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Combination of LOPCOW and MOORA in Restaurant Recommendation Decision Support System Based on User Reviews

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Abstract: A restaurant is a place of business that provides various types of food and beverages to be consumed on the spot or taken home. Restaurants are also often the venue of choice for various events, such as family gatherings, birthday celebrations, or business meetings. Restaurant recommendations based on user reviews are becoming an increasingly popular approach in helping individuals find the best places to eat according to their preferences. The purpose of the research is to develop an effective and objective decision support system in providing the best restaurant recommendations based on user reviews. This research makes a significant contribution to improving the quality of the user review-based recommendation system, by combining the advantages of objective data analysis (LOPCOW) and multi-criteria optimization (MOORA). The results of the combined ranking of the LOPCOW and MOORA methods show that Kedai Kita is ranked the highest with a score of 0.2897, followed by De'leuit Restaurant with a score of 0.284. Lemongrass Restaurant is in third place with a score of 0.2485, while Kluwih Sunda Authentic and Gurih 7 Bogor obtained a score of 0.2223 and 0.1981, respectively. The last position was occupied by RM Bumi Aki Puncak with the lowest score, which was 0.0396. These results show differences in performance or quality levels based on criteria analyzed using a combination of the two methods.
Keywords: Combination; Decision Support System; LOPCOW; MOORA; Recommendations;

1. INTRODUCING

A restaurant is a place of business that provides various types of food and beverages for consumption on location or takeaway. Restaurants are also often the venue of choice for various events, such as family gatherings, birthday celebrations, or business meetings. In addition to the quality of the food, friendly and efficient service is an important factor that affects visitor satisfaction, making it a crucial element in the industry. Restaurant recommendations based on user reviews are an increasingly popular approach in helping individuals find the best places to eat according to their preferences. User reviews, which typically include ratings of food taste, service quality, cleanliness, ambiance, and price, are a reliable source of information because they come from first-hand experience. By utilizing

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technology such as apps and websites, these reviews are often summarized in the form of ratings or ratings to make it easier to make decisions. This kind of recommendation can also be tailored to specific needs, such as restaurants with vegetarian menus, kid-friendly eateries, or locations with a romantic atmosphere. Through the analysis of user reviews, potential diners can get a more accurate picture of the restaurant that best suits their expectations.

A Decision Support System (DSS) is a computer-based system designed to assist decision-makers in solving complex problems by collecting, processing, and analyzing relevant information[1]–[3]. DSS does not aim to replace human decision-making, but rather provides the support and information needed to make better, more informed decisions. This system is typically used in situations where decisions are made involving a variety of alternatives and criteria, which are often difficult to analyze manually[4], [5]. DSS assists decision-makers in processing and analyzing information more efficiently, resulting in more accurate and data-driven decisions[6]. By using a structured method, the decisions taken are more objective and can be accounted for. In situations full of uncertainty or with many alternatives and criteria involved, DSS can provide clearer insights by taking into account the various factors that influence decisions.

The Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA) method is one of the methods in the decision support system used to solve multi-criteria problems by considering several objectives at once[7], [8]. MOORA has an advantage because of its simple, flexible process, and ability to provide accurate results in complex decision-making situations[9]. Restaurant recommendations based on user reviews using the MOORA method is a systematic approach to determining the best restaurants by considering various criteria. In this process, user reviews are analyzed and translated into quantitative values based on criteria such as food taste, service quality, atmosphere, cleanliness, and price. The MOORA method begins with data normalization to make comparisons between criteria more objective, followed by the calculation of optimization value by separating benefit criteria such as taste and service, as well as cost criteria such as price. The restaurant with the highest score from the results of this analysis is recommended as the best choice. This approach ensures that decisions are based on comprehensive user reviews and provide recommendations that best suit the customer's needs and preferences. One of the main drawbacks of the MOORA method lies in its treatment of criterion weights. In the application of the MOORA standard, this method does not explicitly take into account the weight of the criteria directly, so all criteria are considered to have the same level of importance[7], [10], [11]. This becomes less optimal when the criteria used have different significant levels in influencing decisions. To improve the determination of criterion weighting, the Logarithmic Percentage Change-Driven Objective Weighting (LOPCOW) weighting method is used.

