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A COMPARATIVE ANALYSIS OF SIMPLE ADDITIVE WEIGHTING, WEIGHTED PRODUCT, AND SIMPLE MULTI-ATTRIBUTE RATING TECHNIQUES FOR SELECTING TOURIST DESTINATIONS (A CASE STUDY IN MAGELANG REGENCY)

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ABSTRACT

The large number of tourist destinations in Magelang Regency forces tourists to choose which destinations they will visit. The numerous criteria in selecting tourist destinations makes it increasingly difficult for tourists to determine which destinations they will visit. Therefore, a decision support system is needed to help tourists more effectively and efficiently in determining which tourist destinations they will visit. This study uses the Weighted Product (WP), Simple Additive Weighting (SAW), and Simple Multi-Attribute Rating Technique (SMART) methods. These three methods are then compared to determine which method is most appropriate. SAW, WP, and SMART produce identical rankings between methods, indicating consistent modeling quality. This consistency strengthens the validity of the decision results. From the comparison between the SAW, WP, and SMART methods, the total percentage of the SAW method is 99.9934%, greater than the WP and SMART methods with a percentage of 99.9933%. This shows that the data structure, criteria weights, and value ranges between alternatives are relatively uniform, so that the linear (SAW), geometric (WP), and utility-based (SMART) methods produce equivalent decision patterns to solve the problem of determining tourist destinations in Magelang.

ABSTRAK

Banyaknya destinasi wisata di Kabupaten Magelang membuat wisatawan harus memilih destinasi yang akan mereka kunjungi. Banyaknya kriteria dalam memilih destinasi wisata membuat wisatawan semakin sulit dalam menentukan destinasi mana yang akan mereka kunjungi. Oleh karena itu, diperlukan sebuah sistem pendukung keputusan untuk membantu wisatawan agar lebih efektif dan efisien dalam menentukan destinasi wisata yang akan mereka kunjungi. Penelitian ini menggunakan metode Weighted Product (WP), Simple Additive Weighting (SAW), dan Simple Multi – Attribute Rating Technique (SMART). Ketiga metode ini kemudian dibandingkan untuk mengetahui metode mana yang paling tepat. SAW, WP, dan SMART ini menghasilkan peringkat ranking antar-metode yang identik, menunjukkan kualitas pemodelan yang konsisten. Konsistensi ini memperkuat validitas hasil keputusan. Dari perbandingan antara metode SAW, WP, dan SMART diperoleh total prosentase metode SAW sebesar 99.9934% lebih besar dibandingkan dengan metode WP dan SMART dengan prosentase sebesar 99.9933%. hal ini menunjukkan bahwa bahwa struktur data, bobot kriteria, dan rentang nilai antar-alternatif relatif seragam, sehingga metode linier (SAW), geometrik (WP), dan utility-based (SMART) menghasilkan pola keputusan yang setara untuk menyelesaikan permasalahan penentuan destinasi wisata di Magelang.

Kata kunci : *Sistem Pendukung Keputusan, Weighted Product* (WP), *Simple Additive Weighting* (SAW), dan *Simple Multi – Attribute Rating Technique* (SMART)*, wisata Kabupaten Magelang*

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1. Introduction

Tourism is a popular activity among many people today, and it is even a crucial need for modern society. Tourism is a promising socio-economic and industrial activity for the future (Wardhani & Anindyaputri, 2020). Tourism in Magelang can provide additional regional revenue. Magelang boasts numerous beautiful and attractive tourist attractions, attracting local, national, and international tourists. However, the sheer number of tourist destinations in Magelang makes it difficult for tourists to decide which ones to visit. Furthermore, the lack of information about tourist destinations and the differing criteria for each destination further confuse tourists. This decision support system for determining tourist destinations is expected to provide quick and accurate information about tourist attractions, assisting tourists in selecting the destinations they wish to visit based on their needs.

To support the development of tourist attractions and address issues in decision-making, the Decision Support System method is used (Lutfi MA, 2024). A Decision Support System (DSS) is an interactive computer-based system that helps decision-makers utilize data and models to solve problems (Nur et al., 2013).

The purpose of this study was to compare the Weighted Product (WP), Simple Additive Weighting (SAW), and Simple Multi-Attribute Rating Technique (SMART) methods in a decision support system for determining tourist destinations in Magelang. This study aimed to evaluate and compare the effectiveness of these three methods in providing optimal tourist destination recommendations. This study aimed to determine which method was more appropriate and accurate for determining tourist destinations based on predetermined criteria: ticket price, distance from the city center, cleanliness, facilities, and road access.

2. Research Methods

A Decision Support System (DSS) is an interactive computer-based system that helps decision-makers utilize data and models to solve problems (Bachtiar et al., 2021). A DSS consists of three main components: model management, data management, and interface. There are four phases in developing a decision support system: intelligence, design, choice, and implementation (Lutfi et al., 2023).

The methods used in this research are the SAW method, the WP method, and the SMART method. The Weighted Product (WP) method is a decision-making method that uses multiplication to connect attribute ratings. The rating for each attribute must first be raised to the power of the corresponding attribute's weight (Theresia Solot Diri1, Erfanti Fatkiyah2, 2022).

