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# Combination of Fuzzy Weighted Product and Entropy in Determining the Eligibility of Poor Rice Recipients

**Intan Zahira[1*], Sriani[2]**

[1,2*] Department of Computer Science, Faculty of Science and Technology, State Islamic University of North Sumatra

[1*]intanzahira1617@gmail.com, [2]sriani@uinsu.ac.id

**Abstract**

The Indonesian currency crisis caused a significant decline in food production. Therefore, the government attempted to launch a poverty alleviation program in the form of a social assistance program for the poor and also in the form of rice to ease the burden on poor families and increase their access to food which is very important for life. Over time, this assistance program was widely misused and more precisely the inconsistency of those receiving assistance. In order to avoid problems of inconsistency in the recipients of the assistance, a decision support system was created to facilitate determining the eligibility of recipients of poor rice assistance so that it is right on target. In determining the recipients of this social assistance, evaluation criteria are needed. The evaluation criteria required are income, age, dependents, occupation and status. Researchers developed a system that combines the weighting method (Entropy) and the decision method (Fuzzy Weighted Product) to determine recipients of social assistance. Where the data is first converted into fuzzy numbers and then processed using the decision method with the final weight in the form of the entropy weighting method. Entropy is responsible for determining the final weight automatically with its calculations. The combined method of Fuzzy Weighted Product (F-WP) and Entropy enables the optimal selection of recipients of social assistance for the poor and aims to help the development of each sub-district systematically and transparent data results in order to be fair in community life for those who receive assistance.

Keywords: Social Assistance, Fuzzy Weighted Product, Entropy



## 1. Introduction

17.508 islands inhabited by 360 ethnic groups, therefore Indonesia is rich in cultural and traditional diversity and has very beautiful natural scenery[1], Indonesia is one of the countries in the Southeast Asia region that is still developing and experiencing a long economic crisis. As a result of this economic crisis, the majority of the Indonesian population's ability to meet their clothing and food needs is decreasing [2]

Therefore, in order to realize this, the government will hold various poverty alleviation programs, namely in the form of social funds provided to the poor [3]

The rice program for poor families or known as raskin is one of the government's efforts to reduce the burden of expenditure for poor families.The raskin program is also to overcome poverty and maintain food for the less fortunate.[4] The target of this raskin program is to increase access to food for poor families to meet basic needs in order to strengthen household food security and prevent a decrease in energy and protein consumption. In the implementation of this poor rice program, problems often occur that are faced by implementers and poor people as recipients of raskin.Where many people are prosperous but receive poor rice assistance, while people who are truly in the poor category cannot get this program [4].

For this reason, a decision support system (DSS) is needed which is useful in making decisions to determine poor rice recipients with the method that will be used in this study, namely the Fuzzy Weighted Product method and development will also be carried out with a combination of the F-WP and Entropy methods to be able to find solutions and produce accurate results. [5]And what is certain is that it can help the community in seeing the results of social assistance recipients transparently and without covering anything up so that it is fair.

This research was conducted to develop previous research that used a combination method, and the final

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result only produced manual calculations not with a system. For that reason, this research created a web-based system with an XAMPP connector to perform automatic selection.

## 2. Research Methods

This study uses the Investigate And Advancement (R&D) method with a quantitative approach. The R&D method is used to produce new products or solutions and test their effectiveness. In the context of this study, the product developed is a decision support system (DSS) to determine the eligibility of poor rice recipients by combining the Fluffy Weighted Item (WP) and Entropy methods. The quantitative approach is used to collect and analyze information in the form of poor rice aid registrants to obtain rankings and measure the accuracy of the implemented method. The steps in the RnD method [6] are described as follows:

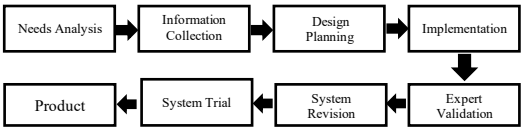


Figure 1 RnD Research Flow

### 2.1. *Needs Analysis*

Analysis means a special method for analyzing problems in cases that arise during research, in the system needs to discuss some input data needs, processes and outputs.

Input needs

The total number of data is 40 data. There are 2 variables that will be used in this study, namely Alternative (m = 40) is a poor rice social assistance registrant while Criteria (n = 5) are in the form of income, age, dependents, work and status.

