**Journal of Actuarial, Finance and Risk Management (JAFRM)**
e-ISSN:28303938
Vol. 3(1), July, 2024.
http://e-journal.president.ac.id/presunivojs/index.php/JAFRM/index

# Determination of Maintenance Priorities on District and City Roads in Lampung Province in 2019 Using the Simple Additive Weighting (Saw) Method

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Receive: May 22, 2024, Revised: June 22, 2024. Accepted: July 19, 2024

***Abstract*****—** Road infrastructure is a primary transportation asset extensively used by society to support economic, educational, and other activities. Consequently, roads function as a crucial supporter of the country's socio-economic activities. UU No. 38 of 2004 regarding Roads stipulates that roads are essential transportation facilities for the economy, social aspects, environment, politics, and defense and security. This research employs the Simple Additive Weighting (SAW) method to collect secondary data. The secondary data is obtained from the Department of Communication, Informatics, and Statistics of Lampung Province and processed to generate an assessment of road segments based on preference values. The research results indicate that, based on the criteria weighting, heavily damaged road conditions have the highest importance weight at 58.6%, followed by the criterion of average daily traffic. These findings suggest that road experts share a similar perspective on how road criteria are prioritized for specific regions. The ranking results using the SAW method with a Likert scale indicate a value of 97.34.

***Keywords*****—** *maintenance priorities, road infrastructure, simple additive weighting*

## I. INTRODUCTION

Road infrastructure is a cornerstone of development and economic growth, particularly in emerging economies like Indonesia. Roads are integral to various aspects of life, supporting economic activities, social interactions, cultural exchanges, political stability, and environmental sustainability. Article 38 of Law No. 38 of 2004 on Roads highlights the multifaceted contributions of road infrastructure to these sectors. In addition, the principles outlined in Law No. 2 of 2022 emphasize the importance of utility, safety, tranquility, unity, efficiency, justice, sustainability, transparency, and public participation in road management.

Maintaining well-functioning road networks is crucial for the smooth flow of economic activities and the overall well-being of society. Efficient road maintenance can significantly enhance local economies by facilitating transportation, reducing vehicle operating costs, and improving accessibility [1]. However, local governments face significant challenges due to the increasing number of deteriorating roads and limited financial resources for repairs [2]. This necessitates a strategic approach to prioritize road maintenance, ensuring that the most critical roads are repaired first.

Several factors contribute to road deterioration, including heavy traffic [3], aging infrastructure [4], and resource constraints [5]. Regular maintenance and timely repairs are essential to mitigate significant damage and prolong the lifespan of road networks [6-7]. In Lampung Province, 14 provincial roads have been identified as highly influential, necessitating an effective prioritization strategy for maintenance efforts, one of them being taking survey from local community [8].

The Simple Additive Weighting (SAW) method is a widely recognized multi-criteria decision-making tool that helps in evaluating and ranking alternatives based on predefined criteria [9-10]. Previous studies have demonstrated the efficacy of the SAW method in various decision-making scenarios, including infrastructure management, environmental sustainability, and resource allocation. This study aims to apply the SAW method to determine maintenance priorities for district and city roads in Lampung Province in 2019.

This study focus on demonstrating the application of the SAW method in the context of road maintenance prioritization. While numerous studies have explored different decision-making techniques for infrastructure management, the specific application of the SAW method to prioritize road maintenance in Lampung Province provides new insights and practical implications [11]. The findings of this study are expected to aid local governments in making informed decisions regarding road maintenance, optimizing resource allocation, and enhancing the overall efficiency of road management practices. The strength of our study lies in its exclusive use of open data for criterion assessment, ensuring transparency and accessibility for the local community. This approach not only facilitates the prioritization of maintenance activities based on readily available data but also empowers the local community to apply the method independently due to its simplicity.

## II. Method

The Simple Additive Weighting (SAW) method is often referred to as a weighted summation method of performance values for each alternative across all characteristics of each option [12-13]. It is considered advantageous because it allows the determination of options for each attribute, and rankings are then made to select the best attributes. The SAW method requires the normalization process of the decision matrix (X) on a scale comparable to all available alternative classifications. Benefit and cost criteria are identified by the SAW method. One of the main differences between the two criteria is how they are selected in the decision-making process.

The steps in using the SAW method are as follows:

1. Identify alternatives, for example, $A_i$.
2. Determine standards for decision-making, such as $C_j$.
3. Assign each option a rating value based on each criterion. The assessment table used to determine the compatibility values by converting linguistic variables to a Likert scale is indicated in Table 1.The Likert scale will be used to quantify subjective opinion such as very low and very high for all Assessment Criteria used in this study. By quantifying an opinion, the Likert value can be used to calculate score which can be used.

