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THE COMPARISON OF SIMPLE ADDITIVE WEIGHTING AND TOPSIS TO MEASURE THE PERFORMANCE OF THE VILLAGE HEAD IN PRINGSEWU REGENCY

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Abstract
The village has an important role in improving the national economy. A developed village will have a good impact on people's lives, both from the economy and the welfare of the community. The village head has an important role in running the government in rural areas. One of the indicators for evaluating the success rate of development and prosperity of an area is the success of a village itself so that the village or village has an important role in the process of improving development. With special autonomy regarding village development, the role of the village head becomes central and becomes the driving force for village development. To find out how well the village head is performing, it is necessary to have a breakthrough in measuring the village head's performance index in Pringsewu Regency. In measuring the performance of the Village Head, the criteria and weighting of the Simple Additive Weighting and TOPSIS methods are used. The sample was tested using eighteen villages spread across nine sub regency in the Pringsewu Regency. The application of two methods of decision support systems using Simple Additive Weighting and TOPSIS in measuring the index of Village Heads in Pringsewu Regency can trigger an increase in the performance of village heads to build the villages based on predetermined criteria. Of the eighteen alternatives tested, the highest value was A16 with a value of 0.8901508.

1.0 INTRODUCTION

Technology has an important role in life. In the current era of globalization, the development of science, information, and communication technology has developed so rapidly and increasingly the quality of human life. The position in which a nation is advanced is based on how far the nation controls the two fields above. The village head is the leader of the government at the village level. The village head is also the leader of the village administration.

Achieving the development of a village requires the role of a qualified leader to balance the demands of change towards more advanced ones.

Pekon is the spearhead of the implementation of government policies to the community and is the frontline that deals directly with the people. According to Regulation of the Minister of Home Affairs of the Republic of Indonesia Number 82 Year 2015 Article 2 concerning Appointment of Pekon Heads, which states that the head of the pekon is the head of the village government who leads the administration of the village government, carries out village development, community development, and community empowerment. Therefore, the head of the Pekon is one of the essential components in a government at the Pekon level as the leadership of the Pekon Government. Their roles, tasks, and responsibilities are very important for the progress of the Pekon so that they can create a more developed and prosperous society. To realize the function, purpose, and role of the right position, a professional and qualified head of staff is needed [1]. To find out the qualified and competent head of Pekon in carrying out his role and duties, it is necessary to measure the head of the Pekon performance index [2]. To measuring the Pekon head index by using the Fuzzy Simple Additive Weighting method and developing the system design in measuring the performance index of the Pekon head. Systems based on information technology and the internet provides many benefits for all parties.

With the reduction of the Pekon Head Index in terms of competency and performance, it can trigger performance improvement because the role of the Pekon Head is very important for the community to progress and the prosperity of the village. The method of measuring the performance index is expected so that the heads of Pekon can have better duties in carrying out the administration of Pekon, carrying out the construction of Pekon, and can foster their community. This study has a problem with how to apply the assessment criteria to measure the performance index of the Village Head in Pringsewu Regency.

Agung Romdoni's research (2014) aims to help village officials and the community to determine the ranking of prospective village heads from the results of the weights of the specified criteria so that they can provide additional information when residents will make their choices [3]. The research [4] aims to assist and facilitate in assessing the performance of lecturers based on predetermined criteria. Using the Simple Additive Weighting method to measure the performance of village heads in the performance districts of the results of the study using genital sex, how long they have been in office, facilities and infrastructure, classification of pekon according to their level of development, education, program achievements, and community welfare as indicators of assessment [5]. Siti Mukodimah (2018) uses the WP method to measure the performance of village heads in Pringsewu Regency with the alternative results A12 is the alternative chosen as the best alternative village head and is declared to meet the criteria as the best performing village head in Pringsewu Regency [6].

From some of the previous research studies mentioned above, the use of the Simple Additive Weighting method to find the weighted sum with the assessment criteria is seen more physically and academically from the village head candidate. In this study to measure the village head index of several villages in Pringsewu Regency, researchers compared two methods namely Simple Additive Weighting and TOPSIS to test the accuracy of the weighted calculation results from each method.

