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COMPARISON OF SAW AND WP METHODS TO DETERMINE THE BEST AGRICULTURAL LAND

SIGIT SUSANTO PUTRO*, FIRMANSYAH ADIPUTRA, EKA MALA SARI ROCHMAN, AERI RACHMAD, MUHAMMAD ALI SYAKUR, SATRIA BAYU SETA

Department of Informatics Engineering, Faculty of Engineering, University of Trunojoyo Madura, Indonesia

Abstract: Rice is a cultivated plant that is very important for human life because it produces rice in making rice. The need for food always increases this is due to the increasing human population. Therefore, rice cultivation must be maximized. Agricultural land used to grow rice greatly affects the production produced. Different characteristics in each region should be considered in selecting suitable agricultural land. The purpose of this research is to determine and map the suitable areas for rice farming in order to obtain maximum production results. The determination of the feasibility of the location of the farm is based on the assessment of the criteria owned by each region. These criteria include soil type, slope, land area, rainfall, and irrigation or water. The criteria for each area will be processed using the Simple Additive Weighting (SAW) and Weighted Product (WP) methods, the process in this method is to find the weight value for each attribute, then a ranking process is carried out which will produce an optimal alternative, namely a suitable area for agriculture. The contribution of this research is to know the comparison of the SAW method with the WP in the process of determining the best agricultural area for rice plants. In this system using the SAW method, resulting in an accuracy rate of 72%. This is better than using the WP method which only produces an accuracy rate

*Corresponding author
E-mail address: sigit.putro@trnojoyo.ac.id
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of 50%.

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1. INTRODUCTION

Agriculture has an important meaning for human life, with agriculture, food needs can be met. Food is a basic human need apart from water and air. Every year the need for food is always increasing because the human population continues to grow [1]. Rice in Latin, Oryza sativa L., is one of the important cultivated plants for human life. Rice produces rice which is the main ingredient for making rice which is the staple food of Indonesian society. So that rice plants become one of the agricultural fields that exist in almost every region in Indonesia [2].

The results of rice cultivation have an effect on the economy, both in terms of farmers' income, regional income, and labor absorption. Development in agriculture is a top priority in Indonesia. Law No. 41 of 2009, Government Regulation No. 1 of 2011 and 41 / Permentan / OT.140 / 9/2009 are urgent to do by realizing sustainable agricultural land. The world's largest rice importing country is Indonesia, at least 14% of the world's traded rice, followed by Bangladesh (4%) and Brazil (3%) [3].

Determining the location or land becomes a matter that must be considered, because each region has different natural conditions. The suitability of natural conditions and the needs of rice plants has an effect on rice production at that location. Along with the rapid development of technology, the use of technology is an efficient and effective step to overcome existing problems. Decision support system for determining the best rice planting location to determine suitable and best land for rice plants. Lack of knowledge about technology and information is one of the factors in determining the best land [4] [5].

This study discusses the application and comparison of Simple Additive Weighting (SAW) and Weighted Product (WP) to determine the best web-based rice planting location in Bangkalan Regency. The advantages of this method are easy to understand, efficient computation and the ability to make judgments more precisely because they are based on predetermined value criteria and preference weights [5]. In previous studies, the application of Simple Additive Weighting (SAW) can produce rankings ranging from the largest alternative to the smallest quality agricultural land [6]. In other studies, the results of the application of the Weighted Product (WP) method after weighting the alternatives obtained the highest value alternatives, this alternative can be used as a reference for the best land [7].

In a study entitled "Decision Support System Mapping of Quality Agricultural Land to Increase Rice Production Using the Simple Additive Weighting (SAW) Method" the assessment was carried out using the criteria of an area. The criteria for an area are soil type, rainfall, water, temperature and soil texture. Research by looking for the weight value for each attribute, then a ranking process is carried out which will determine the optimal alternative, namely areas that are suitable for agriculture [5].

Subsequent research entitled "Decision Support Systems in Determining Types of Plants on Agricultural Land Using the Simple Additive Weighting (SAW) Method" shows that the system created is supported by a ranking process that will get the best alternative from several alternatives. The results obtained from these assessments can be used to increase agricultural yields [8]."Flood-prone Areas Mapping at Semarang City by Using Simple Additive Weighting Method". This study developed a Flood Prone Area Mapping which was analyzed as local flooding. Local flooding only occurs in certain places where it rains. The criteria used are rainfall, topography, drainage, and land use. The advantage of mapping flood-prone areas is that users can easily access information about flood-prone areas [9].