LOPCOW is a criterion weighting method in a multi-criteria-based decision support system that aims to provide objective weights based on the level of data variation in each criterion[12], [13]. This method utilizes logarithmic-based percentage changes to measure the relative contribution of each criterion to decision-making. By taking into account the variation or difference in data between alternatives in each criterion, LOPCOW ensures that the criteria with a more significant value distribution get higher weight[14], [15]. LOPCOW does not require preference input from decision makers, resulting in a completely objective weight. This method is effective in paying attention to the value distribution between alternatives, making it ideal for data with a high degree of heterogeneity.

The combination of the LOPCOW and MOORA methods is an innovative approach in a multi-criteria-based decision support system. LOPCOW is used to objectively determine the weight of the criteria by paying attention to the variation of data between alternatives in each criterion, so that the resulting weight reflects the importance of the contribution of each criterion in the decision-making process. After the weight of the criteria is determined,

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MOORA is used to evaluate and optimize alternatives based on the calculation of the benefit and cost ratios of each criterion. This combination offers a more accurate and objective solution, especially in situations with complex and heterogeneous data. This approach is very effective in a variety of applications, as it is able to produce a final ranking that is more transparent, relevant, and in accordance with the purpose of the decision.

The purpose of the research is to develop an effective and objective decision support system in providing the best restaurant recommendations based on user reviews. This research makes a significant contribution to improving the quality of the user review-based recommendation system, by combining the advantages of objective data analysis (LOPCOW) and multi-criteria optimization (MOORA). The contribution in this study is to combine LOPCOW for objective weighting of criteria and MOORA for strong ranking, this study provides a comprehensive framework in processing and analyzing user reviews, thus supporting more reliable decision-making in choosing restaurants.

2. RESEARCH METHODS

Research stages are systematic steps taken by a researcher to plan, implement, analyze, and conclude a research. This stage is designed to ensure that the research process is directed, objective, and produces valid and trustworthy results. These stages are flexible, depending on the type and purpose of the research being conducted, the stages of the research carried out are shown in Figure 1.

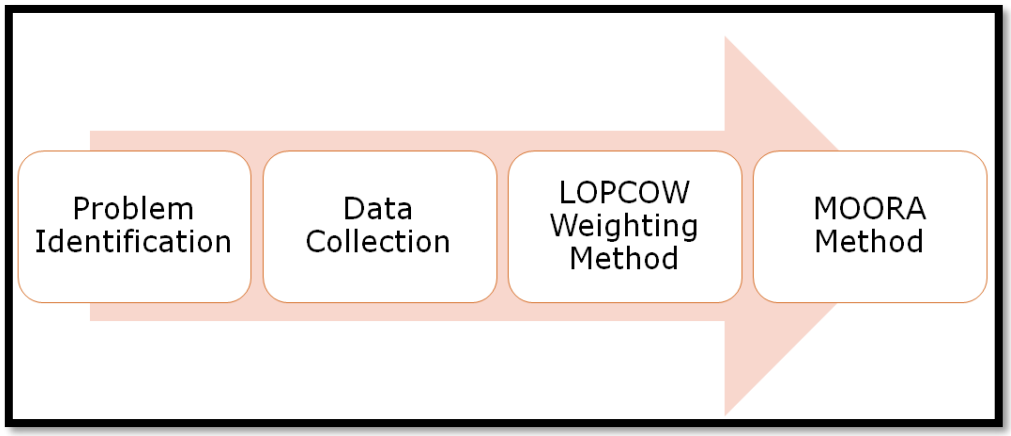

Figure 1. Research Stages

Research begins with problem identification, which is the process of determining the main issue or question that is the focus of the research. This stage aims to understand the needs or gaps that exist in a field and formulate clear research objectives. Once the problem is identified, data collection is carried out to obtain relevant information and support the analysis. This data can be quantitative or qualitative data collected through reviews on available websites. Furthermore, the collected data was analyzed using the LOPCOW weighting method to objectively determine the weight of the criteria. This method ensures more accurate and consistent weighting. After the criteria weights are obtained, the data is processed using the MOORA method, which is a multi-criteria decision-making method. MOORA is used to evaluate and rank alternatives based on ratio values, resulting in the best solution according to the research objectives. These stages are interconnected to ensure the research produces valid and relevant conclusions.

