Building of Informatics, Technology and Science (BITS)
Volume 5, No 3, Desember 2023 Page: 636−648
ISSN 2684-8910 (media cetak)
ISSN 2685-3310 (media online)
DOI 10.47065/bits.v5i3.4663

Decision Support System for Tourist Attraction Recommendations Using Reciprocal Rank and Multi-Objective Optimization on the basis of Ratio Analysis

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Submitted: **07/12/2023**; Accepted: **30/12/2023**; Published**: 30/12/2023**

Abstract−A tourist attraction is a destination or place visited by tourists to enjoy a variety of attractions, natural beauty, culture, history, or recreation. Attractions can be beaches, mountains, lakes, national parks, historical buildings, museums, amusement parks, and much more. One common problem is confusion in choosing the right attraction, where the information available is incomplete or inaccurate, causing tourists difficulty in making the right decision. Therefore, there needs to be a holistic and integrated approach in choosing tourist attractions, taking into account these aspects so that the tourist experience becomes more meaningful and meaningful for all parties involved. The research objective of the Attraction Recommendation Decision Support System Using Reciprocal Rank and MOORA is to develop a system that can provide optimal attraction recommendations to users based on their preferences against diverse criteria, such as distance, cost, travel time, and cleanliness level. By using the Reciprocal Rank approach to take into account the user's subjective preferences towards each criterion. Meanwhile, by applying MOORA, this study aims to optimize the relative performance of alternative attractions based on the relationship between criteria. Thus, this research is to provide useful tools for users to make better and more informed decisions. The ranking results provide recommendations for alternative krui beach with a final value of 0.3752 to rank 1, alternative tanjung setia beach with a final value of 0.3558 to rank 2, alternative klara beach with a final value of 0.3512 to rank 3.

Keywords: Approach; Decision Support System; MOORA; Reciprocal Rank; Recommendations

1. INTRODUCTION

A tourist attraction is a destination or place visited by tourists to enjoy a variety of attractions, natural beauty, culture, history, or recreation. Attractions can be beaches, mountains, lakes, national parks, historical buildings, museums, amusement parks, and much more. Each attraction has its own charm that lures tourists to visit it. Some famous attractions have even become icons of an area and become the main destination for tourists who come from various parts of the world. Tourist attractions also play an important role in the tourism industry of a country or region, which contributes significantly to economic growth and preservation of cultural and natural heritage. With a wide selection of attractions available, tourists have the opportunity to explore and feel the beauty and uniqueness offered by various destinations around the world. One common problem is confusion in choosing the right attraction, where the information available is incomplete or inaccurate, causing tourists difficulty in making the right decision. Therefore, there needs to be a holistic and integrated approach in choosing tourist attractions, taking into account these aspects so that the tourist experience becomes more meaningful and meaningful for all parties involved.

A decision support system is a set of processes, tools, or methods used to choose among available options or alternatives taking into account various factors and criteria[1]–[3]. Its purpose is to assist individuals, groups, or organizations in making appropriate, effective, and efficient decisions. These systems may involve the use of formal or informal approaches, including data analysis, mathematical models, statistical techniques, or qualitative consideration based on knowledge and experience. Using the right decision support system, users can identify, analyze, and select options that best suit their needs, goals, and situation[4]. A decision support system is a process or tool used to choose among several available options or alternatives taking into account various factors and criteria. These systems can be formal or informal methods used by individuals, groups, or organizations to make appropriate and rational decisions. One method in decision support systems is Multi-Objective Optimization on the basis of Ratio Analysis.

The Multi-Objective Optimization on the basis of Ratio Analysis (MOORA) method is an approach used for decision making involving various criteria or conflicting goals[5]–[8]. In this method, different criteria or objectives are analyzed separately using ratios to measure the relative performance of each alternative. After that, the ratios are compared and given relative weights to calculate the total score of each alternative. Taking into account diverse criteria, MOORA allows decision makers to comprehensively evaluate alternatives and select the most optimal solution according to existing preferences and needs. MOORA also provides flexibility in handling situations where there are many criteria that must be considered simultaneously[5], [8]–[10]. By analyzing the ratio between each alternative and each criterion, this method allows decision makers to measure the relative contribution of each alternative to each criterion. In addition, MOORA also makes it possible to adjust the relative weight of each criterion based on the preferences and priorities set by the decision maker. MOORA is a useful tool in dealing with complexity and uncertainty in decision making, especially in contexts where many factors must be considered simultaneously. One of the main drawbacks of MOORA is sensitivity to relative weight selection. Since decision-making depends on

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determining the weights assigned to each criterion, small changes in those weights can result in different alternative ratings. In addition, MOORA tends to provide less stable and objective results due to subjectivity in determining the weight of criteria. One method of weighting criteria using the reciprocal rank method.