Research "Decision Support System for Determining the Quality of Salt in Sumenep Madura-Indonesia" uses the Simple Additive Weighting (SAW) method. This method can support decision making to determine salt quality based on the weight of each attribute. The total score of the final results can produce a good alternative decision according to the specified criteria [10].

This study attempts to apply two methods of Simple Additive Weighting (SAW) and Weighted Product (WP). Through this research, it is hoped that the comparison of the Simple Additive

Weighting (SAW) method and the Weighted Product (WP) method in determining the location of rice planting is accurate and optimal so that it can be taken into consideration by decision makers in choosing the best land.

2. PRELIMINARIES

Decision Support Systems are interactive information systems that provide information, modeling, and data manipulation. The system is used to help decision-making in semi-structured and unstructured situations, where no one knows exactly how decisions should be made [11] [12].

A. Simple Additive Weighting (SAW)

Simple Additive Weighting (SAW) is a weighted addition method [3] [4] [10]. With the basic concept is to find the weighted sum of the performance ratings for each alternative of all attributes, to compare with all existing ratings, this method requires a decision matrix normalization process (x) [13]. The following are steps to resolve SAW [14] [15] [16] [17]:

a. A_i is an alternative.

b. C_{ji} determination criteria

c. For each criterion, a rating of the suitability of each alternative is given

d. W is the level of importance.

$$W = \begin{bmatrix} W_1 & W_2 & W_3 & \dots & W_j \end{bmatrix} \tag{1}$$

e. Create a match rating table.

f.. Make a decision X matrix based on the suitability rating table of each alternative on each criterion. The x value of each alternative (A_i) on each criterion (C_j) that has been determined, where, i = 1, 2,… m and j = 1,2,… n.

$$X = \begin{bmatrix} X_{11} & X_{12} & \cdots & X_{1j} \\ \vdots & & & \vdots \\ X_{i1} & X_{i2} & \cdots & X_{ij} \end{bmatrix} \tag{2}$$

g. Normalize the decision matrix

$$r_{ij} = \begin{cases} \dfrac{X_{ij}}{Max(X_{ij})} \\ \dfrac{Min(X_{ij})}{X_{ij}} \end{cases} \tag{3}$$

h. The results of the normalized performance rating (r_{ij}) form a normalized matrix (R)

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1j} \\ \vdots & & & \vdots \\ r_{i1} & r_{i2} & \cdots & r_{ij} \end{bmatrix} \tag{4}$$

i. The preference value (V_i) is obtained from the sum of the normalized matrix row elements (R) with the preference weight (W) corresponding to the matrix column element (W).

$$V_i = \sum_{j=1}^{n} W_j r_{ij} \tag{5}$$

j. The result of the calculation of a larger V_i value indicates that the alternative Ai is the best alternative.

B. Weighted Product (WP)

The Weighted Product method is one method that can solve the Multi Attribute Decision Making (MADM) problem. The Weighted Product method uses multiplication to relate the attribute rating, where the rating of each attribute must first be ranked with the attribute's weight.[18] The Weighted Product method is called dimensionless analysis because its mathematical structure eliminates the unit of measure [19]. The steps are carried out in the Weighted Product (WP) method, namely:

1. Normalization or Repair Weights

$$wj = \frac{wj}{\sum wj} \tag{6}$$

Normalizing or repairing weights to produce the value of $w_j = 1$ where j = 1, 2,… n is the number of alternatives and $wjwj$ is the total number of weight values.

2. Determine the Value Vector (S)

$$Si = \prod_{i}^{n} X_{ij}^{\ wj} \tag{7}$$

With i = 1, 2, ..., m and j = 1, 2, ..., n as attributes.

Information:

Π : Product

S_i : Score / value of each alternative

X_{ij} : Alternative value to attribute ke j

W_j : The weight of each attribute or criterion

n : Many Criteria

Determine the value of the vector (S) by multiplying all the criteria with the alternative results of normalization or weight improvement which are positive for the benefit criteria from those with the negative rank for the cost criterion. Where (S) is the criteria preference (x) is the criterion value and (n) is the number of criteria.