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Logarithmic Percentage Change-Driven Objective Weighting (LOPCOW)

Logarithmic Percentage Change-Driven Objective Weighting (LOPCOW) is a weighting method that aims to objectively determine the weight of criteria based on the rate of change in data between alternatives using a logarithmic approach. This method is designed to overcome the limitations of subjectivity by utilizing the information contained in the data.

The decision matrix consists of predefined alternatives and criteria. In a decision matrix each row represents an alternative, and each column represents a criterion. The decision matrix is created with the following formula.

$$X = \begin{bmatrix} x_{11} & x_{21} & x_{2n} \\ x_{12} & x_{22} & x_{2n} \\ x_{m1} & x_{m2} & x_{mn} \end{bmatrix} \quad (1)$$

Normalization is carried out to eliminate the influence of the unit scale on each criterion. The normalization formula uses the following formula:

$$n_{ij} = \frac{x_{ij} - x^{j}_{min}}{x^{j}_{max} - x^{j}_{min}} \quad (2)$$

$$n_{ij} = \frac{x^{j}_{max} - x_{ij}}{x^{j}_{max} - x^{j}_{min}} \quad (3)$$

The calculation of the normalization value has the form of an equation, namely for equations (2) used for benefit criteria and equations (3) for cost criteria.

Furthermore, calculating the preference value is that this value score describes the extent to which an alternative meets the desired goal in the decision-making problem, calculated by the following formula.

$$PV_i = \left| \ln \left(\frac{\sqrt{\frac{\sum_{i=1}^{m} {n_{ij}}^2}{m}}}{\sigma} \right) * 100 \right| \quad (4)$$

Criterion weights are values that indicate the relative importance of each criterion in the multi-criteria decision-making process. Criterion weights are used to objectively assess and compare alternatives, where more important criteria will be given higher weight. The weight of the criteria in LOPCOW is calculated by the following formula.

$$w_j = \frac{PV_i}{\sum_{j=1}^{n} PV_i} \quad (5)$$

The LOPCOW method is designed to objectively determine the weight of the criteria by considering the relative priority between the criteria.

Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA) Method

The MOORA method is one of the methods in the DSS that is used to solve multi-criteria problems. MOORA helps in evaluating alternatives based on several criteria by optimizing for conflicting goals (e.g. maximizing benefits and minimizing costs). The decision matrix consists of predefined alternatives and criteria. In a decision matrix each row represents an alternative, and each column represents a criterion. The decision matrix is made with equation (1).

Normalization is carried out to eliminate the influence of the unit scale on each criterion. The normalization formula uses the following formula:

$$x^{*}_{ij} = \frac{x_{ij}}{\sqrt{\left[\sum_{i=1}^{j} x^{2}_{ij}\right]}} \quad (6)$$

After normalization, the MOORA value is calculated by combining the benefit criteria and the cost criteria. The formula for benefit and cost values uses the following formula:

$$y_i = \sum_{j=1}^{n} w_j * x^{*}_{ij} - \sum_{j=g+1}^{n} w_j * x^{*}_{ij} \quad (7)$$

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The MOORA method is a simple and easy-to-use method, can accommodate criteria with different objectives (benefits and costs), as well as objective results because they are based on mathematical calculations.

