TOPSIS and WP for BLT Decision Support in Srimulyo

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***Abstract***

*Srimulyo Village, situated in Anak Ratu Aji District, Central Lampung Regency, faces difficulties in ensuring an accurate and efficient process for determining recipients of Direct Cash Assistance (BLT). The current manual system often results in errors and perceived inequities. This research explores the application of the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method alongside the Weighted Product (WP) method to enhance decision-making in selecting BLT recipients. TOPSIS is employed to identify optimal alternatives based on their closeness to a positive ideal solution, while WP emphasizes the importance of criteria through assigned weights.*

*The findings indicate that integrating these two methods yields recommendations that are more objective, transparent, and efficient. The TOPSIS approach enables the system to rank alternatives by assessing their proximity to the ideal solution, facilitating data-driven decision-making. Meanwhile, the WP method ensures that each criterion's importance is appropriately weighted, thereby increasing the reliability of the results. This dual-method approach not only minimizes human error but also promotes fairness in the selection process.*

*The proposed integrated system offers a practical solution to improve the accuracy of social assistance distribution in Srimulyo Village. By adopting these decision-support methods, local authorities can establish a more equitable, reliable, and efficient mechanism for BLT allocation, ensuring that aid reaches the individuals who need it most..*

***Keywords****: SPK, BLT, TOPSIS, WP*

**1. Introduction**

The COVID-19 pandemic has profoundly affected the economic conditions(Conefrey & Walsh, 2020) of society, especially among underprivileged families in rural areas(Sasmiharti, 2024), (Yamali & Putri, 2020). To mitigate these impacts, the Indonesian government introduced Direct Cash Assistance (BLT) funded through village allocations, as outlined in Ministry of Finance Regulation No. 40/PMK.07/2020(Haryo, 2023). Srimulyo Village, encompassing 902 hectares and comprising 7 RW (neighborhood units) and 26 RT (neighborhood groups), currently uses a manual system to identify BLT recipients. However, this method often falls short in ensuring accuracy and transparency.

Key challenges associated with the manual approach include potential errors in data entry, inconsistencies in applying criteria, and perceived unfairness in beneficiary selection. To address these issues, a decision support system (Khasanah & Herlawati, 2021)(DSS) is required to enhance the precision and effectiveness of the process(Rendi Haryono Septy & Devega, 2022) (Rustam & Aziz, 2019) This research applies the TOPSIS and WP methods, both of which evaluate multiple criteria to rank and select optimal alternatives. By implementing this approach, the determination of BLT recipients is expected to become more reliable, equitable, and transparent(Mualifu et al., 2019).

**2. Research Method**

This study employs qualitative data collection methods and utilizes the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) and Weighted Product (WP)(Yang et al., 2019) methods as decision-making tools (Crystallography, 2023)(Rahmansyah & Lusinia, 2016)(Rahmansyah & Lusinia, 2016). The research process consists of several stages. Initially, a literature review is conducted using the Systematic Literature Review (SLR) approach(Rachmawati, 2024) which involves collecting journal articles and conference papers related to existing decision-making systems and methodologies. This literature collection process has commenced and is still ongoing.

Subsequently, data is gathered concerning the process of selecting BLT recipients in Srimulyo Village, Anak Ratu Aji District, Central Lampung Regency. During the preparation phase, the requirements for applying the WP and TOPSIS methods are established. This includes defining the criteria to be considered, assigning weights to these criteria, and compiling the alternative data to be evaluated.In the implementation phase, calculations are performed using the WP and TOPSIS methods to determine the BLT recipients(Sefriyanto et al., n.d.). Several trials are then conducted to test the system, followed by a comprehensive analysis of the results to ensure the system operates as intended. Input data plays a critical role in achieving accurate outcomes. The data is categorized into external data, which represents the residents eligible for BLT, and internal data, which outlines the criteria for recipient selection sourced from Srimulyo Village, Anak Ratu Aji District, Central Lampung Regency(Agustin et al., 2023).