The Simple Additive Weighting (SAW) method is a method for finding the weighted sum of the performance ratings for each alternative across all attributes. The SAW method requires normalizing the decision matrix (X) to a scale that can be compared across all available alternative ratings. This method is the most well-known and widely used method for dealing with Multiple Attribute Decision Making (MADM) situations (Pakpahan et al., 2023).

The Simple Multi-Attribute Rating Technique (SMART) method is a multi-criteria decision-making method developed by Edward in 1977. SMART is a multi-criteria decision-making method based on the theory that each alternative consists of several criteria that have values, and each criterion has a weight that reflects its importance compared to other criteria (Lutfi MA, 2025) This weighting is used to assess each alternative to obtain the best alternative (Haki et al., 2021).

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3. Results and Discussion

3.1 Research Results

The SAW, WP, and SMART methods will be used to solve this problem, and then compared to find the best method as a solution (Lutfi MA, 2025). In this case, there are 5 criteria (C) that are used as a reference in decision-making, as can be seen in Table 1 below:

Table 1. *Criteria for Selecting Tourist Destinations in Magelang*

NO	Criteria	Criteria Name
1.	C1	Ticket Price
2.	C2	Distance from City Center
3.	C3	Cleanliness
4.	C4	Facilities
5.	C5	Road Access

Table 2. *Tourist attractions surveyed*

Kode	Keterangan
A01	Ketep Pass
A02	Silanjur Highland
A03	Candi Borobudur
A04	Mangli Skyview
A05	Gunung Andong
A06	Negeri Kahyangan

The next step will be to assign a value/weight to each alternative for each predetermined criterion, these criteria include:

a. Ticket Prices
Ticket pricing criteria can be seen in Table 3 below:

Table 3. *Ticket Price Criteria*

Criteria	Range	Value
Ticket Prices	Cheap (0 – 10,000)	4
	Fairly Expensive (11,000 – 24,000)	3
	Expensive (25,000 – 50,000)	2
	Very Expensive (50,000 and above)	1

b. Distance from the City Center
The security criteria can be seen in Table 4 below :

Table 4. *Distance Criteria from City Center:*

Criteria	Range	Value
Distance from the City Center	Near (0 – 10 km)	4
	Far enough (11 – 19 km)	3
	Far away (20 – 30 km)	2

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Very far (31 km and above)	1

c. Cleanliness
Cleanliness criteria can be seen in Table 5 below:
- Clean : A waste disposal area is available.
- Unclean : No waste disposal area is available.

Table 5. *Cleanliness Criteria*

Criteria	Range	Value
Cleanliness	Not Clean	1
	Clean	4

d. Facilities
The facilities criteria can be seen in Table 6 below:

Table 6. *Facilities Criteria*

Criteria	Range	Value
Facilities	Incomplete (Parking)	1
	Fairly Complete (Parking, Restrooms)	2
	Complete (Parking, Restrooms, Cafeteria)	3
	Very Complete (Parking, Restrooms, Cafeteria, Prayer Room)	4

e. Road Access
Road Access Criteria can be seen in Table 7 below:

Table 7. *Road Access Criteria*

Criteria	Range	Value
Road Access	Footpath	1
	Rocky	2
	Concrete	3
	Asphalt	4

The next step is to determine the weight of each criterion. The table below shows the priority weights for each criterion.

Table 8. *Weight of Each Criteria*

Kriteria	**Bobot**
C1	4
C2	2
C3	1
C4	4
C5	3

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3.1.1 Calculation Results Using the SAW Method

The following tourism data can be seen in the following table:

Table 8. *Tourism Data*

No	Alternative	Kriteria				
		C1	C2	C3	C4	C5
1.	A01	12.500	18 KM	There's a Trash Can	Parking, Restrooms, Cafeteria, Prayer Room	Concrete Roads
2.	A02	10.000	15 KM	There's a Trash Can	Parking, Restrooms, Cafeteria	Concrete Roads
3.	A03	50.000	14 KM	There's a Trash Can	Parking, Restrooms, Cafeteria, Prayer Room	Asphalt Roads
4.	A04	15.000	1 KM	There's a Trash Can	Parking, Restrooms, Cafeteria	Asphalt Roads
5.	A05	10.000	20 KM	There's a Trash Can	Parking, Restrooms, Cafeteria	Concrete Roads
6.	A06	10.000	20 KM	There's No Trash Can	Parking, Restrooms, Cafeteria	Concrete Roads

Table 9. *Converted Tourism Data*

No	Altern ative	Kriteria				
		C1	C2	C3	C4	C5
1.	A01	C. Expensive	C. Far	Clean	S. Complete	Concrete Roads
2.	A02	Cheap	B. Far	Clean	Complete	Concrete Roads
3.	A03	S. Expensive	C. Far	Clean	S. Complete	Asphalt Roads
4.	A04	C. Expensive	Near	Clean	Complete	Asphalt Roads
5.	A05	Cheap	Far	T. Clean	Complete	Concrete Roads
6.	A06	Cheap	Far	Clean	Complete	Concrete Roads

Based on the data above, a decision matrix X can be formed that has been converted into fuzzy numbers , as in the following table:

Table 10. *Suitability Rating*

No	Alternative	Kriteria				
		C1	C2	C3	C4	C5
1.	A01	3	3	4	4	3
2.	A02	4	3	4	3	3
3.	A03	1	3	4	4	4
4.	A04	3	4	4	3	4
5.	A05	4	2	1	3	3
6.	A06	4	2	4	3	3

So the decision matrix X, which is made based on Table 10 is as follows:

$$\begin{bmatrix} 3 & 3 & 4 & 4 & 3 \end{bmatrix}$$

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$$\mathbf{X} = \begin{vmatrix} 4 & 3 & 4 & 3 & 3 \\ 1 & 3 & 4 & 4 & 4 \\ 3 & 4 & 4 & 3 & 4 \\ 4 & 2 & 1 & 3 & 3 \\ 4 & 2 & 4 & 3 & 3 \end{vmatrix}$$

Then below are the calculation results for each of the criteria (C) :

C1

$R_{11}= \frac{3}{\max(3,4,1,3,4,4)} = \frac{3}{4} = 0.75$

$R_{12}= \frac{3}{\max(3,3,3,4,2,2)} = \frac{3}{4} = 0.75$

$R_{13}= \frac{4}{\max(4,4,4,4,1,4)} = \frac{4}{4} = 1$

$R_{14}= \frac{4}{\max(4,3,4,3,3,3)} = \frac{4}{4} = 1$

$R_{15}= \frac{3}{\max(3,3,4,4,3,3)} = \frac{3}{4} = 0.75$

C2

$R_{21}= \frac{4}{\max(3,4,1,3,4,4)} = \frac{4}{4} = 1$

$R_{22}= \frac{3}{\max(3,3,3,4,2,2)} = \frac{3}{4} = 0.75$

$R_{23}= \frac{4}{\max(4,4,4,4,1,4)} = \frac{4}{4} = 1$

$R_{24}= \frac{3}{\max(4,3,4,3,3,3)} = \frac{3}{4} = 0.75$

$R_{25}= \frac{3}{\max(3,3,4,4,3,3)} = \frac{3}{4} = 0.75$

C3

$R_{31}= \frac{1}{\max(3,4,1,3,4,4)} = \frac{1}{4} = 0.25$

$R_{32}= \frac{3}{\max(3,3,3,4,2,2)} = \frac{3}{4} = 0.75$

$R_{33}= \frac{4}{\max(4,4,4,4,1,4)} = \frac{4}{4} = 1$

$R_{34}= \frac{4}{\max(4,3,4,3,3,3)} = \frac{4}{4} = 1$

$R_{35}= \frac{4}{\max(3,3,4,4,3,3)} = \frac{4}{4} = 1$

C4

$R_{41}= \frac{3}{\max(3,4,1,3,4,4)} = \frac{3}{4} = 0.75$

$R_{42}= \frac{4}{\max(3,3,3,4,2,2)} = \frac{4}{4} = 1$

$R_{43}= \frac{4}{\max(4,4,4,4,1,4)} = \frac{4}{4} = 1$

$R_{44}= \frac{3}{\max(4,3,4,3,3,3)} = \frac{3}{4} = 0.75$

$R_{45}= \frac{4}{\max(3,3,4,4,3,3)} = \frac{4}{4} = 1$

C5

$R_{51}= \frac{4}{\max(3,4,1,3,4,4)} = \frac{4}{4} = 1$

$R_{52}= \frac{2}{\max(3,3,3,4,2,2)} = \frac{2}{4} = 0.5$

$R_{53}= \frac{1}{\max(4,4,4,4,1,4)} = \frac{1}{4} = 0.25$

$R_{54}= \frac{3}{\max(4,3,4,3,3,3)} = \frac{3}{4} = 0.75$

$R_{55}= \frac{3}{\max(3,3,4,4,3,3)} = \frac{3}{4} = 0.75$

C6

$R_{61}= \frac{4}{\max(3,4,1,3,4,4)} = \frac{4}{4} = 1$

$R_{62}= \frac{2}{\max(3,3,3,4,2,2)} = \frac{2}{4} = 0.5$

$R_{63}= \frac{4}{\max(4,4,4,4,1,4)} = \frac{4}{4} = 1$

$R_{64}= \frac{3}{\max(4,3,4,3,3,3)} = \frac{3}{4} = 0.75$

$R_{65}= \frac{3}{\max(3,3,4,4,3,3)} = \frac{3}{4} = 0.75$

The table below shows the results of the calculation process for each criterion (C) :

Table 11. *Suitability Rating*

No	Alternative	Kriteria				
		C1	C2	C3	C4	C5
1.	A01	0.75	0.75	1	1	0.75
2.	A02	1	0.75	1	0.75	0.75
3.	A03	0.25	0.75	1	1	1
4.	A04	0.75	1	1	0.75	1
5.	A05	1	0.5	0.25	0.75	0.75
6.	A06	1	0.5	1	0.75	0.75

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So that the normalized matrix (R) is obtained as follows:

$$R = \begin{bmatrix} 0.75 & 0.75 & 1 & 1 & 0.75 \\ 1 & 0.75 & 1 & 0.75 & 0.75 \\ 0.25 & 0.75 & 1 & 1 & 1 \\ 0.75 & 1 & 1 & 0.75 & 1 \\ 1 & 0.5 & 0.25 & 0.75 & 0.75 \\ 1 & 0.5 & 1 & 0.75 & 0.75 \end{bmatrix}$$