**Table 1** The relationship between linguistic variables and Likert scale.

| Linguistic Variable | Code | Likert Scale |
|---|---|---|
| Very Low | SR | 1 |
| Low | R | 2 |
| Medium | S | 3 |
| High | T | 4 |
| Very High | ST | 5 |

The SAW method is utilized for decision-making by evaluating and ranking alternatives based on their performance against predefined criteria. This allows for a systematic approach to selecting the most suitable alternative for a given set of attributes.

4. To determine the level of importance or preference weight (W) for each criterion.

$$W = [W_1 W_2 W_3 \ldots\ldots W_j]$$

5. Create an assessment table for each option based on each criterion.
6. Create the decision matrix X from the rating table that corresponds to each alternative for each criterion. The value of each alternative ($A_i$) on the predetermined criteria ($C_j$), where i = 1,2,... m, and j = 1,2,... n.

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

7. Normalize the decision matrix by calculating the normalized performance rating values of alternative $A_i$ on criterion $C_j$.

$$r_{ij} = \begin{cases} \dfrac{x_{ij}}{Max(x_{ij})} \\ \dfrac{Min(x_{ij})}{x_{ij}} \end{cases}$$

Above formula is used if j is a benefit criterion. Otherwise, If j is a cost criterion we use the bottom part.

8. The results of the normalized performance rating values form the normalized matrix ($R$).

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

9. The results of preference values ($V_i$) are obtained by summing the multiplication of row elements in the normalized matrix ($R$) by corresponding preference weights ($W$) with column elements in the matrix ($W$).

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

The calculation results with larger values indicate that the alternative is the best alternative.

## III. RESULT AND DISCUSSION

### A. Data Preparation

The data used consists of the provincial road segments in Lampung in the year 2019.

**Table 2** The data for the provincial road segments in Lampung in 2019. Source: Dinas Komunikasi Informatika dan Statistik Provinsi Lampung.

| No. | Subdistrict | Road Condition (KM) 2019 | | | |
|---|---|---|---|---|---|
| | | RB | RR | S | B |
| 1 | Bandar Lampung | 0.00 | 0.72 | 1.00 | 7.66 |
| 2 | Lampung Selatan | 3.20 | 3.10 | 3.70 | 94.47 |
| 3 | Pesawaran | 14.40 | 12.20 | 21.80 | 94.04 |
| 4 | Pringsewu | 3.80 | 1.60 | 2.10 | 32.75 |
| 5 | Tanggamus | 68.96 | 9.40 | 12.82 | 105.35 |
| 6 | Lampung Timur | 21.40 | 3.05 | 5.95 | 104.53 |
| 7 | Metro | 0.00 | 0.90 | 0.30 | 14.65 |
| 8 | Lampung Tengah | 30.75 | 17.25 | 20.70 | 201.51 |
| 9 | Tulang Bawang | 27.65 | 4.07 | 2.80 | 33.33 |
| 10 | Mesuji | 1.00 | 0.00 | 0.00 | 40.05 |
| 11 | Tulang Bawang Barat | 36.60 | 9.40 | 14.60 | 69.34 |
| 12 | Lampung Utara | 10.60 | 6.00 | 25.27 | 121.17 |
| 13 | Way kanan | 100.06 | 17.86 | 10.20 | 117.46 |
| 14 | Lampung Barat | 22.48 | 4.80 | 10.20 | 75.46 |

**Table 3** The processed data of road segments.

| No. | Nama Ruas Jalan | Kondisi Jalan (%) | | | |
|---|---|---|---|---|---|
| | | RB | RR | S | B |
| 1 | Bandar Lampung | 0.00% | 7.68% | 10.66% | 81.66% |
| 2 | Lampung Selatan | 3.06% | 2.97% | 3.54% | 90.43% |
| 3 | Pesawaran | 10.11% | 8.57% | 15.30% | 66.02% |
| 4 | Pringsewu | 9.44% | 3.98% | 5.22% | 81.37% |
| 5 | Tanggamus | 35.09% | 4.78% | 6.52% | 53.61% |
| 6 | Lampung Timur | 15.86% | 2.26% | 4.41% | 77.47% |
| 7 | Metro | 0.00% | 5.68% | 1.89% | 92.43% |
| 8 | Lampung Tengah | 11.38% | 6.38% | 7.66% | 74.58% |
| 9 | Tulang Bawang | 40.75% | 6.00% | 4.13% | 49.12% |
| 10 | Mesuji | 2.44% | 0.00% | 0.00% | 97.56% |
| 11 | Tulang Bawang Barat | 28.17% | 7.23% | 11.24% | 53.36% |
| 12 | Lampung Utara | 6.50% | 3.68% | 15.50% | 74.32% |
| 13 | Way kanan | 40.74% | 7.27% | 4.15% | 47.83% |
| 14 | Lampung Barat | 19.90% | 4.25% | 9.03% | 66.81% |