Process needs

Several processes are needed to process input data into output in the form of expected information, namely first, determining the initial data where in decision making can provide values that are in accordance with namely by changing the initial data into fuzzy numbers. after that find the matrix value of each criterion in each alternative according to the decision matrix equation can be taken from the Kij decision matrix. then Calculate entropy for each criterion and Calculate dispersion for each criterion and normalize the dispersion value or can be called the final entropy weight [7] . and finally the stages of the fuzzy weighted product method, namely before determining the weight value with entropy, the data is first converted into fuzzy logic to facilitate processing and after that determine the weight value of the previous entropy and then determine the value of the S vector and the last stage is to determine the value of the V vector before selecting/ranking poor rice recipients with the weighted product method.

Output requirements

The output of the system produces a V vector value or can be called a ranking from the largest to the smallest which will be displayed in the web-based decision support system

### 2.2. *Discussion Plan*

At this stage, start collecting data that is needed to complete the research. The data needed is the record data from the social service and the data is only the requested sub-district, namely the city of Matsum I from the Medan Area sub-district.

Determining the criteria for prospective recipients of Raskin (poor rice) assistance based on the results of interviews conducted with one of the persons in charge of the social service, which we can see through the following table:

Table 1 Criteria For Total Income

| No. | Total Income (C1) |
|---|---|
| 1. | <500.000 |
| 2. | 500.000 – 1.500.000 |
| 3. | 1.500.000 – 2.000.000 |
| 4. | 2.000.000 – 3.000.000 |

Table 2 Criteria For Age

| No. | Age (C2) |
|---|---|
| 1. | 20 – 30 |
| 2. | 31 – 40 |
| 3. | 41- 50 |
| 4. | 51 – 60 |
| 5. | >61 |

Table 3 Liability Criteria

| No. | Liability (C3) |
|---|---|
| 1. | No |
| 2. | 1-2 person |
| 3. | 3-4 person |
| 4. | >4 person |

Table 4 Job Criteria

| No. | Job (C4) |
|---|---|
| 1. | Unemployed/Not working/no income |
| 2. | Self-employed/sales/laborer/driver/craftsman/coolie/casual job/houseworker |
| 3. | Private/civil servant/teacher |
| 4. | Businessman/woman |

Table 5 Status Criteria

| No. | Status (C5) |
|---|---|

| | |
|---|---|
| 1. | Marry |
| 2. | Not married / Divorced |
| 3. | Widow / Divorced died |

Source : [8]

The process of determining the weight value using the entropy method, namely calculating the entropy value for each criterion to obtain the final weight that will be used to find the S vector value in the selection method, namely Weighted Product

Selection of prospective recipients using the Fuzzy Weighted Product Method At this stage, first determine the S vector value of each alternative using the formula, second determine the V vector value of each alternative and finally make a ranking based on the V vector value.

2.3. *Entropy Method*

The Entropy method is a method for weighting the criteria included in the MCDM (Multi-Criterion Decision Making) model [9] . By using the entropy method, it can produce criteria weights for decision making and divide the criteria weight values according to the data contained in the alternatives used for decision making, the entropy method can also investigate discrimination between sets of data [10]. In addition, the entropy method can also normalize the values in each criterion, even though they have different units, qualitative or quantitative, and different value ranges. The formula for finding the matrix value from the results of normalizing the initial data before entering the entropy calculation is equations 1 and 2.

$$a_{ij} = \frac{K_{ij}}{\sum_{i=1}^{n} K_{ij}} \quad (1)$$

$$\sum_{i=1}^{n}[aij \ln(aij)] \quad (2)$$

Then for the formula of the entropy method [11] as in equation 3 and 4.

$$E_j = \frac{-1}{In\, m} \quad (3)$$

$$W_j = \frac{D_j}{\sum_{s=1}^{n} D_j} \quad j = 1, \ldots, n \quad (4)$$

2.4. *Weighted Product*

Decision support system is a computer-based information system that produces various decision alternatives to help management in handling various structured or unstructured problems using data and models. It can also be called a computer system that processes data into information to make decisions from specific semi-structured problems. [12]

Decision Support Systems (DSS) can help companies in conducting faster, more accurate, and structured analysis of available information and provide the best recommendations in choosing the right supplier [13]. Therefore, researchers choose the decision support method, namely Fuzzy weighted product, as a research experiment.