The final result is obtained from the ranking process, namely the addition and multiplication of the normalized matrix R with the weight vector so that the largest value is obtained which is selected as the best alternative as a solution with the following formula (Widianta et al., 2018):

$$Vi \sum_{j=4}^{n} Wjrij$$

Description:
Vi = Ranking for each Alternative (A)
Wj = Weighted value for each criterion (C)
rij = Normalized performance rating value
(Bachtiar et al., 2021)

Therefore, the final value obtained for each alternative (A) is as follows:

V_1 = (4 x 0.75) + (2 x 0.75) + (1 x 1) + (4 x 1) + (3 x 0.75) = 11.750
V_2 = (4 x 1) + (2 x 0.75) + (1 x 1) + (4 x 0.75) + (3 x 0.75) = 11.750
V_3 = (4 x 0.25) + (2 x 0.75) + (1 x 1) + (4 x 1) + (3 x 1) = 10.500
V_4 = (4 x 0.75) + (2 x 1) + (1 x 1) + (4 x 0.75) + (3 x 1) = 12.000
V_5 = (4 x 1) + (2 x 0.5) + (1 x 0.25) + (4 x 0.75) + (3 x 0.75) = 10.500
V_6 = (4 x 1) + (2 x 0.5) + (1 x 1) + (4 x 0.75) + (3 x 0.75) = 11.250

The largest value is in V4 so alternative A04 is the alternative selected as the best alternative because it has the largest value.

3.1.2. Calculation Results Using the WP Method

The problem in table 11 will be solved using the Weighted Product (WP) method. First, the weights will be adjusted. The initial weights W = (4, 2, 1, 4, 3) will be adjusted so that the total weight ∑Wj = 1, using the following formula :

$$W_j = \frac{W_j}{\sum W_j}$$

Wj is the W index j. So for W1 it is 4, W2 is 2 and so on. And ∑Wj is the sum of W, namely 4 + 2 + 1 + 4 + 3, so to improve the weight becomes :

$$W_1 = \frac{4}{4+2+1+4+3} = \frac{4}{14} = 0.29$$
$$W_2 = \frac{2}{4+2+1+4+3} = \frac{2}{14} = 0.14$$
$$W_3 = \frac{1}{4+2+1+4+3} = \frac{1}{14} = 0.07$$

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$$W_4 = \frac{4}{4+2+1+4+3} = \frac{4}{14} = 0.29$$
$$W_5 = \frac{3}{4+2+1+4+3} = \frac{3}{14} = 0.21$$

After normalizing the weights, the next step is to calculate the S vector using the following formula :

$$S_i = \prod_{j=1}^{n} X_{ij\ wj}$$

$$S_1 = (3^{0.29})\ (3^{0.14})\ (4^{0.07})\ (4^{0.29})\ (3^{0.21}) = 3.33$$
$$S_2 = (4^{0.29})\ (3^{0.14})\ (4^{0.07})\ (3^{0.29})\ (3^{0.21}) = 3.33$$
$$S_3 = (1^{0.29})\ (3^{0.14})\ (4^{0.07})\ (4^{0.29})\ (4^{0.21}) = 2.57$$
$$S_4 = (3^{0.29})\ (4^{0.14})\ (4^{0.07})\ (3^{0.29})\ (4^{0.21}) = 3.39$$
$$S_5 = (4^{0.29})\ (2^{0.14})\ (1^{0.07})\ (3^{0.29})\ (3^{0.21}) = 2.85$$
$$S_6 = (4^{0.29})\ (2^{0.14})\ (4^{0.07})\ (3^{0.29})\ (3^{0.21}) = 3.14$$

Then the calculation for vector V is carried out as follows::

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

Description:
V1 = Alternative preferences, analogous to the vector V
x = Criterion value
w = Criterion/subcriterion weight
i = Alternative
j = Criterion
n = Number of Criteria
* = Number of criteria assessed in vector S

Simply put, it is as follows:

$$\boldsymbol{V}_1 = \frac{\boldsymbol{Si}}{\boldsymbol{S1+S2+S3}\ldots}$$

So the final value obtained by each Alternative (A) is as follows :

$$V_1 = \frac{3.33}{3.33+3.33+2.57+3.39+2.85+3.14} = \frac{3.33}{18.61} = 0.179$$
$$V_2 = \frac{3.33}{3.33+3.33+2.57+3.39+2.85+3.14} = \frac{3.33}{18.61} = 0.179$$
$$V_3 = \frac{2.57}{3.33+3.33+2.57+3.39+2.85+3.14} = \frac{2.57}{18.61} = 0.138$$
$$V_4 = \frac{3.39}{3.33+3.33+2.57+3.39+2.85+3.14} = \frac{3.39}{18.61} = 0.182$$
$$V_5 = \frac{2.85}{3.33+3.33+2.57+3.39+2.85+3.14} = \frac{2.85}{18.61} = 0.153$$
$$V_6 = \frac{3.14}{3.33+3.33+2.57+3.39+2.85+3.14} = \frac{3.14}{18.61} = 0.169$$

The highest value is in V4 so that Alternative A04 is the Alternative selected as the best Alternative.