B. Determination of Criteria and Criteria Weights

In this study, a total of 14 criteria obtained from the data of Lampung provincial road segments were used.

**Table 4** Assessment Criteria and Importance Level Weights

| Criterion Code | Criteria | Weight |
|---|---|---|
| $C_1$ | Average Daily Traffic | 19.1489 |
| $C_2$ | Length of Road Segments | 13.8298 |
| $C_3$ | Severely Damaged Condition | 23.4043 |
| $C_4$ | Lightly Damaged Condition | 18.0851 |
| $C_5$ | Moderate Condition | 14.8936 |
| $C_6$ | Good Condition | 10.6383 |

***Simple Additive Weighting***

1. Determining compatibility values based on each criterion. The assessment table used to determine compatibility values by converting linguistic variables to the Likert scale is shown in Table 1.
2. Creating the decision matrix $\boldsymbol{X}$ from the matching rating table for each alternative on each criterion. The value

of each alternative ($\boldsymbol{A_i}$) on the predetermined criteria ($\boldsymbol{C_j}$), where i = 1,2,... m and j = 1,2,... n.

**Table 5** Table of Alternatives Against Compatibility Assessment with the Simple Additive Weighting Method

| | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ | $C_6$ | | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ | $C_6$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $A_1$ | 5.0 | 2.0 | 1.0 | 1.0 | 1.0 | 5.0 | $A_8$ | 3.0 | 1.0 | 1.0 | 1.0 | 1.0 | 4.0 |
| $A_2$ | 3.0 | 5.0 | 1.0 | 1.0 | 1.0 | 5.0 | $A_9$ | 2.0 | 4.0 | 2.0 | 1.0 | 1.0 | 3.0 |
| $A_3$ | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 4.0 | $A_{10}$ | 1.0 | 2.0 | 1.0 | 1.0 | 1.0 | 5.0 |
| $A_4$ | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 5.0 | $A_{11}$ | 1.0 | 2.0 | 2.0 | 1.0 | 1.0 | 3.0 |
| $A_5$ | 2.0 | 3.0 | 2.0 | 1.0 | 1.0 | 3.0 | $A_{12}$ | 2.0 | 5.0 | 1.0 | 1.0 | 1.0 | 4.0 |
| $A_6$ | 3.0 | 4.0 | 1.0 | 1.0 | 1.0 | 4.0 | $A_{13}$ | 1.0 | 3.0 | 2.0 | 1.0 | 1.0 | 3.0 |
| $A_7$ | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 5.0 | $A_{14}$ | 1.0 | 3.0 | 1.0 | 1.0 | 1.0 | 4.0 |

3. Normalizing the decision matrix by calculating the normalized performance rating values for alternatives on each criterion.

**Table 6** Normalized Decision using the Simple Additive Weighting Method

| | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ | $C_6$ | | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ | $C_6$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $A_1$ | 0.2 | 0.5 | 1.0 | 1.0 | 1.0 | 0.6 | $A_8$ | 0.3 | 1.0 | 1.0 | 1.0 | 1.0 | 0.8 |
| $A_2$ | 0.3 | 0.2 | 1.0 | 1.0 | 1.0 | 0.6 | $A_9$ | 0.5 | 0.3 | 0.5 | 1.0 | 1.0 | 1.0 |
| $A_3$ | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 0.75 | $A_{10}$ | 1.0 | 0.5 | 1.0 | 1.0 | 1.0 | 0.6 |
| $A_4$ | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 0.6 | $A_{11}$ | 1.0 | 0.5 | 0.5 | 1.0 | 1.0 | 1.0 |
| $A_5$ | 0.5 | 0.3 | 0.5 | 1.0 | 1.0 | 1.0 | $A_{12}$ | 0.5 | 0.2 | 1.0 | 1.0 | 1.0 | 0.75 |
| $A_6$ | 0.3 | 0.3 | 1.0 | 1.0 | 1.0 | 0.75 | $A_{13}$ | 1.0 | 0.3 | 0.5 | 1.0 | 1.0 | 1.0 |
| $A_7$ | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 0.6 | $A_{14}$ | 1.0 | 0.3 | 1.0 | 1.0 | 1.0 | 0.8 |