2.0 RESEARCH METHODS

2.1. Simple Additive Weighting Method

Method [7] Simple Additive Weighting is a weighted sum method with the basic concept of finding the weighted sum of performance ratings for each alternative for each attribute. Simple Additive Weighting completion steps[8], [9][10]–[12]:
The final results are obtained from the ranking results.

$$r_{ij} = \begin{cases} \dfrac{X_{ij}}{\underset{i}{Max}\ X_{ij}} \\ \dfrac{\underset{i}{Min}\ X_{ij}}{X_{ij}} \end{cases} \qquad (1)$$

Information:
rij = normalized performance rating value
Xij = row and column matrix
Max Xij = the greatest value of each criterion
Min Xij = the smallest value of each criterion

2.2. TOPSIS Method

The technique for Order Performance of Similarity to Ideal Solution (TOPSIS) is one of the multi-criteria criteria support systems. TOPSIS has the principle that the chosen alternative must have the shortest distance from the positive ideal solution and have the farthest distance from the negative ideal solution from a geometric point of view using the Euclidean distance (distance between two points) to determine the relative proximity of an alternative.

Steps to solve MADM problems with TOPSIS [13]–[18] :

a. Make a normalized decision matrix.
b. Make a normalized weighted decision matrix.
c. Determine the positive ideal solution matrix & the negative ideal solution matrix.
d. Determine the distance between the values of each alternative with the positive ideal solution matrix & the negative ideal solution matrix.
e. Determine the preference value for each alternative.

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad (2)$$

i=1,2,….m; and j=1,2,….n. The positive ideal solution A + and the negative ideal solution A- can be determined based on the normalized weight rating (yij) as:

$$y_{ij} = w_i r_{ij} \quad (3)$$

With i=1,2,….m; and j=1,2,…..n.

TOPSIS requires a performance rating of each Ai alternative on each normalized Cj criteria, namely:

$$A^+ = (y_1^+, y_2^+, \cdots, y_n^+);$$

$$A^- = (y_1^-, y_2^-, \cdots, y_n^-); \quad (4)$$

$$y_j^+ = \begin{cases} \max_i y_{ij}; & \textit{jika}\ \text{j adalah atribut keuntungan} \\ \min_i y_{ij}; & \text{jika j adalah atribut biaya} \end{cases}$$

$$y_j^- = \begin{cases} \min_i y_{ij}; & \textit{jika}\ \text{j adalah atribut keuntungan} \\ \max_i y_{ij}; & \text{jika j adalah atribut biaya} \end{cases} \quad (5)$$

The distance between the Ai alternatives and the positive ideal solution is formulated as:

$D_i^+ = \sqrt{\sum_{j=1}^{n} (y_1^+ - y_{ij})^2}$; i = 1,2,…….,m

The distance between the alternative Ai with the negative ideal solution is formulated as:

$D_i^- = \sqrt{\sum_{j=1}^{n} (y_{ij} - y_i^-)^2}$; i =1,2,…….,m

Determine the preference value for each alternative:

$V_i = \frac{D_i^-}{D_i^- + D_i^+}$; i=1,2,…,m.

2.3. Weight Used as a Comparison

In this study, there are weights and criteria needed to determine village heads who carry out their obligations seriously. The criteria are:

Table1. Research Criteria

Code	Criteria	Information
C1	Gender	
C2	Long served	Benefit
C3	Facilities and infrastructure	Benefit

C4	Pekon classification based on development level	Benefit
C5	Education	Benefit
C6	Achievement program	Benefit
C7	Public welfare	Benefit

3.0 RESULANTS AND DISCUSSION

3.1. Calculation of Criteria Weight

The method of calculating the simple additive weighting method is the result of the village head data input process that has been changed based on the criteria weights that have been determined through the calculation process.