3.1.3. Calculation Using the SMART Method

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The next calculation is using the SMART method. The steps in the SMART method are as follows:

a. Determine the criteria to be used in solving the decision-making problem.
b. In determining tourist destinations using the SMART method, the first step is to determine the criteria. The criteria used in this study can be seen in Table 1.
c. Based on the determined criteria, the second step is to assign weights to each criterion based on their highest priority. The following are tourist assessments of tourist destinations in Magelang.

Table 12. *Evaluation Factor Value (NEF) A01 (Ketep Pass)*

No.	Criteria Name	A01
1	Ticket Price	3
2	Distance from City Center	3
3	Cleanliness	4
4	Facilities	4
5	Road Access	3

Table 13. *Evaluation Factor Value (NEF) A02 (Silancur Highland)*

No.	Criteria Name	A02
1	Ticket Price	4
2	Distance from City Center	3
3	Cleanliness	4
4	Facilities	3
5	Road Access	3

Table 14. *Evaluation Factor Value (NEF) A03 (Candi Borobudur)*

No.	Criteria Name	A03
1	Ticket Price	1
2	Distance from City Center	3
3	Cleanliness	4
4	Facilities	4
5	Road Access	4

Table 15. *Evaluation Factor Value (NEF) A04 (Mangli Sky View)*

No.	Criteria Name	A04
1	Ticket Price	3
2	Distance from City Center	4
3	Cleanliness	4
4	Facilities	3

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5	Road Access	4

Table 16. *Evaluation Factor Value (NEF) A05 (Gunung Andong)*

No.	Criteria Name	A05
1	Ticket Price	4
2	Distance from City Center	2
3	Cleanliness	1
4	Facilities	3
5	Road Access	3

Table 17 *Evaluation Factor Value (NEF) A06 (Negeri Kahyangan)*

No.	Criteria Name	A05
1	Ticket Price	4
2	Distance from City Center	2
3	Cleanliness	4
4	Facilities	3
5	Road Access	3

Then the next step is to calculate the Utility Value using the following formula :

$$U1(a1) = 100\frac{(Cout - Cmin)}{(\text{Cmax} - \text{Cmin})}$$

a. Utility Value A01 (Ketep Pass)

$$U1(A01) = 100\%\frac{(Cmax - Cout\ i)}{(\text{Cmax} - \text{Cmin})} = 100\%\frac{(4-3)}{(4-1)} = 100\%\frac{1}{3} = 33.33$$
$$U2(A01) = 100\%\frac{(Cmax - Cout\ i)}{(\text{Cmax} - \text{Cmin})} = 100\%\frac{(4-3)}{(4-1)} = 100\%\frac{1}{3} = 33.33$$
$$U3(A01) = 100\%\frac{(Cmax - Cout\ i)}{(\text{Cmax} - \text{Cmin})} = 100\%\frac{(4-4)}{(4-1)} = 100\%\frac{0}{3} = 0$$
$$U4(A01) = 100\%\frac{(Cmax - Cout\ i)}{(\text{Cmax} - \text{Cmin})} = 100\%\frac{(4-4)}{(4-1)} = 100\%\frac{0}{3} = 0$$
$$U5(A01) = 100\%\frac{(Cmax - Cout\ i)}{(\text{Cmax} - \text{Cmin})} = 100\%\frac{(4-3)}{(4-1)} = 100\%\frac{1}{3} = 33.33$$

b. Utility Value A02 (Silancur Highland)

$$U1(A02) = 100\%\frac{(Cmax - Cout\ i)}{(\text{Cmax} - \text{Cmin})} = 100\%\frac{(4-4)}{(4-1)} = 100\%\frac{0}{3} = 0$$
$$U2(A02) = 100\%\frac{(Cmax - Cout\ i)}{(\text{Cmax} - \text{Cmin})} = 100\%\frac{(4-3)}{(4-1)} = 100\%\frac{1}{3} = 33.33$$
$$U3(A02) = 100\%\frac{(Cmax - Cout\ i)}{(\text{Cmax} - \text{Cmin})} = 100\%\frac{(4-4)}{(4-1)} = 100\%\frac{0}{3} = 0$$
$$U4(A02) = 100\%\frac{(Cmax - Cout\ i)}{(\text{Cmax} - \text{Cmin})} = 100\%\frac{(4-3)}{(4-1)} = 100\%\frac{1}{3} = 33.33$$
$$U5(A02) = 100\%\frac{(Cmax - Cout\ i)}{(\text{Cmax} - \text{Cmin})} = 100\%\frac{(4-3)}{(4-1)} = 100\%\frac{1}{3} = 33.33$$