The reciprocal rank weighting method is an approach used in multi-criteria decision making to evaluate and rank alternatives based on the decision maker's preference for a given criterion[11]–[13]. In this method, each criterion is given a relative weight that reflects its importance to the end goal. Then, the relative rating of each alternative is calculated based on the rank relative to each criterion and its weight. The weight of these criteria is often determined through subjective methods, such as consultation with experts or direct judgment from decision makers. The reciprocal rank weighting method provides flexibility in addressing different preferences and allows decision makers to consider the interaction between criteria directly. One of the main advantages of the reciprocal rank weighting method is its ability to consider the relative preferences of the decision maker against any given criterion. By assigning weight to each criterion, the method allows users to evaluate alternatives based on the degree of importance of each criterion to the end goal. This flexibility allows for more focused decision-making that suits individual preferences or the specific needs of a given situation. In addition, the reciprocal rank weighting method is also relatively easy to understand and implement, allowing users to produce results quickly and efficiently. Thus, this method can be a useful tool in overcoming the complexities in multi-criteria decision making and assisting users in achieving solutions that are better and more in line with their goals.

The combination of Reciprocal Rank and MOORA can result in a robust approach to multi-criteria decision making. By combining Reciprocal Rank, which ranks each alternative relative to decision makers' preferences, with MOORA, which optimizes the performance of alternatives based on ratios between criteria, users can gain a more comprehensive and structured perspective on evaluating alternatives. Reciprocal rank can be used to assign relative weights to each criterion based on subjective preference, while MOORA is used to measure and compare alternative relative performance based on ratios between criteria. This combination allows decision makers to combine their subjective preferences with more objective and measurable analysis, thus enabling better and more informed decision making. By combining Reciprocal Rank and MOORA, decision makers can leverage the advantages of both simultaneously. Reciprocal rank makes it possible to take into account individual preferences and relative importance of each criterion, while MOORA provides a more structured and measurable approach in evaluating alternative performance[14], [15]. Thus, users can optimize their decisions by considering subjective and objective factors in a balanced manner. In addition, this combination can also provide greater flexibility in handling complexity and uncertainty in multi-criteria decision-making situations. Thus, the use of a combination of reciprocal rank and MOORA can improve the accuracy, objectivity, and effectiveness of decision-making processes in various contexts and fields of application.

Research related to tourist attraction recommendations, namely first by applying the Analytical Hierarchy Process (AHP) method as an algorithm that selects tourist destinations based on criteria entered by users can provide information and provide recommendations about tourist destinations[16]. Further research decision support systems can help prospective tourists in choosing tourist destinations using the Simple Additive Weighting (SAW) method using criteria of distance, cost, facilities, time and age. The results of this study will easily determine tourist destinations that suit their criteria and desires[17]. Further research on the Weighted Product method in selecting the best beach attractions gave the same results between the test results on the system and the results of manual calculations. Then based on system testing and manual testing conducted by 20 beach tours showed that 100% of the system was running well[18]. The last study applied the TOPSIS method to provide decision-making recommendations for the selection of tourist sites based on criteria of distance, travel time, entrance fees, and cleanliness levels[19]. The difference with previous research conducted is that this study uses the reciprocal rank weighting method for evaluating the weight of criteria used based on the importance of existing criteria and the MOORA method for evaluating alternative tourist attractions.

The research objective of the Attraction Recommendation Decision Support System Using Reciprocal Rank and MOORA is to develop a system that can provide optimal attraction recommendations to users based on their preferences against diverse criteria, such as distance, cost, travel time, and cleanliness level. By using the Reciprocal Rank approach to take into account the user's subjective preferences towards each criterion. Meanwhile, by applying MOORA, this study aims to optimize the relative performance of alternative attractions based on the relationship between criteria. Thus, this research is to provide useful tools for users to make better and more informed decisions.

2. RESEARCH METHODOLOGY

2.1 Research Stages

The research stage is a series of steps needed to design, run, and present research results in a systematic and structured way[20], [21]. This stage helps in controlling the research process and ensuring that the study meets the required scientific standards. The stages of research form an essential framework for researchers to produce valid and meaningful knowledge. The stages of research carried out are as shown in Figure 1.