Fuzzy language is vague or vague, where a value can be true and false at the same time. Although the term is vague, it does not mean that this logic is unclear, but rather a logic that functions to provide an overview of the ambiguity that occurs. The value of the degree of membership in this logic is at a distance of 1 or 0 (yes or no) [14]. Fuzzy in this study is used in the assessment of each criterion later.

The Weighted Product (WP) method uses multiplication to relate attribute ratings, where the rating of each attribute must first be raised to the power of the relevant weight. According to [15] the preference for the alternative Ai is given by the equation 5

$$S_i = \prod_{j=1}^{n} X_{ij} w_j \quad (5)$$

The relative preference of each alternative or vector V is given by the following equation 6

$$V_i = \frac{j=\prod_{j=1}^{n}(X_{ij})^{wj}}{j=\prod_{j=1}^{n}(X_{j^*})^{wj}} \quad (6)$$

## 3. Results and Discussion

The process of calculating alternative values with the Fuzzy Weighted Product algorithm makes it easy to select a location according to the criteria desired by the user. Before showing the criteria, there is an assumption of fuzzy numbers in the weighted product method, namely that the assessment data for each alternative must first be normalized into the form of fuzzy numbers 0-1. The following Table 6 shows a table of assumptions of fuzzy numbers in the weighted product method.

Table 6 Assumptions Of Fuzzy

| Value Range | Fuzzy Range |
|---|---|
| No Feasible | 0-0,2 |
| Less Worthy | 0,3 |
| Quite Worthy | 0,4 – 0,6 |
| Worthy | 0,7- 0,8 |
| Very Worthy | 0,9-1 |

As for the fuzzy value distance curve model, to see the value distance curve for each alternative weight as follows

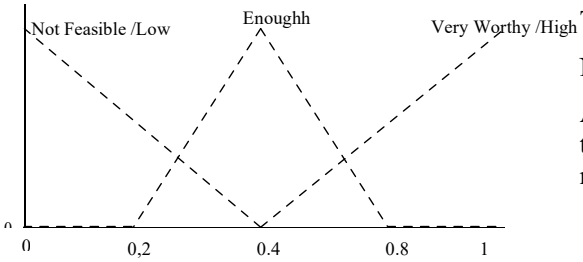


Figure 2 Fuzzy Value Range Curve

The data of social assistance recipients is first changed into fuzzy numbers according to their respective criteria, namely with the following provisions:

Table 7 Income Assessment

| Income Assessment (C1) | Value |
|---|---|
| <500.000 | 1 |
| 600.000 – 1.500.000 | 0.8 |
| 1.600.000 – 2.000.000 | 0.6 |
| 2.100.000 – 3.000.000 | 0.2 |
| >3.000.000 | 0 |

Table 8 Age Assessment

| Age Assessment (C2) | Value |
|---|---|
| 20 – 30 | 0.2 |
| 31 – 40 | 0.4 |
| 41- 50 | 0.6 |
| 51 – 60 | 0.8 |
| >61 | 1 |

Table 9 Liability Assessment

| Liability Assessment (C3) | Value |
|---|---|
| No | 0 |
| 1-2 person | 0.3 |
| 3-4 person | 0.6 |
| >4 person | 1 |

Table 10 Job Assessment

| Job Assessment (C4) | Value |
|---|---|
| Unemployed/Not working/no income | 1 |
| Self-employed/sales/laborer/driver/craftsman/coolie/casual job/houseworker | 0.6 |
| Private/civil servant/teacher | 0.4 |
| Businessman/woman | 0.2 |

Table 11 Status Assessment

| Status Assessment (C5) | Value |
|---|---|
| Marry | 0.3 |
| Not married / Divorced | 0.6 |
| Widow / Divorced died | 0.9 |

The next step is the Calculation of Entropy Weight

Normalization of the suitability rating table

According to equation (1), previously shown the data that has been converted into fuzzy numbers. then the normalization results are obtained as follows:

Table 12 Data That Has Been Normalized To Fuzzy Values

| No | Alternative | C1 | C2 | C3 | C4 | C5 |
|---|---|---|---|---|---|---|
| A1 | Puja P | 0,8 | 0,6 | 0,3 | 0,6 | 0,3 |
| A2 | Ir Fannando | 0,8 | 0,8 | 0,3 | 0,6 | 0,9 |
| A3 | Julina | 0,6 | 1 | 0,3 | 0,6 | 0,3 |
| A4 | Ramlan | 1 | 0,8 | 0,3 | 1 | 0,3 |
| A5 | Era Sartika | 1 | 0,6 | 1 | 0,6 | 0,9 |
| . | . | . | . | . | . | . |
| . | . | . | . | . | . | . |
| . | . | . | . | . | . | . |
| A40 | M Ichsan S | 1 | 0,6 | 0,6 | 1 | 0,3 |

Table 13 Normalization Data Matrix Values

| No | Alternative | C1 | C2 | C3 | C4 | C5 |
|---|---|---|---|---|---|---|
| A1 | Puja P | 0,0248 | 0,0296 | 0,0168 | 0,0225 | 0,0188 |
| A2 | Ir Fannando | 0,0248 | 0,0370 | 0,0168 | 0,0225 | 0,0566 |
| A3 | Julina | 0,0186 | 0,0296 | 0,0168 | 0,0225 | 0,0188 |
| A4 | Ramlan | 0,0310 | 0,0222 | 0,0168 | 0,0375 | 0,0188 |
| A5 | Era Sartika | 0,0310 | 0,0296 | 0,0561 | 0,0225 | 0,0566 |
| . | . | . | . | . | . | . |
| . | . | . | . | . | . | . |
| . | . | . | . | . | . | . |
| A40 | M Ichsan S | 0.0310 | 1 | 0.03370 | 0.0375 | 0.0188 |

Then calculate the entropy value of each criterion according to equation (2)

$\alpha 11 = [\alpha 11 \ln \alpha 11]$

$\alpha 11 = [0{,}0248 (\ln 0{,}0248) = -0{,}0918$

After that, each entropy value for each criterion is added up. The next step is to calculate the entropy for each i-th criterion with the equation formula (3) using a lot of data, namely m = 40.

emax = In m (40) = 3,6888

$E1 = -\frac{1}{\ln(40)} = -\frac{1}{3{,}6888} (-3{,}6038) = 0{,}9769$

Calculate the dispersion value for each criterion and normalize the dispersion value according to equation (4),

D1 = 1 – 0,9769= 0,0230

$W1 = \frac{0{,}0230}{0{,}1656} = 0{,}1390$

So that the results obtained from the entropy calculation can produce the final weight value for each criterion that will be used in the weighted product calculation. The results obtained from the entropy calculation, namely the final weight value for each criterion (C1-C5), can be seen in the following table.

Table 14 Final Weight Value Data Calculation of Criteria Entropy

| Code | Criteria | Weight |
|---|---|---|
| C1 | Penghasilan | 0,1390 |
| C2 | Usia | 0,2499 |
| C3 | Tanggungan | 0,3972 |
| C4 | Pekerjaan | 0,0531 |
| C5 | Status | 0,1605 |

Next are the steps for solving using the Weighted Product (WP) method according to equation (5), as follows:

Table 15 Result Value Vector S

| Alternative | Vektor S |
|---|---|
| A1 | 0,424231076 |
| A2 | 0,543800627 |
| A3 | 0,463092988 |
| A4 | 0,483169129 |
| A5 | 0,84220062 |
| . | . |
| . | . |
| . | . |
| A40 | 0.592193563 |

Next, determine the value of the vector V by using the value of the vector S which will later produce the highest alternative of each vector V. The following is the calculation to find the value of the vector V according to equation (6):

Table 16 Data/Vector V ranking results

| Alternative | Name | Vektor V | Information |
|---|---|---|---|
| A5 | Era Sartika | 0,044514691 | Rank 1 |
| A2 | Ir Fannando | 0.028742697 | Rank 2 |
| A4 | Ramlan | 0.025538006 | Rank 3 |
| A3 | Julina | 0.024476877 | Rank 4 |
| A1 | Puja P | 0.022422823 | Rank 5 |
| . | . | . | . |
| . | . | . | . |
| A13 | Syahri Ramadhani | 0 | Rank 40 |