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c. Utility Value A03 (Candi Borobudur)

$$U1(A03) = 100\% \frac{(Cmax - Cout\ i)}{(\text{Cmax}-\text{Cmin})} = 100\% \frac{(4-1)}{(4-1)} = 100\% \frac{3}{3} = 100$$
$$U2(A03) = 100\% \frac{(Cmax - Cout\ i)}{(\text{Cmax}-\text{Cmin})} = 100\% \frac{(4-3)}{(4-1)} = 100\% \frac{1}{3} = 33.33$$
$$U3(A03) = 100\% \frac{(Cmax - Cout\ i)}{(\text{Cmax}-\text{Cmin})} = 100\% \frac{(4-4)}{(4-1)} = 100\% \frac{0}{3} = 0$$
$$U4(A03) = 100\% \frac{(Cmax - Cout\ i)}{(\text{Cmax}-\text{Cmin})} = 100\% \frac{(4-4)}{(4-1)} = 100\% \frac{0}{3} = 0$$
$$U5(A03) = 100\% \frac{(Cmax - Cout\ i)}{(\text{Cmax}-\text{Cmin})} = 100\% \frac{(4-4)}{(4-1)} = 100\% \frac{0}{3} = 0$$

d. Utility Value A04 (Mangli Sky View)

$$U1(A04) = 100\% \frac{(Cmax - Cout\ i)}{(\text{Cmax}-\text{Cmin})} = 100\% \frac{(4-3)}{(4-1)} = 100\% \frac{1}{3} = 33.33$$
$$U2(A04) = 100\% \frac{(Cmax - Cout\ i)}{(\text{Cmax}-\text{Cmin})} = 100\% \frac{(4-4)}{(4-1)} = 100\% \frac{0}{3} = 0$$
$$U3(A04) = 100\% \frac{(Cmax - Cout\ i)}{(\text{Cmax}-\text{Cmin})} = 100\% \frac{(4-4)}{(4-1)} = 100\% \frac{0}{3} = 0$$
$$U4(A04) = 100\% \frac{(Cmax - Cout\ i)}{(\text{Cmax}-\text{Cmin})} = 100\% \frac{(4-3)}{(4-1)} = 100\% \frac{1}{3} = 33.33$$
$$U5(A04) = 100\% \frac{(Cmax - Cout\ i)}{(\text{Cmax}-\text{Cmin})} = 100\% \frac{(4-4)}{(4-1)} = 100\% \frac{0}{3} = 0$$

e. Utility Value A05 (Gunung Andong)

$$U1(A05) = 100\% \frac{(Cmax - Cout\ i)}{(\text{Cmax}-\text{Cmin})} = 100\% \frac{(4-4)}{(4-1)} = 100\% \frac{0}{3} = 0$$
$$U2(A05) = 100\% \frac{(Cmax - Cout\ i)}{(\text{Cmax}-\text{Cmin})} = 100\% \frac{(4-2)}{(4-1)} = 100\% \frac{2}{3} = 66.67$$
$$U3(A05) = 100\% \frac{(Cmax - Cout\ i)}{(\text{Cmax}-\text{Cmin})} = 100\% \frac{(4-1)}{(4-1)} = 100\% \frac{3}{3} = 100$$
$$U4(A05) = 100\% \frac{(Cmax - Cout\ i)}{(\text{Cmax}-\text{Cmin})} = 100\% \frac{(4-3)}{(4-1)} = 100\% \frac{1}{3} = 33.33$$
$$U5(A05) = 100\% \frac{(Cmax - Cout\ i)}{(\text{Cmax}-\text{Cmin})} = 100\% \frac{(4-3)}{(4-1)} = 100\% \frac{1}{3} = 33.33$$

f. Utility Value A06 (Negeri Kahyangan)

$$U1(A06) = 100\% \frac{(Cmax - Cout\ i)}{(\text{Cmax}-\text{Cmin})} = 100\% \frac{(4-4)}{(4-1)} = 100\% \frac{0}{3} = 0$$
$$U2(A06) = 100\% \frac{(Cmax - Cout\ i)}{(\text{Cmax}-\text{Cmin})} = 100\% \frac{(4-2)}{(4-1)} = 100\% \frac{2}{3} = 66.67$$
$$U3(A06) = 100\% \frac{(Cmax - Cout\ i)}{(\text{Cmax}-\text{Cmin})} = 100\% \frac{(4-4)}{(4-1)} = 100\% \frac{0}{3} = 0$$
$$U4(A06) = 100\% \frac{(Cmax - Cout\ i)}{(\text{Cmax}-\text{Cmin})} = 100\% \frac{(4-3)}{(4-1)} = 100\% \frac{1}{3} = 33.33$$
$$U5(A06) = 100\% \frac{(Cmax - Cout\ i)}{(\text{Cmax}-\text{Cmin})} = 100\% \frac{(4-3)}{(4-1)} = 100\% \frac{1}{3} = 33.33$$

The next step is to calculate the total number of Ui(A0i) by multiplying the value of Ui(A0i) by the criteria weight (Wj) then adding up the total value

Table 18. *Total Utility Value A01 (Ketep Pass)*

No.	Criteria Name	NEF	NBF	NBE
1	Ticket Price	33,33	4	133,33

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2	Distance from City Center	33,33	2	66,67
3	Cleanliness	0,00	1	0,00
4	Facilities	0,00	4	0,00
5	Road Access	33,33	3	100,00
	Than TBE A01			300,00

Table 19. *Total Utility Value A02 (Silancur Highland)*

No.	Criteria Name	NEF	NBF	NBE
1	Ticket Price	0,00	4	0,00
2	Distance from City Center	33,33	2	66,67
3	Cleanliness	0,00	1	0,00
4	Facilities	33,33	4	133,33
5	Road Access	33,33	3	100
	Than TBE A02			300