3. RESULT AND DISCUSSIONS

The combination of LOPCOW and MOORA in the restaurant recommendation decision support system based on user reviews is a state-of-the-art approach designed to optimize restaurant recommendation systems by utilizing objective weighting techniques and multi-criteria-based decision-making. LOPCOW is used to objectively determine the weighting of various criteria, based on variations in user reviews. This ensures that criteria with greater variation in data, such as food or service quality, get more precise weight. Once the weights are determined, MOORA is applied to evaluate and rank restaurants taking into account favorable criteria and unfavorable criteria. This combination allows for an unbiased, data-driven decision-making process, which accommodates a wide range of user preferences and provides more accurate and relevant recommendations. By combining LOPCOW's ability to objectively calculate weights and MOORA's efficiency in multi-criteria optimization, the system offers a robust solution for selecting the best restaurants based on diverse and dynamic user reviews. This integrated approach ensures that the final recommendation reflects user preferences effectively while minimizing subjective influence in the decision-making process.

Collection of Restaurant Recommendation Data Based on User Reviews

Collecting restaurant recommendation data based on user reviews can be done by utilizing review websites. The process starts with identifying the restaurant you want to evaluate, then collecting data from user reviews available on the platform. The data collected typically includes usernames, ratings (on a star scale), text comments or reviews, and review times. In addition, key criteria such as food taste, cleanliness, quality of service, price, atmosphere, and location can be evaluated from the information provided by users in their reviews.

Table 1. Data Collection

Restaurant	Number of Reviews	Rating	Service	Food	Value	Distance
Lemongrass	582	4	3.7	3.5	3.6	5.5
RM Bumi Aki Puncak	438	4.5	4.2	4.3	4.2	37.2
De'leuit Restaurant	614	4	4	4	4	4.2
Gurih 7 Bogor	113	4	3.7	3.6	3.6	4.8
Kedai Kita	813	4	3.3	4	3.8	4.1
Kluwih Sunda Authentic	103	4	4	4	4	4.1

Weight Determination Using the LOPCOW Method

Weighting using the LOPCOW method is an objectivity-based approach that combines the analysis of logarithmic changes between criteria to determine the level of importance of each criterion in decision-making. This method is based on the relationship between criteria, in which changes in values or influences between criteria are analyzed to identify the level of sensitivity and its contribution proportionally. LOPCOW uses logarithmic percentage changes to capture the dynamics of criterion relationships more accurately, resulting in weights that reflect the relative significance of each criterion in the context of decisions. This approach is designed to reduce subjectivity and improve consistency in weighting, making it suitable for decision support systems that involve mutually influencing

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criteria. With its excellence in capturing data complexity and relationships between criteria, LOPCOW is a reliable tool to support multi-criteria analysis in a wide range of applications.

The decision matrix consists of predefined alternatives and criteria. In a decision matrix each row represents an alternative, and each column represents a criterion. The decision matrix is created with the using equation (1).

$$X = \begin{bmatrix} 582 & 4.0 & 3.7 & 3.5 & 3.6 & 5.50 \\ 438 & 4.5 & 4.2 & 4.3 & 4.2 & 37.2 \\ 614 & 4.0 & 4.0 & 4.0 & 4.0 & 4.20 \\ 113 & 4.0 & 3.7 & 3.6 & 3.6 & 4.80 \\ 813 & 4.0 & 3.3 & 4.0 & 3.8 & 4.10 \\ 103 & 4.0 & 3.0 & 4.0 & 4.0 & 4.10 \end{bmatrix}$$

Normalization is carried out to eliminate the influence of the unit scale on each criterion. The normalization formula using equation (2) and (3).

$$n_{11} = \frac{x_{11} - x^1_{min}}{x^1_{max} - x^1_{min}} = \frac{582 - 103}{813 - 103} = 0.6746$$

The results of the calculation of normalization values in the overall LOPCOW method are shown in table 2.