Table2. Gender Criteria

Gender	Value
Ladies	1
Gentleman	1

Table3. Criteria for How Long Served

Long Served	Value
1-2 Year	0,2
2-3 Year	0,4
3-4 Year	0,6
4-5 Year	0,8
5-6 Year	1

Table4. Criteria for Facilities and Infrastructure

Facilities and Infrastructure	Value
Not good	0,2
Pretty good	0,6
Good	0,8
Very Good	1

Table5. Criteria for the Growth Level of Pekon

Facilities and Infrastructure	Value
Not good	0,2
Pretty good	0,6
Good	0,8
Very Good	1

Table 6. Education Criteria

Facilities and infrastructure	Value
Diploma 1	0,4
Diploma 2	0,6
Diploma 3	0,8
S1	1

Table 7. Criteria for Program Achievement

Program Achievement	Value
Not suitable	0,2
Quite appropriate	0,6
Corresponding	0,8
Very appropriate	1

Table 9. Community Welfare Criteria

Public Welfare	Value
Very low	0,2
Low	0,4
Enough	0,6
High	0,8
Very high	1

Table 10. Weight of Each Criteria

Criteria	Value
C1	0,10
C2	0,10
C3	0,15
C4	0,20
C5	0,10
C6	0,15
C7	0,20

From the existing criteria then weighted then made variables that will be converted into fuzzy numbers whose value weights are as follows:
Very low (SR) = 0, Low (R) = 0,2, Medium (S) = 0,4, The middle (T1) = 0,6, High (T2) = 0,8, Very high (ST) = 1

To get this variable a graph is made like in the picture:

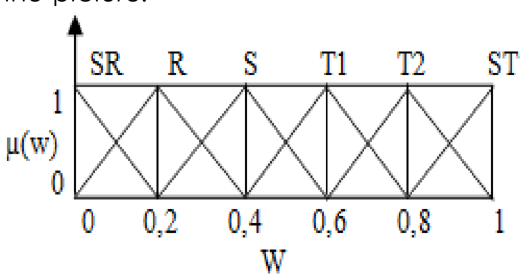

Figure2. Assessment Weight [7]

Table11. Alternative Weighting of Each Criteria

Sub Regency		C1	C2	C3	C4	C5	C6	C7
Sub Regency 1	A1	1	0,2	0,6	0,6	0,8	0,2	0,6
	A2	1	0,6	0,8	0,8	1	1	0,8
Sub Regency 2	A3	1	0,4	0,6	0,8	0,6	0,6	0,6
	A4	1	0,8	0,8	0,6	0,8	1	0,8
Sub Regency 3	A5	1	0,4	0,2	0,2	0,4	0,6	0,6
	A6	1	1	0,6	0,6	0,8	0,6	0,8
Sub Regency 4	A7	1	0,2	0,6	0,2	0,6	0,6	0,4
	A8	1	0,6	0,2	0,2	0,4	0,2	0,4
Sub Regency 5	A9	1	0,8	0,8	0,6	0,8	0,8	0,8
	A10	1	0,4	0,8	0,6	0,8	0,6	0,4
Sub Regency 6	A11	1	1	0,6	0,6	0,8	1	0,6
	A12	1	0,4	0,8	0,6	0,6	0,8	0,6
Sub Regency 7	A13	1	0,8	0,2	0,2	0,6	0,6	0,6
	A14	1	0,4	0,6	0,6	0,8	1	0,4
Sub Regency 8	A15	1	1	0,6	0,8	0,8	0,6	0,6
	A16	1	1	0,8	0,8	1	0,8	0,8
Sub Regency 9	A17	1	0,4	0,8	0,6	0,8	0,8	0,6
	A18	1	1	0,6	0,6	0,8	0,6	0,6

Calculation
Normalization for Each Matrix
Criteria Benefit (C1,C2,C3,C4,C5)
Rii = (Xij/max {Xij}