Table 20. *Total Utility Value A03 (Candi Borobudur)*

No.	Criteria Name	NEF	NBF	NBE
1	Ticket Price	100	4	400
2	Distance from City Center	33,33	2	66,67
3	Cleanliness	0	1	0
4	Facilities	0	4	0
5	Road Access	0	3	0
	Than TBE A03			466,67

Table 21. *Total Utility Value A04 (Mangli Sky View)*

No.	Criteria Name	NEF	NBF	NBE
1	Ticket Price	33,33	4	133,33
2	Distance from City Center	0,00	2	0,00
3	Cleanliness	0	1	0
4	Facilities	33,33	4	133,33
5	Road Access	0,00	3	0
	Than TBE A04			266,67

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Table 22. *Total Utility Value A05 (Gunung Andong)*

No.	Criteria Name	NEF	NBF	NBE
1	Ticket Price	0	4	0
2	Distance from City Center	66,67	2	133,33
3	Cleanliness	100	1	100
4	Facilities	33,33	4	133,33
5	Road Access	33,33	3	100
	Than TBE A05			466,67

Table 23. *Total Utility Value A06 (Negeri Kahyangan)*

No.	Criteria Name	NEF	NBF	NBE
1	Ticket Price	0	4	0
2	Distance from City Center	66,67	2	133,33
3	Cleanliness	0	1	0
4	Facilities	33,33	4	133,33
5	Road Access	33,33	3	100
	Than TBE A06			366,67

Then carry out ranking using the SMART method based on the Total Evaluation Weight (TBE) (Firdonsyah et al., 2022) as in the table below :

Table 24. *SMART Method Ranking*

No.	Alternative Name	Nilai TBE	Rank
1	A01	300,00	2
2	A02	300,00	2
3	A03	466,67	4
4	A04	266,67	1
5	A05	466,67	4
6	A06	366,67	3

The largest values are in A03 and A05 so that alternatives A03 and A05 are the alternatives selected as the best alternatives based on the SMART method.

3.2. Comparative Analysis of the SAW, WP, and SMART Methods..

The three methods were then compared, and the results showed several variations and similarities in terms of Rank and value, including similarities between the top and bottom Ranks. To further clarify the comparison of the SAW, WP, and SMART methods, we normalized the WAS and SMART methods into the WP method, which refers to the formula for calculating the V Vector, so that the weight becomes 1, as follows :

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$$V_i = \frac{\prod_{j=1}^{n} X_{ij\,wj}}{\prod_{j=1}^{n} (X_j^*)_{wj}}$$

SAW Method

$$V_1 = \frac{11.750}{11.750 + 11.750 + 10.500 + 12.000 + 10.500 + 11.250} = \frac{11.750}{66.750} = 0.173$$
$$V_2 = \frac{11.750}{11.750 + 11.750 + 10.500 + 12.000 + 10.500 + 11.250} = \frac{11.750}{66.750} = 0.173$$
$$V_3 = \frac{10.500}{11.750 + 11.750 + 10.500 + 12.000 + 10.500 + 11.250} = \frac{10.500}{66.750} = 0.155$$
$$V_4 = \frac{12.000}{11.750 + 11.750 + 10.500 + 12.000 + 10.500 + 11.250} = \frac{12.000}{66.750} = 0.177$$
$$V_5 = \frac{10.500}{11.750 + 11.750 + 10.500 + 12.000 + 10.500 + 11.250} = \frac{10.500}{66.750} = 0.155$$
$$V_6 = \frac{11.250}{11.750 + 11.750 + 10.500 + 12.000 + 10.500 + 11.250} = \frac{11.250}{66.750} = 0.166$$

SMART Method

$$V_1 = \frac{300}{300 + 300 + 15 + 266.67 + 466.67 + 366.67} = \frac{300}{1715} = 0.175$$
$$V_2 = \frac{300}{300 + 300 + 15 + 266.67 + 466.67 + 366.67} = \frac{300}{1715} = 0.175$$
$$V_3 == \frac{466.67}{300 + 300 + 15 + 266.67 + 466.67 + 366.67} = \frac{466.67}{1715} = 0.272$$
$$V_4 = \frac{266.67}{300 + 300 + 15 + 266.67 + 466.67 + 366.67} = \frac{266.67}{1715} = 0.155$$
$$V_5 = \frac{466.67}{300 + 300 + 15 + 266.67 + 466.67 + 366.67} = \frac{466.67}{1715} = 0.272$$
$$V_6 = \frac{366.67}{300 + 300 + 15 + 266.67 + 466.67 + 366.67} = \frac{366.67}{1715} = 0.214$$

The results of the comparison between the SAW, WP, and SMART methods are shown in the table below :

Table 25 . *Comparison of the SAW, WP, and SMART Methods*

No	Alternative	Methode SAW	Methode WP	Methode SMART	Rank
1.	A01	0,173	0,179	0,175	2
2.	A02	0,173	0,179	0,175	2
3.	A03	0,155	0,138	0,272	4
4.	A04	0,177	0,182	0,155	1
5.	A05	0,155	0,153	0,272	4
6.	A06	0,166	0,169	0,214	3
	SUM	0.999	1.000	1.000	

The next step is to analyze suitability by calculating the suitability level for each method (Mallu & Profesional, 2023). The formula used is :

$$Tki = 100 \frac{xi}{Data\ F\ M\ A\ D\ M\ (100\%)}$$

The calculation begins by adding up all the resulting data and dividing it by the number of data.