* 1. ***Weighted Product***

The data analysis in this section involves detailing the formulas and equations used. The Weighted Product (WP) method, as described by(Mario & Lestari, 2026) applies a multiplication technique to relate attribute ratings(Hidayat et al., 2023), where each rating is first exponentiated to the power of its corresponding attribute weight. The calculation process begins with identifying the criteria (Ci) and their respective characteristics used as references in the decision-making process(Susanto et al., 2020). Compatibility ratings are then assigned to each alternative for every criterion, followed by constructing a decision matrix. Subsequently, the weights of the criteria are normalized by dividing each weight by the total sum of all weights, ensuring that the total weight satisfies the normalization equation required by the WP method(Nurhayati et al., 2019)(Rahmansyah & Lusinia, 2016)(Lestari & Agustiansyah, 2023) This structured approach enables accurate and reliable decision-making.

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(1)

Definition:

𝑊j = represents the normalized weight of criterion j

𝑤j = refers to the initial weight of criterion j

∑j = ∑wj is the total weight of all criteria

Determining the Value of Vector S

To calculate the preference value for an alternative, a vector S is used. The preference value for each alternative is computed based on a specific formula that evaluates how well the alternative aligns with the ideal solution. This process involves determining the relative performance of each alternative in relation to the criteria(Abuhussain, 2024) and subsequently calculating the preference value to rank the alternatives.

Definition:

S = alternative preference.

W = criterion weight.

X = criterion value.

i = alternative i to n.

j = criterion.

is determined by multiplying the criterion values from 1 to by the corresponding weights W, where each weight is normalized. If W represents a benefit attribute, the resulting value will be positive, while if W represents a cost attribute, the value will be negative. This approach helps assess the relative performance of alternatives based on the given criteria, taking into account the nature of each attribute (benefit or cost).

Determining the Value of Vector V

The value of vector V represents the value used for ranking alternatives. The relative preference value of each alternative is calculated by applying a specific formula that evaluates how well each alternative performs according to the criteria. This value allows for the comparison of alternatives, where the higher the value, the more preferable the alternative is in relation to the others based on the defined criteria.:

Definition:

Vi = represents the preference result for alternativei.

Xij = refers to the variable value of alternative i for criterion j.

wj = is the weight value of criterion jj,

n = the number of criteria.

i = is the alternative value.

j = is the criterion value.

\* = number of criteria that have been assessed in the vector S.

The criteria are classified into two categories: those with positive values are classified as benefit criteria, while those with negative values are considered cost criteria. This distinction helps in properly evaluating alternatives, where benefit criteria are sought to be maximized and cost criteria minimized(Prabowo & Noranita, 2015).

* 1. **TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution)**

The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) is a(Uchani Gutierrez & Xu, 2023) method commonly used in decision support systems to identify the best alternative from several options based on specific criteria. Introduced by Yoon and Hwang in 1981(Ramadhan et al., 2022). the core concept of TOPSIS is to select an alternative that is closest to the positive ideal solution (the best option) and farthest from the negative ideal solution (the worst option). This method relies on the Euclidean distance to evaluate the relative proximity of each alternative to the ideal solution. In essence, TOPSIS aims to ensure that the chosen alternative performs exceptionally well on the most desirable criteria while minimizing undesirable attributes. The stages of TOPSIS calculations involve systematic steps to achieve accurate and reliable decision-making(Corrente & Tasiou, 2023):

Normalized Decision Matrix (R)

Because each criterion can have different units, the next step is to normalize the decision matrix(Khalida & Fadhilla Ramdhania, 2024) to ensure that each criterion has the same weight. Normalization is done with the formula:

Here, i ranges from 1 to m, where m represents the total number of alternatives being evaluated. The value Xij denotes the rating of the i-th alternative with respect to the j-th criterion, indicating its suitability

Weighted Normalized Decision Matrix (Y

The value of each normalized data point (R) is then multiplied by its corresponding weight (W) to generate the weighted normalized decision matrix (Y).

wj​ is a positive exponent for benefit attributes and a negative exponent for cost attributes. The value of wj​ represents the weight assigned to the j-th criterion.