Table12. Normalized Factor Results

	C1	C2	C3	C4	C5	C6	C7
A1	1	0,2	0,75	0,75	0,8	0,2	0,75
A2	1	0,6	1	1	1	1	1
A3	1	0,4	0,75	1	0,6	0,6	0,75
A4	1	0,8	1	0,75	0,8	1	1
A5	1	0,4	0,25	0,25	0,4	0,6	0,75
A6	1	1	0,75	0,75	0,8	0,6	1
A7	1	0,2	0,75	0,25	0,6	0,6	0,5
A8	1	0,6	0,25	0,25	0,4	0,2	0,5
A9	1	0,8	1	0,75	0,8	0,8	1
A10	1	0,4	0,5	0,75	0,8	0,6	0,5
A11	1	1	1,25	0,75	0,8	1	0,75
A12	1	0,4	1	0,75	0,6	0,8	0,75
A13	1	0,8	0,25	0,25	0,6	0,6	0,75
A14	1	0,4	0,75	0,75	0,8	1	0,5
A15	1	1	0,75	1	0,8	0,6	0,75
A16	1	1	1	1	1	0,8	1
A17	1	0,4	1	0,75	0,8	0,8	0,75
A18	1	1	0,75	0,75	0,8	0,6	0,75

y multiplying each column of the table with the weight of the criteria declared. With the equation the preference value for each alternative (Vi):

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

Vi = Preference value
Wj = Rating weights
rij = Normalized performance rating value

Table13. Manual Test Results

Result			Rank
Sub Regency 1	A1	0,6425	13
	A2	0,96	2
Sub Regency 2	A3	0,7525	11
	A4	0,91	4
Sub Regency 3	A5	0,5075	17
	A6	0,8325	6
Sub Regency 4	A7	0,5325	16
	A8	0,4175	18
Sub Regency 5	A9	0,88	5
	A10	0,635	14
Sub Regency 6	A11	0,9175	3
	A12	0,77	10
Sub Regency 7	A13	0,5675	15
	A14	0,7325	12
Sub Regency 8	A15	0,8325	6
	A16	0,97	1
Sub Regency 9	A17	0,79	8
	A18	0,7825	9

The normalizing equation for attribute values to form a normalized matrix (R) and multiplication between weights and values for each attribute to form a matrix (Y), is done using the following equation:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i-1}^{m} x_{ij}^2}};$$

Square	**18**	**8,68**	**7,48**	**6,32**	**10,16**	**9,52**	**7,08**
Root	4,242641	2,946184	2,73495887	2,51396102	3,187475	3,0854497	2,6608269

From the calculation results above, the normalized matrix is obtained (R):

Table14. Normalized Matrix R

Normalized Matrix R		C1	C2	C3	C4	C5	C6	C7
	A1	0,235702	0,0678844	0,21938173	0,23866719	0,250982	0,0648204	0,2254938
	A2	0,235702	0,2036533	0,29250897	0,31822291	0,313728	0,3241019	0,3006584
	A3	0,235702	0,1357688	0,21938173	0,31822291	0,188237	0,1944611	0,2254938
	A4	0,235702	0,2715377	0,29250897	0,23866719	0,250982	0,3241019	0,3006584
	A5	0,235702	0,1357688	0,07312724	0,07955573	0,125491	0,1944611	0,2254938
	A6	0,235702	0,3394221	0,21938173	0,23866719	0,250982	0,1944611	0,3006584
	A7	0,235702	0,0678844	0,21938173	0,07955573	0,188237	0,1944611	0,1503292
	A8	0,235702	0,2036533	0,07312724	0,07955573	0,125491	0,0648204	0,1503292
	A9	0,235702	0,2715377	0,29250897	0,23866719	0,250982	0,2592815	0,3006584

A10	0,235702	0,1357688	0,29250897	0,23866719	0,250982	0,1944611	0,1503292
A11	0,235702	0,3394221	0,21938173	0,23866719	0,250982	0,3241019	0,2254938
A12	0,235702	0,1357688	0,29250897	0,23866719	0,188237	0,2592815	0,2254938
A13	0,235702	0,2715377	0,07312724	0,07955573	0,188237	0,1944611	0,2254938
A14	0,235702	0,1357688	0,21938173	0,23866719	0,250982	0,3241019	0,1503292
A15	0,235702	0,3394221	0,21938173	0,31822291	0,250982	0,1944611	0,2254938
A16	0,235702	0,3394221	0,29250897	0,31822291	0,313728	0,2592815	0,3006584
A17	0,235702	0,1357688	0,29250897	0,23866719	0,250982	0,2592815	0,2254938
A18	0,235702	0,3394221	0,21938173	0,23866719	0,250982	0,1944611	0,2254938