3. Relative preference of each alternative

$$Vi = \frac{\prod_i^n {x_{ij}}^{wj}}{\prod_i^n ({X_j}^*)^{wj}} \tag{8}$$

$i = 1, 2....., m$

Relative preference of each alternative Determine the value of the vector (V) where the vector (V) is the alternative preference that will be used for the ranking of each of the total vector values (S) with the sum of all vector values (S) [18].

C. Accuracy

To calculate the accuracy value using equation (9) which uses the number of correct data compared to the test data [9].

$$accuracy = \frac{\sum correct\ test\ data}{\sum total\ test\ data}\ x\ 100\% \tag{9}$$

3. MAIN RESULTS

A. Data Collection

The dataset used in this study came from the Bangkalan Regency Agriculture Office from 2017, including:

1. Land data used comes from 18 sub-districts in Bangkalan Regency can be seen in Table 1 regarding the criteria and land in Bangkalan Regency.
2. The number of criteria used is 5, namely type of soil, slope, rainfall, land area, and irrigation or water. As shown in Table 1.

Table 1. Criteria

Criteria	Land	Weighted	Value
Type of soil (C1)	Aluvial Hidromurf	Very High (VH)	5
	Litosol	Very Low (VL)	1
	Regosol	Low (L)	2
	Grumosol	Enough €	3
	Mediteran	Height (H)	4
Slope (C2)	0 – 2 %	Very High (VH)	5
	2 – 15 %	Height (H)	4
	15 – 40 %	Enough €	3
	> 40 %	Low (L)	2
Land area (C3)	< 2000 Ha	Low (L)	2
	2000<C3<3000	Enough €	3
	3000<C3<4000	Height (H)	4
	>4000 Ha	Very High (VH)	5
Rainfall (C4)		Low (L)	2
		Height (H)	4
		Very High (VH)	5
		Enough €	3
Irrigation or waters (C5)	Technical Irrigation	Very High (VH)	5
	Irrigation ½ Technical	Height (H)	4
	Simple Irrigation	Enough €	3
	Rainfed Rice Fields	Low (L)	2

B. Testing SAW method

After determining the alternatives and criteria, the steps to be taken are determining the suitability rating. This can be seen in Table 2. Then carry out the normalization stage, this can also be seen in Table 3. From this normalization, it produces a preference value, which is the final stage of the SAW method. This value can be seen in Table 4.

Table 2. Converting the input data to a match rating value

	benefit	benefit	benefit	benefit	benefit
Location (A)	**C1**	**C2**	**C3**	**C4**	**C5**
Bangkalan	5	5	3	5	5
Burneh	4	5	5	4	5
Socah	5	5	4	4	2
Kamal	5	5	3	2	2
Arosbaya	2	5	5	4	5
Klampis	3	4	3	5	5
Geger	3	3	5	4	2
Sepulu	4	4	3	2	2
Tanjung Bumi	1	3	2	3	5
Kokop	4	3	3	2	2
Blega	3	5	5	3	2
Galis	1	3	3	4	4
Modung	3	5	4	2	3
Konang	1	3	4	5	2
Kwanyar	5	5	3	5	3
Tanah Merah	5	4	5	4	4
Tragah	3	3	3	3	4
Labang	4	4	2	4	4

Table 3. Normalization of the decision matrix

Location	**C1**	**C2**	**C3**	**C4**	**C5**
Bangkalan	1	1	0,6	1	1
Burneh	0,8	1	1	0,8	1
Socah	1	1	0,8	0,8	0,4
Kamal	1	1	0,6	0,4	0,4
Arosbaya	0,4	1	1	0,8	1
Klampis	0,6	0,8	0,6	1	1
Geger	0,6	0,6	1	0,8	0,4
Sepulu	0,8	0,8	0,6	0,4	0,4
Tanjung Bumi	0,2	0,6	0,4	0,6	1
Kokop	0,8	0,6	0,6	0,4	0,4
Blega	0,6	1	1	0,6	0,4
Galis	0,2	0,6	0,6	0,8	0,8
Modung	0,6	1	0,8	0,4	0,6
Konang	0,2	0,6	0,8	1	0,4

Location	C1	C2	C3	C4	C5
Kwanyar	1	1	0,6	1	0,6
Tanah Merah	1	0,8	1	0,8	0,8
Tragah	0,6	0,6	0,6	0,6	0,8
Labang	0,8	0,8	0,4	0,8	0,8

Table 4. Preference Values

Location	V
Bangkalan	94
Burneh	91
Socah	78
Kamal	67
Arosbaya	81
Klampis	81
Geger	65
Sepulu	59
Tanjung Bumi	57
Kokop	56
Blega	67
Galis	59
Modung	65
Konang	56
Kwanyar	84
Tanah Merah	88
Tragah	65
Labang	74

C. Testing WP method

Similar to the SAW method, the WP method corrects the weight and determines the vector value S. which can be shown in Table 5.