Table 2. The Results of the Calculation of Normalization Values

Restaurant	Number of Reviews	Rating	Service	Food	Value	Distance
Lemongrass	0.6746	0.0000	0.4444	0.0000	0.0000	0.9577
RM Bumi Aki Puncak	0.4718	1.0000	1.0000	1.0000	1.0000	0.0000
De'leuit Restaurant	0.7197	0.0000	0.7778	0.6250	0.6667	0.9970
Gurih 7 Bogor	0.0141	0.0000	0.4444	0.1250	0.0000	0.9789
Kedai Kita	1.0000	0.0000	0.0000	0.6250	0.3333	1.0000
Kluwih Sunda Authentic	0.0000	0.0000	0.7778	0.6250	0.6667	1.0000

Furthermore, calculating the preference value is that this value score describes the extent to which an alternative meets the desired goal in the decision-making problem, calculated using equation (4).

$$PV_1 = \left| \ln \left(\frac{\sqrt{\frac{\sum_{i=1}^{m} {n_{11,16}}^2}{m}}}{\sigma} \right) * 100 \right| = \left| \ln \left(\frac{\sqrt{\frac{2.1960}{6}}}{0.3682} \right) * 100 \right| = \left| \ln \left(\frac{0.6050}{0.3682} \right) * 100 \right| = 49.6641$$

$$PV_2 = \left| \ln \left(\frac{\sqrt{\frac{\sum_{i=1}^{m} {n_{21,26}}^2}{m}}}{\sigma} \right) * 100 \right| = \left| \ln \left(\frac{\sqrt{\frac{1}{6}}}{0.3727} \right) * 100 \right| = \left| \ln \left(\frac{0.4082}{0.3727} \right) * 100 \right| = 9.1161$$

$$PV_3 = \left| \ln \left(\frac{\sqrt{\frac{\sum_{i=1}^{m} {n_{31,36}}^2}{m}}}{\sigma} \right) * 100 \right| = \left| \ln \left(\frac{\sqrt{\frac{2.6049}{6}}}{0.3234} \right) * 100 \right| = \left| \ln \left(\frac{0.6589}{0.3234} \right) * 100 \right| = 71.1653$$

$$PV_4 = \left| \ln \left(\frac{\sqrt{\frac{\sum_{i=1}^{m} {n_{41,46}}^2}{m}}}{\sigma} \right) * 100 \right| = \left| \ln \left(\frac{\sqrt{\frac{2.1875}{6}}}{0.3385} \right) * 100 \right| = \left| \ln \left(\frac{0.6038}{0.3385} \right) * 100 \right| = 57.8726$$

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$$PV_5 = \left| \ln\left(\frac{\sqrt{\frac{\sum_{i=1}^{m} {n_{51,56}}^2}{m}}}{\sigma} \right) * 100 \right| = \left| \ln\left(\frac{\sqrt{\frac{2}{6}}}{0.3685} \right) * 100 \right| = \left| \ln\left(\frac{0.5774}{0.3685} \right) * 100 \right| = 44.8971$$

$$PV_6 = \left| \ln\left(\frac{\sqrt{\frac{\sum_{i=1}^{m} {n_{61,66}}^2}{m}}}{\sigma} \right) * 100 \right| = \left| \ln\left(\frac{\sqrt{\frac{4.8693}{6}}}{0.3680} \right) * 100 \right| = \left| \ln\left(\frac{0.9009}{0.3680} \right) * 100 \right| = 89.5181$$

Criterion weights are values that indicate the relative importance of each criterion in the multi-criteria decision-making process. Criterion weights are used to objectively assess and compare alternatives, where more important criteria will be given higher weight calculated using equation (5).

$$w_1 = \frac{PV_1}{\sum_{j=1}^{n} PV_{1,6}} = \frac{49.6641}{49.6641 + 9.1161 + 71.1653 + 57.8726 + 44.8971 + 89.5181} = 0.1541$$

$$w_2 = \frac{PV_2}{\sum_{j=1}^{n} PV_{1,6}} = \frac{9.1161}{49.6641 + 9.1161 + 71.1653 + 57.8726 + 44.8971 + 89.5181} = 0.0283$$

$$w_3 = \frac{PV_3}{\sum_{j=1}^{n} PV_{1,6}} = \frac{71.1653}{49.6641 + 9.1161 + 71.1653 + 57.8726 + 44.8971 + 89.5181} = 0.2209$$

$$w_4 = \frac{PV_4}{\sum_{j=1}^{n} PV_{1,6}} = \frac{57.8726}{49.6641 + 9.1161 + 71.1653 + 57.8726 + 44.8971 + 89.5181} = 0.1796$$

$$w_5 = \frac{PV_5}{\sum_{j=1}^{n} PV_{1,6}} = \frac{44.8971}{49.6641 + 9.1161 + 71.1653 + 57.8726 + 44.8971 + 89.5181} = 0.1393$$

$$w_6 = \frac{PV_6}{\sum_{j=1}^{n} PV_{1,6}} = \frac{89.5181}{49.6641 + 9.1161 + 71.1653 + 57.8726 + 44.8971 + 89.5181} = 0.2778$$