After the normalized matrix (R) is obtained, then look for the matrix V based on the equation:
$V_{ij} = W_j X_{ij}$ (2)

From calculations using the formula above, a matrix is obtained Y

Table15. Normalized Matrix Y

Normalized Matrix Yij	Wj	0,1	0,1	0,15	0,2	0,1	0,15	0,2
	V1	0,02357	0,0067884	0,03290726	0,04773344	0,025098	0,0097231	0,0450988
	V2	0,02357	0,0203653	0,04387635	0,06364458	0,031373	0,0486153	0,0601317
	V3	0,02357	0,0135769	0,03290726	0,06364458	0,018824	0,0291692	0,0450988
	V4	0,02357	0,0271538	0,04387635	0,04773344	0,025098	0,0486153	0,0601317
	V5	0,02357	0,0135769	0,01096909	0,01591115	0,012549	0,0291692	0,0450988
	V6	0,02357	0,0339422	0,03290726	0,04773344	0,025098	0,0291692	0,0601317
	V7	0,02357	0,0067884	0,03290726	0,01591115	0,018824	0,0291692	0,0300658
	V8	0,02357	0,0203653	0,01096909	0,01591115	0,012549	0,0097231	0,0300658
	V9	0,02357	0,0271538	0,04387635	0,04773344	0,025098	0,0388922	0,0601317
	V10	0,02357	0,0135769	0,04387635	0,04773344	0,025098	0,0291692	0,0300658
	V11	0,02357	0,0339422	0,03290726	0,04773344	0,025098	0,0486153	0,0450988
	V12	0,02357	0,0135769	0,04387635	0,04773344	0,018824	0,0388922	0,0450988
	V13	0,02357	0,0271538	0,01096909	0,01591115	0,018824	0,0291692	0,0450988
	V14	0,02357	0,0135769	0,03290726	0,04773344	0,025098	0,0486153	0,0300658
	V15	0,02357	0,0339422	0,03290726	0,06364458	0,025098	0,0291692	0,0450988
	V16	0,02357	0,0339422	0,04387635	0,06364458	0,031373	0,0388922	0,0601317
	V17	0,02357	0,0135769	0,04387635	0,04773344	0,025098	0,0388922	0,0450988
	V18	0,02357	0,0339422	0,03290726	0,04773344	0,025098	0,0291692	0,0450988

The positive (A +) and Negative (A-) ideal solutions are calculated based on the equation
$A^+ = (y_1^+, y_2^+, \ldots\ldots y_n^+)$ and $A^- = (y_1^-, y_2^-, \ldots\ldots y_n^-)$

Max (Y+)/ The Positive Ideal Solution	**0,02357**	**0,0339422**	**0,04387635**	**0,06364458**	**0,031373**	**0,0486153**	**0,0601317**
Min (Y-)/ The Negative Ideal Solution	0,02357	0,0067884	0,01096909	0,01591115	0,012549	0,0097231	0,0300658

The distance between the weighted values of each alternative to the Positive and Negative ideal solutions are calculated based on the equation:

$D_i^+ = \sqrt{\sum_{j=1}^{n}(y_1^+ - y_{ij})^2}$; i = 1,2,...,m. and $D_i^- = \sqrt{\sum_{j=1}^{n}(y_{ij} - y_i^-)^2}$; i = 1,2,...,m.