Table 5. Vector Values

Location	S
Bangkalan	4,631191
Burneh	4,522312
Socah	3,677617
Kamal	3,066336

Arosbaya	3,802796
Klampis	3,941795
Geger	3,100013
Sepulu	2,804502
Tanjung Bumi	2,43719
Kokop	2,686055
Blega	3,159752
Galis	2,594558
Modung	3,118323
Konang	2,381928
Kwanyar	4,075966
Tanah Merah	4,373448
Tragah	3,22371
Labang	3,605002

After determining the vector value, the next thing is the final value of the preferences. Can be seen in Table 6 below.

Table 6. Preference Values

Location	V
Bangkalan	0,075669973
Burneh	0,073890973
Socah	0,060089333
Kamal	0,050101482
Arosbaya	0,062134655
Klampis	0,064405787
Geger	0,050651742
Sepulu	0,045823322
Tanjung Bumi	0,039821749
Kokop	0,043887997
Blega	0,05162784
Galis	0,042393011
Modung	0,050950918
Konang	0,038918812
Kwanyar	0,066598032
Tanah Merah	0,071458663
Tragah	0,052672851
Labang	0,05890286

D. Analysis

Testing on agricultural land is based on these two methods according to the steps described in chapter 2. The use of these five criteria is the basis for the data processing process, so that the results shown in Figure 1 and Table 7 are obtained. The matching scores in Tables 4 and 6 have been sorted from highest to lowest. From these results, the highest value becomes the highest alternative for decision makers to determine whether the best land is suitable for planting rice.

The SAW accuracy value is higher than the score on the WP. This is due to the difference in the cost and benefit values of each method. In SAW, the value of cost and benefit is in the form of Max for benefit, Min for costs in all data. Meanwhile, the weighting criteria are given based on the predetermined value and preference weights. In a weighted product the value of costs and benefits is given in the form of plus for benefit and minus for cost, on the weighted product weight for certain criteria based on the highest weighted value ranking. So that in determining the decision, the result taken as the final decision is the SAW method score based on the criteria used in data processing. So that for the end result simple additive weighting gives clearer results than weighting because it is based on predetermined value and weight preferences.

In Figure 1, it describes that the system built is able to determine suitable soil for planting rice seeds so that it can be used as a decision to determine suitable land. The highest ranking was Bangkalan District which was rated as the most suitable Subdistrict for planting rice, and Konang Subdistrict with the lowest ranking which could be rated as a Subdistrict that was not suitable for planting rice.