Next, data testing is carried out using the system. The testing used to test the manual calculations that have been carried out is by using a web-based program. The system requirements used in the data collection of decision support systems in assessing poor rice aid recipients are Software requirements, including a.) Web as a programming language application used. b.) Xampp as a server c.) Sublime Text as a form design application and here is a display of the results of the v vector which is the final result of data processing using the system:

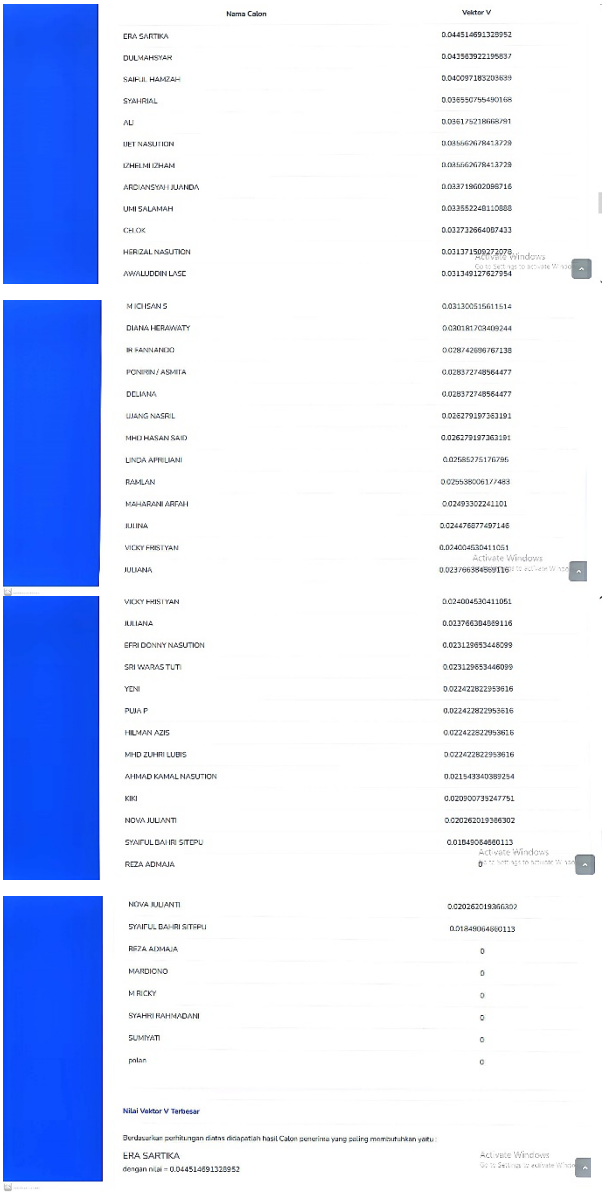


Figure 3 Overall Vector V Result On System

## 4. Conclusion

By using the entropy method for weighting, it can be determined that the most influential weight according to the processed data is the dependent (C3) where the final weighting result of entropy produces the largest number, namely 0.3972 and the smallest weight is work (C4) with several 0.0531. This means that the dependent criteria have a major influence so that poor rice recipient applicants can receive assistance.

By using both of these methods, the accuracy in

determining prospective recipients is good, this is proven by the existence of a more precise determination according to the weighting criteria of the entropy itself and is not determined selectively but according to real calculations and the fuzzy weighted product (WP) method can be used to help select recipients of poor rice social assistance. for the final result, the highest value falls on the 5th alternative, namely (A5) ERA SARTIKA. This second combination produces results sequentially from the highest to the lowest value, and has been successfully proven in this web-based aid recipient decision support system. So the admin can see and at the same time determine who is entitled to receive social assistance, and depending on the superior, how many people are needed

This study also shows the importance of fairness in processing data for social assistance recipients that are very confidential but open from the ranking results. and it is recommended to continue to develop and maintain the system so that it remains relevant and can facilitate further work.

For further development that can be done from this research is to use different weighting besides entropy methods such as Rank Order Centroid (ROC) or also besides F-WP methods such as AHP, TOPSIS and others. In addition, it can also provide a comparison of results between combination methods to see the difference in the final value results between the comparison of these methods.

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