Table16. The distance of Positive and Negative Ideal Solutions

	+	-
D1	0,002889	0,0018774
D2	0,000184	0,0063166
D3	0,001297	0,0034494
D4	0,000339	0,0050843
D5	0,004735	0,0006502

D6	0,000791	0,0036709
D7	0,004576	0,0008988
D8	0,006317	0,0001843
D9	0,000433	0,0044226
D10	0,001989	0,0026773
D11	0,000639	0,0041273
D12	0,001146	0,0032578
D13	0,004169	0,0010583
D14	0,001732	0,0032101
D15	0,000764	0,0042587
D16	9,45E-05	0,0062078
D17	0,001028	0,0033759
D18	0,001017	0,0029929

The proximity of each alternative to the ideal solution is calculated based on the equation:

$V_i = \frac{D_i^-}{D_i^- + D_i^+}$; i=1,2,…,m.

Table17. Positive and Negative Root Tables

Root +	Root -	(+)+(-)	Value
0,05374734	0,0433291	0,097076	0,44634
0,01357688	0,07947698	0,093054	0,8540965
0,03600955	0,05873123	0,094741	0,619915
0,01840156	0,07130451	0,089706	0,7948682
0,06880833	0,02549947	0,094308	0,2703856
0,02812484	0,06058758	0,088712	0,6829661
0,06764403	0,02998007	0,097624	0,307097
0,07947698	0,01357688	0,093054	0,1459035
0,02081239	0,06650239	0,087315	0,7616396
0,04460255	0,05174225	0,096345	0,5370529
0,02527537	0,0642444	0,08952	0,717656
0,03385141	0,05707739	0,090929	0,6277152
0,06456835	0,03253086	0,097099	0,335027
0,04161198	0,05665783	0,09827	0,5765538
0,02763749	0,06525881	0,092896	0,7024909
0,00972306	0,07878973	0,088513	0,8901508
0,03205944	0,05810282	0,090162	0,6444251
0,03189037	0,0547073	0,086598	0,6317411

Table18. TOPSIS Ranking Results

Alternative	Result	Rank
A1	0,44634	14
A2	0,8540965	2
A3	0,619915	11
A4	0,7948682	3
A5	0,2703856	17
A6	0,6829661	7
A7	0,307097	16
A8	0,1459035	18
A9	0,7616396	4
A10	0,5370529	13
A11	0,717656	5
A12	0,6277152	10
A13	0,335027	15
A14	0,5765538	12
A15	0,7024909	6

A16	0,8901508	1
A17	0,6444251	8
A18	0,6317411	9

Table19. Comparison of test results for the SAW Method and TOPSIS

Result (SAW)			**Rank**	**Result (TOPSIS)**	**Rank**
Sub Regency 1	A1	0,6425	13	0,44634	14
	A2	0,96	2	0,8540965	2
Sub Regency 2	A3	0,7525	11	0,619915	11
	A4	0,91	4	0,7948682	3
Sub Regency 3	A5	0,5075	17	0,2703856	17
	A6	0,8325	6	0,6829661	7
Sub Regency 4	A7	0,5325	16	0,307097	16
	A8	0,4175	18	0,1459035	18
Sub Regency 5	A9	0,88	5	0,7616396	4
	A10	0,635	14	0,5370529	13
Sub Regency 6	A11	0,9175	3	0,717656	5
	A12	0,77	10	0,6277152	10
Sub Regency 7	A13	0,5675	15	0,335027	15
	A14	0,7325	12	0,5765538	12
Sub Regency 8	A15	0,8325	6	0,7024909	6
	A16	0,97	1	0,8901508	1
Sub Regency 9	A17	0,79	8	0,6444251	8
	A18	0,7825	9	0,6317411	9

The table shows the results of calculations using two methods, SAW and TOPSIS. From the table, it can be seen that the results of calculations using the comparison of two methods show that there is not much difference, it proves that the SAW method can be combined using the TOPSIS method or vice versa in the performance evaluation of the head of the Pekon in Pringsewu Regency.

4.0 CONCLUSION

The application of two methods of decision support systems using Simple Additive Weighting and TOPSIS in measuring the index of Village Heads in Pringsewu Regency can trigger an increase in the performance of village heads to build their villages based on predetermined criteria. Of the eighteen alternatives tested that obtained the highest value was A16.

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