Positive (A+) and Negative (A-) Ideal Solution Matrix

The Positive Ideal Solution (A+) is defined using the following equation formula:

The Negative Ideal Solution (A-) with the equation formula:

The Positive Ideal Solution (A+) is the alternative that holds the best value for each criterion, while the Negative Ideal Solution (A-) is the alternative that holds the worst value for each criterion(Chu et al., 2007).

Positive/Negative Ideal Solution Distance (D+ and D-):

The distances from the alternatives to the Positive and Negative Ideal Solutions are calculated, denoted as D+D+ using the following equation formula:

Definition.

yj = is the positive ideal solution for attribute J

y-j = is the negative ideal solution for attribute j

yij = represents the element of the weighted normalized decision matrix Y

Preference Value (V)

The preference value for each alternative (Vi) is calculated using the following equation:

(10)

A larger Vi value indicates that alternative Ai is preferred.

1. **Results and Analysis**

**3.1. Collection and Determination of Data Criteria for TOPSIS and WP Calculations**

This study uses ten criteria obtained from observations and interviews with officers authorized to handle the provision of BLT (Direct Cash Assistance) assistance. The first criterion is the Floor Area of ​​the House with a weight of 5, which shows the importance of a larger house size for the comfort and suitability of the place to live. The second criterion is the Floor of the House with a weight of 4, because a good floor can affect the health and comfort of the occupants. The third criterion, House Walls (weight 4), reflects the structural condition of the house that is sturdy and safe. Drinking Water Sources also have a weight of 5, considering that access to clean drinking water is very important for health. MCK facilities with a weight of 4 are an important factor in maintaining household sanitation and health. Lighting (weight 3) also affects comfort and safety in the house. Fuel, with a weight of 2, reflects efficiency and impact on household costs. Savings (weight 3) reflect financial independence and the ability to face urgent needs. Income/Month with a weight of 4 is an important indicator in assessing the financial ability of a household to meet basic needs(Virus, 2021). Finally, Education of the Head of Family (weight 3) is a factor that influences household decision-making and management of existing resources. By using this weight, the study aims to provide a more comprehensive assessment of the eligibility and urgency of BLT assistance recipients(Bachtiar & Mahradianur, 2023).

Table 1. Criteria

|  |  |  |
| --- | --- | --- |
| **Criteria** | **Name** | **Weight** |
| **C1** | Floor Area of the House | 5 |
| **C2** | Type of House Flooring | 4 |
| **C3** | Type of House Walls | 4 |
| **C4** | Source of Drinking Water | 5 |
| **C5** | Sanitation Facilities (MCK) | 4 |
| **C6** | Lighting | 3 |
| **C7** | Type of Fuel Used | 2 |
| **C8** | Savings | 3 |
| **C9** | Monthly Income | 4 |
| **C10** | Head of Household's Education | 3 |

* + 1. **WP Calculation Method**

Based on table 1 criteria, the next step is to determine the relative value of the initial weight (wj) of = 1 with the formula equation number 1 based on six criteria so that the initial weight is obtained according to Table 2.

Table 2. Normalized Weights

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Criteria** | **C1** | **C2** | **C3** | **C4** | **C5** | **C6** | **C7** | **C8** | **C9** | **C10** |
| **Weight** | 0.14 | 0.11 | 0.11 | 0.14 | 0.11 | 0.08 | 0.05 | 0.08 | 0.11 | 0.08 |

From the initial weight, it can be seen that the criteria with the highest value are C1 and C4 at 0.14, while the criteria with the lowest value is C7 with a value of 0.05 from the initial weight value. The next step is the formation of a comparison matrix of alternatives and criteria, where the criteria data are obtained from the survey results at the research location, as shown in Table 3.

