic calculations are obtained from the SAW DSS software, as shown in Figure 4.

7. Conclusion

From the description and discussion that has been explained, it can be concluded that several points are as follows: The decision support system for selecting raw materials that are built is used to determine the best alternative formula for selecting raw materials with problems. The result in the manual count is that the best alternative is Alternative 1, with a value of 1.360. And the calculation result in the system that is built is Alternative 1 with a value of 1.36, and then it is concluded that the manual and system counts are appropriate. With the existence of a decision support system for selecting raw materials, the company can provide the decision results for selecting raw materials for the best alternative formula.

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