The final result of the criterion weights obtained from the LOPCOW method will ensure that decision-making is more objective, fair, and reflects the distribution of relevant data.

Implementation of the MOORA Method in Restaurant Recommendation

The MOORA method is one of the methods in the DSS that is used to solve multi-criteria problems. MOORA helps in evaluating alternatives based on several criteria by optimizing for conflicting goals (e.g. maximizing benefits and minimizing costs). The decision matrix consists of predefined alternatives and criteria. In a decision matrix each row represents an alternative, and each column represents a criterion. The decision matrix is made with equation (1).

Normalization is carried out to eliminate the influence of the unit scale on each criterion. The normalization calculated using equation (6).

$$x_{11}^{*} = \frac{x_{11}}{\sqrt{[\sum_{i=1}^{j} x_{11,62}^2]}} = \frac{582}{\sqrt{1591911}} = \frac{582}{1261.7096} = 0.4613$$

The results of the calculation of normalization values in the overall MOORA method are shown in table 3.

Table 3. The Results of the Calculation of Normalization Values

Restaurant	Number of Reviews	Rating	Service	Food	Value	Distance
Lemongrass	0.4613	0.3995	0.3946	0.3655	0.3795	0.1426
RM Bumi Aki Puncak	0.3471	0.4494	0.4480	0.4490	0.4427	0.9642
De'leuit Restaurant	0.4866	0.3995	0.4266	0.4177	0.4216	0.1089

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Gurih 7 Bogor	0.0896	0.3995	0.3946	0.3759	0.3795	0.1244
Kedai Kita	0.6444	0.3995	0.3520	0.4177	0.4006	0.1063
Kluwih Sunda Authentic	0.0816	0.3995	0.4266	0.4177	0.4216	0.1063

After normalization, the final value of MOORA is calculated by combining the benefit criteria and the cost criteria calculated using equation (6).

$$y_1 = \sum_{j=1}^{n} w_{1,5} * x^*_{11,51} - \sum_{j=g+1}^{n} w_6 * x^*_{61}$$

$$y_1 = \big((0.1541 * 0.4613) + (0.0283 * 0.3995) + (0.2209 * 0.3946) + (0.1796 * 0.3655) + (0.1393 * 0.3795)\big) - (0.2778 * 0.1426)$$

$$y_1 = 0.2485$$

The results of the calculation of the final value of MOORA method are shown in table 4.

Table 4. The Results of the Calculation of Final Value MOORA

Restaurant	Final Value
Lemongrass	0.2485
RM Bumi Aki Puncak	0.0396
De'leuit Restaurant	0.2840
Gurih 7 Bogor	0.1981
Kedai Kita	0.2897
Kluwih Sunda Authentic	0.2223

Alternative ranking is carried out by calculating the final score of each alternative based on the weight of the criteria and the value of its performance. In a method like MOORA, the value of each alternative is obtained by subtracting the total value of the profit (maximized criterion) by the total value of the loss (the minimized criterion). The alternative with the highest score is considered the best choice because it has the most optimal performance compared to other alternatives. This process ensures objective results based on a comprehensive analysis of all criteria. The ranking results are shown in Figure 2.