Table 3. Criteria Matrix

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Alternativ** | **KRITERIA** | | | | | | | | | |
| **C1** | **C2** | **C3** | **C4** | **C5** | **C6** | **C7** | **C8** | **C9** | **C10** |
| **A1** | 5 | 5 | 5 | 4 | 4 | 3 | 5 | 4 | 5 | 3 |
| **A2** | 4 | 4 | 4 | 3 | 2 | 3 | 5 | 4 | 4 | 3 |
| **A3** | 5 | 5 | 5 | 4 | 5 | 3 | 4 | 3 | 2 | 3 |
| **A4** | 3 | 3 | 2 | 3 | 5 | 5 | 4 | 3 | 4 | 3 |
| **A5** | 5 | 2 | 2 | 2 | 3 | 1 | 5 | 3 | 5 | 3 |
| **A6** | 5 | 2 | 2 | 2 | 2 | 2 | 4 | 3 | 5 | 5 |
| **A7** | 3 | 4 | 4 | 3 | 4 | 3 | 3 | 3 | 1 | 2 |
| **A8** | 5 | 5 | 5 | 3 | 5 | 3 | 2 | 3 | 5 | 5 |
| **A9** | 5 | 3 | 4 | 3 | 5 | 5 | 2 | 2 | 3 | 1 |
| **A10** | 1 | 5 | 3 | 3 | 1 | 2 | 2 | 2 | 2 | 2 |

Based on Tables 2 and 3, the value of the S factor is obtained from equation number 2, and the value of the V vector is obtained from equation 3. These values ​​are shown in Table 4.

Table 4. Vector S and Vector V

|  |  |  |  |
| --- | --- | --- | --- |
| **(Alternatif)** | **Veksot S** | **Vektor V** | **Ranking** |
| **A1** | 2,8277 | 0,1198 | 2 |
| **A2** | 2,3140 | 0,0981 | 7 |
| **A3** | 2,8987 | 0,1228 | 1 |
| **A4** | 2,3385 | 0,0991 | 6 |
| **A5** | 1,7929 | 0,0760 | 9 |
| **A6** | 1,8370 | 0,0779 | 8 |
| **A7** | 2,4131 | 0,1023 | 5 |
| **A8** | 2,7630 | 0,1171 | 3 |
| **A9** | 2,6881 | 0,1139 | 4 |
| **A10** | 1,7227 | 0,0730 | 10 |

Based on Table 4, it can be concluded that the highest value for calculations using the WP method, the highest value for the S vector and the V vector is owned by alternative A3 with an S vector value of 2,8987and a V vector of 0,1228.

**3.2. TOPSIS Calculation Method**

With the sample and alternative criteria based on Tables 1 and 2, the next step is to find the weight of each criterion by creating a normalized decision matrix. This process is important to ensure that each criterion has the same impact on decision making. By following these steps carefully, we can ensure that the final result of the TOPSIS analysis will provide an optimal and reliable solution. This can be presented using the equation formula 4 as shown in Table 5.