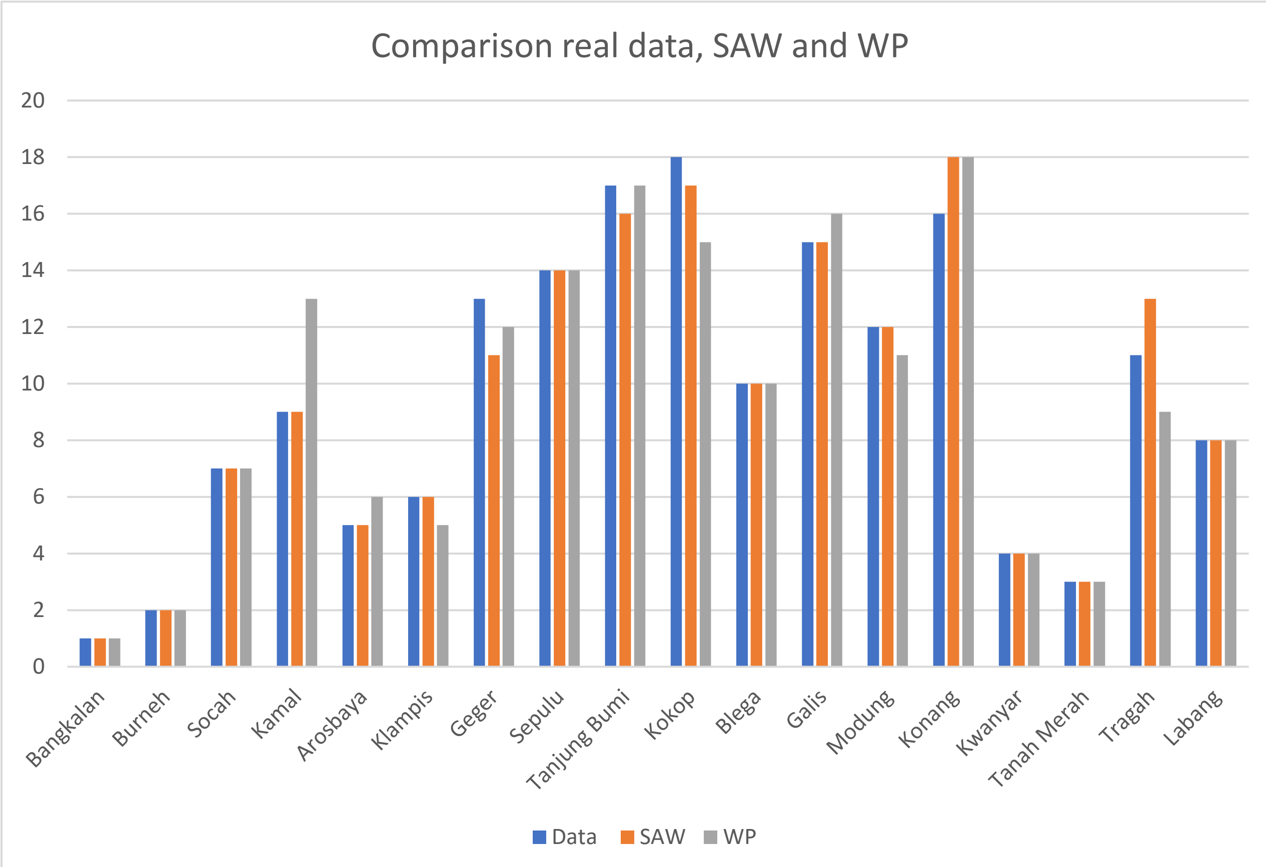

Figure 1. Comparison of system results with data

Table 7. Rank results

No	District	Data	SAW	WP
1	Bangkalan	1	1	1
2	Burneh	2	2	2
3	Socah	7	7	7
4	Kamal	9	9	13
5	Arosbaya	5	5	6
6	Klampis	6	6	5
7	Geger	13	11	12
8	Sepulu	14	14	14
9	Tanjung Bumi	17	16	17

COMPARISON OF SAW AND WP METHODS

10	Kokop	18	17	15
11	Blega	10	10	10
s12	Galis	15	15	16
13	Modung	12	12	11
14	Konang	16	18	18
15	Kwanyar	4	4	4
16	Tanah Merah	3	3	3
17	Tragah	11	13	9
18	Labang	8	8	8
	Result		**13**	**9**

Based on the accuracy calculation formula (9), in this system using the SAW method, it produces 13 correct test data divided by a total of 18 data, resulting in an accuracy rate of 72%. This thing is better than using the WP method where it only produces correct test data, only 9 of the total data, namely 18 data, amounting to 50% only.

CONCLUSION

Based on the results of research with the calculation of Simple Additive Weighting (SAW) compared to the Product Weighting Method (WP), the advantages of the SAW Method lie in its ability to make assessments more precisely and more completely because in this method there is a matrix process which is an assessment process on criteria and weights. Decision making using the SAW method gets a greater accuracy value of 72% compared to the WP method of only 50%. From the results of the research conducted, the areas that were considered the most suitable for planting rice were Bangkalan District and Konang District with the lowest rank which were considered to be less suitable districts for planting rice.

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CONFLICT OF INTERESTS

The author(s) declare that there is no conflict of interests.

REFERENCES

[1] B. Ayshwarya, F.A. Firdiansah, F.Y. Alfian, et al. The best land selection using simple additive weighting, Int. J. Recent Technol. Eng. 8 (2019), 1520-1525.