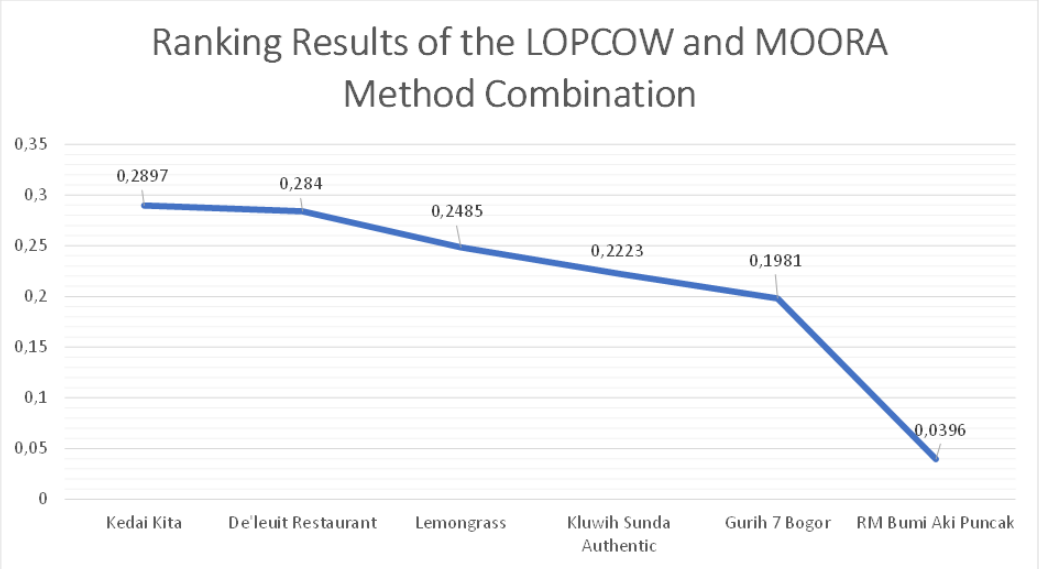

Figure 2. The Results of the Calculation of Final Value MOORA

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The results of the combined ranking of the LOPCOW and MOORA methods show that Kedai Kita is ranked the highest with a score of 0.2897, followed by De'leuit Restaurant with a score of 0.284. Lemongrass Restaurant is in third place with a score of 0.2485, while Kluwih Sunda Authentic and Gurih 7 Bogor obtained a score of 0.2223 and 0.1981, respectively. The last position was occupied by RM Bumi Aki Puncak with the lowest score, which was 0.0396. These results show differences in performance or quality levels based on criteria analyzed using a combination of the two methods.

4. CONCLUSION

The combination of LOPCOW and MOORA in the restaurant recommendation decision support system based on user reviews is a state-of-the-art approach designed to optimize restaurant recommendation systems by utilizing objective weighting techniques and multi-criteria-based decision-making. LOPCOW is used to objectively determine the weighting of various criteria, based on variations in user reviews. This ensures that criteria with greater variation in data, such as food or service quality, get more precise weight. Once the weights are determined, MOORA is applied to evaluate and rank restaurants taking into account favorable criteria and unfavorable criteria. This combination allows for an unbiased, data-driven decision-making process, which accommodates a wide range of user preferences and provides more accurate and relevant recommendations. By combining LOPCOW's ability to objectively calculate weights and MOORA's efficiency in multi-criteria optimization, the system offers a robust solution for selecting the best restaurants based on diverse and dynamic user reviews. This integrated approach ensures that the final recommendation reflects user preferences effectively while minimizing subjective influence in the decision-making process. The results of the combined ranking of the LOPCOW and MOORA methods show that Kedai Kita is ranked the highest with a score of 0.2897, followed by De'leuit Restaurant with a score of 0.284. Lemongrass Restaurant is in third place with a score of 0.2485, while Kluwih Sunda Authentic and Gurih 7 Bogor obtained a score of 0.2223 and 0.1981, respectively. The last position was occupied by RM Bumi Aki Puncak with the lowest score, which was 0.0396. These results show differences in performance or quality levels based on criteria analyzed using a combination of the two methods. The contribution in this study is to combine LOPCOW for objective weighting of criteria and MOORA for strong ranking, this study provides a comprehensive framework in processing and analyzing user reviews, thus supporting more reliable decision-making in choosing restaurants.

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