Table 5. Normalization Matrix (R)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Alternatif** | **C1** | **C2** | **C3** | **C4** | **C5** | **C6** | **C7** | **C8** | **C9** | **C10** |
| **A1** | 0.3676 | 0.3978 | 0.4167 | 0.4126 | 0.3266 | 0.2942 | 0.4903 | 0.3922 | 0.4903 | 0.2942 |
| **A2** | 0.2941 | 0.3182 | 0.3333 | 0.3094 | 0.1633 | 0.2942 | 0.4903 | 0.3922 | 0.3922 | 0.2942 |
| **A3** | 0.3676 | 0.3978 | 0.4167 | 0.4126 | 0.4082 | 0.2942 | 0.3922 | 0.2942 | 0.1961 | 0.2942 |
| **A4** | 0.2206 | 0.2387 | 0.1667 | 0.3094 | 0.4082 | 0.4903 | 0.3922 | 0.2942 | 0.3922 | 0.2942 |
| **A5** | 0.3676 | 0.1591 | 0.1667 | 0.2063 | 0.2449 | 0.0981 | 0.4903 | 0.2942 | 0.4903 | 0.2942 |
| **A6** | 0.3676 | 0.1591 | 0.1667 | 0.2063 | 0.1633 | 0.1961 | 0.3922 | 0.2942 | 0.4903 | 0.4903 |
| **A7** | 0.2206 | 0.3182 | 0.3333 | 0.3094 | 0.3266 | 0.2942 | 0.2942 | 0.2942 | 0.0981 | 0.1961 |
| **A8** | 0.3676 | 0.3978 | 0.4167 | 0.3094 | 0.4082 | 0.2942 | 0.1961 | 0.2942 | 0.4903 | 0.4903 |
| **A9** | 0.3676 | 0.2387 | 0.3333 | 0.3094 | 0.4082 | 0.4903 | 0.1961 | 0.1961 | 0.2942 | 0.0981 |
| **A10** | 0.0735 | 0.3978 | 0.2500 | 0.3094 | 0.0816 | 0.1961 | 0.1961 | 0.1961 | 0.1961 | 0.1961 |

The table above represents certain criteria, while each row shows an alternative. The values ​​in the table reflect the relative preference level of each alternative based on each criterion. The calculation of the criteria weight for each alternative is done using equation number 5, with the results presented in Table 6. This step is done to give influence or priority to each criterion according to the weight that has been determined.

Table 6. Weighted Normalization Matrix Y

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Alternatif** | **C1** | **C2** | **C3** | **C4** | **C5** | **C6** | **C7** | **C8** | **C9** | **C10** |
| **A1** | 1.8380 | 0.7956 | 1.6667 | 0.8251 | 1.3064 | 0.8825 | 1.4709 | 1.1767 | 1.4709 | 0.8825 |
| **A2** | 1.4704 | 0.6364 | 1.3333 | 0.6189 | 0.6532 | 0.8825 | 1.4709 | 1.1767 | 1.1767 | 0.8825 |
| **A3** | 1.8380 | 0.7956 | 1.6667 | 0.8251 | 1.6330 | 0.8825 | 1.1767 | 0.8825 | 0.5883 | 0.8825 |
| **A4** | 1.1028 | 0.4773 | 0.6667 | 0.6189 | 1.6330 | 1.4709 | 1.1767 | 0.8825 | 1.1767 | 0.8825 |
| **A5** | 1.8380 | 0.3182 | 0.6667 | 0.4126 | 0.9798 | 0.2942 | 1.4709 | 0.8825 | 1.4709 | 0.8825 |
| **A6** | 1.8380 | 0.3182 | 0.6667 | 0.4126 | 0.6532 | 0.5883 | 1.1767 | 0.8825 | 1.4709 | 1.4709 |
| **A7** | 1.1028 | 0.6364 | 1.3333 | 0.6189 | 1.3064 | 0.8825 | 0.8825 | 0.8825 | 0.2942 | 0.5883 |
| **A8** | 1.8380 | 0.7956 | 1.6667 | 0.6189 | 1.6330 | 0.8825 | 0.5883 | 0.8825 | 1.4709 | 1.4709 |
| **A9** | 1.8380 | 0.4773 | 1.3333 | 0.6189 | 1.6330 | 1.4709 | 0.5883 | 0.5883 | 0.8825 | 0.2942 |
| **A10** | 0.3676 | 0.7956 | 1.0000 | 0.6189 | 0.3266 | 0.5883 | 0.5883 | 0.5883 | 0.5883 | 0.5883 |

Based on the Weighted Normalized Matrix Y, the highest value of 1.8380 is observed for alternatives A1, A3, A5, A6, A8, and A9 on criterion C1, suggesting that this criterion has the greatest impact on these alternatives. Conversely, the lowest value of 0.2942 is found for A7 on criterion C9 and A9 on criterion C10, indicating the least influence. This matrix reflects how the criterion weights affect the alternatives, with higher values corresponding to higher priority. Once these values are obtained, the subsequent step is to determine the positive ideal solution and the negative ideal solution based on the normalized weight ranking. This is accomplished using equations 6 and 7, with the results presented in Table 7..