4. The result of preference values ($\boldsymbol{V_i}$) is obtained by summing the multiplication of row elements in the normalized matrix ($\boldsymbol{R}$) with corresponding preference weights ($\boldsymbol{W}$) column elements in the matrix ($\boldsymbol{W}$). The results of the final preference values can be seen in the table below:

**Table 7** Preference Values Using the Simple Additive Weighting Method

| Alternatives | Values | Alternatives | Values |
|---|---|---|---|
| V1 | 73.5106 | V8 | 84.5744 |
| V2 | 71.9148 | V9 | 68.3510 |

| | | | |
|---|---|---|---|
| V3 | 97.3404 | V10 | 88.8297 |
| V4 | 95.7446 | V11 | 81.3829 |
| V5 | 69.5035 | V12 | 76.7021 |
| V6 | 74.2021 | V13 | 79.0780 |
| V7 | 95.7446 | V14 | 88.12056 |

5. The average values for each alternative ($A_i$) are obtained from the data entered into the table above. These values are then sorted or ranked from the highest to the lowest. According to the highest value, this option is considered the best."

**Table 8** Ranking Based on Preference Values Using the Simple Additive Weighting Method

| No. | Subdistrict | Alternatives | Values | No. | Subdistrict | Alternatives | Values |
|---|---|---|---|---|---|---|---|
| 3 | Pesawaran | V3 | 97,3404 | 13 | Way Kanan | V13 | 79,078 |
| 4 | Pringsewu | V4 | 95,7446 | 12 | Lampung Utara | V12 | 76,7021 |
| 7 | Metro | V7 | 95,7446 | 6 | Lampung Timur | V6 | 74,2021 |
| 10 | Mesuji | V10 | 88,8297 | 1 | Bandar Lampung | V1 | 73,5106 |
| 14 | Lampung Barat | V14 | 88,1205 | 2 | Lampung Selatan | V2 | 71,9148 |
| 8 | Lampung Tengah | V8 | 84,5744 | 5 | Tanggamus | V5 | 69,5035 |
| 11 | Tulang Bawang Barat | V11 | 81,3829 | 9 | Tulang Bawang | V9 | 68,351 |

The final result of the Simple Additive Weighting method, taken from the conclusion of the calculation process, has the highest value with a score of 97,34042553, indicating that the Pesawaran road segment is the one that should be prioritized for maintenance. Additionally, factors such as road condition, average daily traffic, and road length contribute to the prioritization, as indicated by the predefined criteria weighting.

On the other hand, the lowest score is 68,35106383, belonging to the Tulang Bawang road segment. This is due to factors such as road length, road condition, and average daily traffic that influenced the weighting and contributed to its lower prioritization in maintenance.

## IV. CONCLUSION

Based on the findings from prioritizing road repairs using the Simple Additive Weighting (SAW) method, several conclusions can be drawn. Analysis of road conditions and secondary data on average daily traffic revealed distinct patterns: Tulang Bawang showed the highest severity of road damage, Pesawaran had the most lightly damaged roads, North Lampung showed moderate road conditions, and Mesuji displayed the best road conditions. Applying the SAW method to the 2019 dataset confirmed that the criteria used in decision-making were appropriately weighted. The prioritization of road segments identified Pesawaran as the top priority for maintenance in Lampung Province, while Tulang Bawang was assigned the lowest priority. Comparison with actual road condition data in 2022 indicated a decrease in severely damaged roads due to maintenance efforts, but an increase in lightly and moderately damaged roads, signaling evolving maintenance needs.

Practical limitations of this study include its reliance on basic data such as road condition area and average daily traffic, which may not encompass all factors affecting road deterioration and maintenance requirements. Moreover, while the SAW method proved effective and straightforward, its simplicity may oversimplify complex decision-making processes that could benefit from more advanced techniques. Future research should consider incorporating diverse data sources such as traffic density, road usage patterns, and economic impact assessments to enhance the depth of analysis. Exploring more sophisticated multi-criteria decision-making methods or hybrid approaches and engaging local community stakeholders in decision-making processes are recommended to better align maintenance priorities with community needs and expectations.

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