[2] D. Rosadi, I. Sidharta, Model perancangan sistem informasi dalam mendukung ketahanan pangan, Majalah Bisnis Dan Iptek, 9 (2016), 17-27.

[3] R.I. Kementrian Tanaman, Laporan Tahunan UPTD Pertanian Tanaman Pangan dan Holtikultura, (2012)

[4] N. Setiawan, M.D.T.P. Nasution, Y. Rossanty, et al. Simple additive weighting as decision support system for determining employees salary, Int. J. Eng. Technol. 7 (2018), 309-313.

[5] D. Wira Trise Putra, A. Agustian Punggara, Comparison analysis of simple additive weighting (SAW) and weigthed product (WP) in decision support systems, MATEC Web Conf. 215 (2018), 01003.

[6] D. Krisbiantoro, W.M. Baihaqi, , The Implementation of Simple Additive Weighting Method In The Selection Of Rehabilitation Fund Recipients For Uninhabitable Home, Simetris: Jurnal Teknik Mesin, Elektro dan Ilmu Komputer, 10 (2019.), 309-318.

[7] A. Khumiadi, U. Latifah, Rinawati, Taufiq, Implementasi Weighted Product Pengklasifikasian Lahan Pertanian, Ilmu Komput, 4 (2018), 13–18.

[8] W.R. Hasibuan, Sistem Pendukung Keputusan Dalam Menentukan Jenis Tanaman Pada Lahan Pertanian Dengan Menggunakan Metode Simple Additive Weighting (SAW), J. Agrium, 20 (2016), 157–162.

[9] A. Rohim, A. Iswahyudi, F. Ariyanto, Sistem Pendukung Keputusan Menentukan Tanah Yang Cocok Untuk Penanaman Sorgum Menggunakan Metode Simple Additive Weigthing (SAW), in Seminar Nasional Humaniora & Aplikasi Teknologi Informasi (2016), 76–80.

[10] Ach. Khozaimi, Y.D. Pramudita, E.M.S. Rochman, A. Rachmad, Decision Support System for Determining the Quality of Salt in Sumenep Madura-Indonesia, J. Phys.: Conf. Ser. 1477 (2020), 052057.

[11] F. Haswan, Decision Support System for Election of Members Unit Patients Pamong Praja, Int. J. Artif. Intell. Res. 1 (2017), 21-25.

[12] E. Sediyono, A. Setiawan, D.R. Kaparang, Fuzzy Simple Additive Weighting Algorithm to Determine Land Suitability for Crop in Minahasa Tenggara, Int. J. Computer Appl. 84 (2013), 26-29.

[13] R. Nurmalini, Study Approach of Simple Additive Weighting for Decision Support System, Int. J. Sci. Res. Sci. Technol. 3 (2017), 541-544.

[14] Adriyendi, Multi-Attribute Decision Making Using Simple Additive Weighting and Weighted Product in Food Choice, Int. J. Inform. Eng. Electron. Bus. 6 (2015), 8-14.

[15] N. Jaya, Perbandingan Metode SAW Dengan Metode WP Pada Sistem Seleksi, in Seminar Nasional Teknologi Informasi, Bisnis, dan Desain (2017), 369–372.

[16] A. Rachmad, M. Syakur, E. Widjaya, et al. The Selection of New Students RSBI Using Fuzzy SAW Based Application, in: Proceedings of the The 1st International Conference on Computer Science and Engineering Technology Universitas Muria Kudus, EAI, Kudus, Indonesia, 2018.

[17] A. Khozaimi, Y. Pramudita, E. Rochman, A. Rachmad, Sales Quality Determination Using Simple Additive Weighting (SAW) and Analytical Hirarki Process (AHP) Methods. J. Ilmiah Kursor, 10 (2019), 95-100.

[18] D.R. Anamisa, A. Rachmad, R. Widiastutik, Selection system of the boarding house based on fuzzy multi attribute decision making method, J. Theor. Appl. Inform. Technol. 92 (2016), 52-58.

[19] P.A. Pratomo, M. Gumanti, S. Mukodimah, Perbandingan Metode Simple Additive Weighting (SAW) dan Weighted Product (WP) Untuk Penilaian Rumah Sehat, J. Teknol. Komputer Sist. Inform. 2 (2019), 94–99.