Table 7.Value Of Positive And Negative Ideal Solutions

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Information** | **C1** | **C2** | **C3** | **C4** | **C5** | **C6** | **C7** | **C8** | **C9** | **C10** |
| **Solution (A+)** | 1.838 | 0.796 | 1.667 | 0.825 | 1.633 | 1.471 | 1.471 | 1.177 | 1.471 | 1.471 |
| **Solution (A-)** | 0.368 | 0.318 | 0.667 | 0.413 | 0.327 | 0.294 | 0.588 | 0.588 | 0.294 | 0.294 |

The analysis revealed that category C1 exhibited the highest positive value at 1.838, whereas categories C9 and C10 displayed the lowest positive value at 1.471. Conversely, category C3 showed the highest negative value at 0.667, while category C6 exhibited the lowest negative value at 0.294. Subsequently, equations 8 and 9 were employed to compute the distance of each alternative from both the positive and negative ideal solutions, as well as to determine the preference value for each alternative. The detailed results of these calculations are presented in Table 8.

Table 8. Distance Between Positive and Negative Ideals

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Alternativ** | **D+** | **D-** | **V** | **Rank** |
| **A1** | 0,7424 | 14,0306 | 0,950 | 2 |
| **A2** | 2,8880 | 5,9829 | 0,674 | 7 |
| **A3** | 1,5152 | 14,8753 | 0,908 | 1 |
| **A4** | 12,5635 | 3,8522 | 0,235 | 6 |
| **A5** | 11,5076 | 2,5518 | 0,182 | 8 |
| **A6** | 12,4519 | 2,6973 | 0,178 | 10 |
| **A7** | 3,5152 | 6,3654 | 0,644 | 5 |
| **A8** | 1,5755 | 14,5026 | 0,902 | 3 |
| **A9** | 4,5806 | 9,6428 | 0,678 | 4 |
| **A10** | 9,0983 | 2,3062 | 0,202 | 9 |

The calculation results of the distance of each alternative from the positive ideal solution (D+) and the negative ideal solution (D-) and the preference value (V) can be seen in Table 8 above. Based on the calculation results, the alternative with the highest preference value is A3 with a V value of 0.908 and is ranked 1st. Meanwhile, alternative A1 with a V value of 0.950 is ranked 2nd. The alternative with the lowest preference value is A6 with a V value of 0.178 and is ranked 10

**4. Conclusion**

This study shows that the integrated application of the TOPSIS and Weighted Product (WP) methods can help solve problems in the BLT recipient selection process in Srimulyo Village. The TOPSIS method provides the ability to determine the best alternative based on the proximity of the value to the ideal solution, while the WP method allows for more flexible weighting according to the level of importance of the criteria. The combination of these two methods has succeeded in producing an accurate, transparent, and efficient decision support system. Based on the calculation results, the alternative with the highest preference value is the priority for BLT recipients. The developed system is able to reduce manual selection errors and provide objective recommendations. This implementation is not only relevant to Srimulyo Village but can also be adapted by other areas facing similar challenges.

Provide a statement that what is expected, as stated in the "Introduction" chapter can ultimately result in "Results and Discussion" chapter, so there is compatibility. Moreover, it can also be added the prospect of the development of research results and application prospects of further studies into the next (based on result and discussion)(Sekaran et al., 2020).

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