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$$\boldsymbol{SAW\ Method} = \frac{\boldsymbol{Number\ of\ Final\ Results}}{\boldsymbol{Number\ of\ Data}} = \frac{\mathbf{0.999}}{\mathbf{6}} = \mathbf{0.66}$$

$$\boldsymbol{WP\ Method} = \frac{\boldsymbol{Number\ of\ Final\ Results}}{\boldsymbol{Number\ of\ Data}} = \frac{\mathbf{1{,}000}}{\mathbf{6}} = \mathbf{0.67}$$

$$\boldsymbol{WP\ Method} = \frac{\boldsymbol{Number\ of\ Final\ Results}}{\boldsymbol{Number\ of\ Data}} = \frac{\mathbf{1{,}000}}{\mathbf{6}} = \mathbf{0.67}$$

Then, to obtain the percentage, a calculation is performed using the conformity level formula, resulting in the following result:

$$\textbf{\textit{Percentage Method of SAW}} = \mathbf{100} - \frac{\mathbf{0.66}}{\mathbf{100}} = \mathbf{99.9934}\ \%$$

$$\textbf{\textit{Percentage Method of WP}} = \mathbf{100} - \frac{\mathbf{0.67}}{\mathbf{100}} = \mathbf{99.9933}\ \%$$

$$\textbf{\textit{Percentage Method of SMART}} = \mathbf{100} - \frac{\mathbf{0.67}}{\mathbf{100}} = \mathbf{99.9933\%}$$

Based on the calculation of the level of suitability above, this study can determine the priority of the method by comparing the percentage suitability value between 99.9934% in the SAW method, with 99.9933% in the WP method and the SMART method.

3.3. Discussion

A destination is a specific area chosen by tourists to stay for a specific period of time. The term "destination" can be used for a planned area, most or all of which feature facilities and services related to tourism products, such as rest areas, hotels, attractions, and souvenir shops. A tourist attraction is a place visited by people because of its abundance of natural and man-made resources, such as aquatic and terrestrial plants and animals, animal skeletons, ancient buildings with educational value, monuments, temples, dances, attractions, and other traditional crafts.

According to (Haki et al., 2021), the SMART method is a multi-attribute decision support system that facilitates tourists in determining tourist attractions to visit, prioritizing the closest distance and accessibility to the most popular tourist attractions based on the Rank obtained from the SMART method. According to (Haki et al., 2021), the SMART method is a multi-attribute decision support system that facilitates tourists in determining tourist attractions to visit, prioritizing the closest distance and accessibility to the most popular tourist attractions based on the Rank obtained from the SMART method.

According to (Deni Ahmad Jakaria, 2019), a decision support system was designed using the Simple Additive Weighting (SAW) and Weighted Product (WP) methods with predetermined criteria. These two methods will be compared to determine the best method for loan allocation. This is expected to assist in determining more appropriate and suitable loan allocation. The three studies mentioned above aim to develop a decision support system for determining tourist destinations, using the SAW, WP, and SMART methods. In this study, these three methods will be compared to determine which method is most appropriate for implementation in a decision support system for determining tourist destinations in Magelang.

In this research SAW and WP mutually reinforce each other's results; this increases confidence that the basic calculations (normalization, weighting, and decision matrix) have been performed correctly. This means: SAW normalization is correct, WP consistently uses weights and multiplications, and there are no extreme values/outliers that cause WP to deviate. The SMART method is also consistent with SAW and WP, both in terms of values and rankings.

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SAW, WP, and SMART produce identical ranking results, indicating consistent modeling quality. This consistency strengthens the validity of the decision-making results, especially if the research is aimed at recommending the best alternative. This indicates that in this study:

a. The comparison of the SAW, WP, and SMART methods was conducted neatly.
b. The values for each method are consistent, so the research is mathematically valid.
c. Stable rankings indicate good data quality and weighting.
d. The presentation of comparative tables greatly helps readers understand the reliability of each method.

The consistency of rankings between methods indicates that the data structure, criteria weights, and value ranges between alternatives are relatively uniform, so that the linear (SAW), geometric (WP), and utility-based (SMART) methods produce equivalent decision patterns.

According to (Wardhani & Anindyaputri, 2020) the weighted product method is implemented in a mobile-based system. The mobile application was created to facilitate administrators and users in selecting tourist attractions through a process that requires users to input several desired criteria. This application also includes Google Maps, so users can immediately find their chosen tourist attractions.

4. Conclusion

From the comparison between the Simple Additive Weighting (SAW), Weighted Product (WP), and Simple Multi-Attribute Rating Technique (SMART) methods, the total percentage obtained for the SAW method was 99.9934%, higher than the WP and SMART methods, which had a percentage of 99.9933%. SAW, WP, and SMART. In this document also produce identical ranking results, demonstrating consistent modeling quality. There are no criteria dominance or transformation errors, so SMART no longer deviates as in previous versions. This consistency strengthens the validity of the decision-making results, especially if the research is aimed at recommending the best alternative method for solving the problem of determining tourist destinations in Magelang.

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