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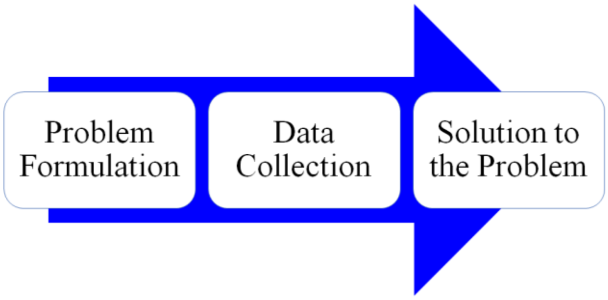

Figure 1. Research Stage

The research stages of Figure 1 show the process carried out, the initial stage involves identifying and formulating problems to be solved, such as uncertainty in the selection of tourist attractions, complexity in considering various criteria, or the need for a decision support system. The next stage is the collection of data related to existing attractions, including information about criteria that have been identified, such as distance, entrance rates, travel time, and previous visitor reviews. The last process uses the Reciprocal Rank and MOORA methods in providing tourist attraction recommendations.

2.2 Research Framework

The research framework is a methodological and structural foundation that guides the implementation of a research. The research framework is an important tool for researchers to compile and carry out research in a structured and systematic manner. The framework of the research conducted is as in Figure 2.

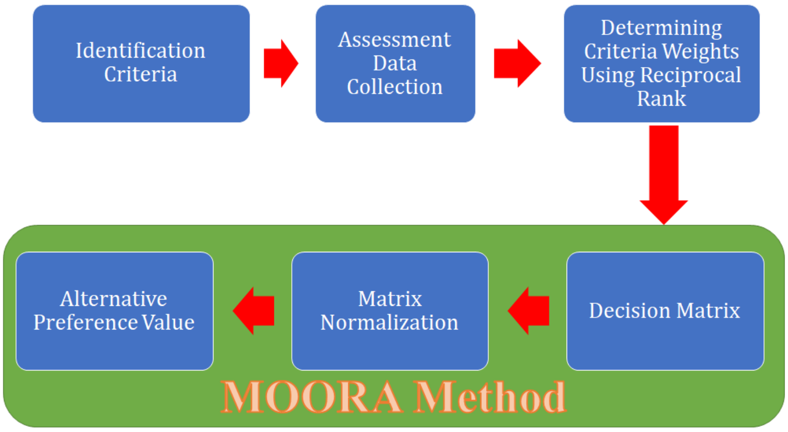

Figure 2. Research Framework

The research framework figure 1 is a structure or plan to be carried out in this study, the research framework has 6 stages, namely identification of criteria, collection of assessment data, determination of criteria weight, decision matrix, matrix normalization, and alternative preference values. Each stage carried out will be explained as follows.

a. Identification of criteria in the context of attraction selection is an important step to understand the factors to be evaluated and taken into account in the decision-making process. Here are some criteria that can be identified in the selection of attractions:
   1. Location (Benefit): Distance from the user's location, accessibility by public transportation, and location safety are important factors that influence the choice of attraction.
   2. Facilities (Benefit): The availability of facilities such as parking lots, toilets, rest areas, and places to eat can affect the comfort of visitors during their visit.
   3. Admission Fee (Cost): The entrance fee to the attraction is an important consideration for many users. Affordable prices can be a deciding factor in choosing a particular attraction.
   4. Quality of Service (Benefit): Friendly, informative, and responsive service from attraction staff or staff can also affect the visitor experience.
   5. Hygiene (Benefit): The cleanliness and sanitation of the tourist attraction's environment, including public toilets, places to eat, and public areas, are also important factors in decision making.
   6. Visitor Reviews (Benefit): Opinions and reviews from past visitors can provide valuable insight into their experience at the attraction.

b. Alternative assessment data is information collected to evaluate the relative performance of the various alternatives available in a given context. In the selection of attractions, alternative assessment data can cover various aspects relevant to the decision. This data can be obtained through a variety of sources, including surveys, online browsing, direct observation, and information from related parties. Using this alternative assessment data, decision makers

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can conduct a comprehensive analysis to select attractions that best suit their needs and preferences. Alternative assessment data plays an important role in helping decision makers to make more informed and informed decisions in attraction selection.

Table 1. Alternative Assessment Data

Alternative	Location	Facilities	Admission Fee	Quality of Service	Hygiene	Visitor Reviews
Krui Beach	5	4.3	0	4.4	4.7	4.2
Mutun Beach	4.3	4.3	250000	4.3	4.5	3.5
Sari Ringgung Beach	4.8	4.4	250000	4.4	4.6	4
Klara Beach	4.5	4.3	0	4.2	4.4	4
Tanjung Setia Beach	4.6	4.4	10000	4.5	4.4	4
Dewi Mandapa Beach	4	4	10000	4.2	4	3

c. The Reciprocal Rank (RR) weighting method is a method in multi-criteria decision making that assesses and assigns weight to each criterion based on alternative relative ratings. This weight is calculated using the reciprocal value of the rank, where the top rank is given the lowest weight and so on. These weighted values are then summed to get the Reciprocal Rank (RR) value for each alternative. This method allows dynamically determining the relative weight of criteria, where the relative preferences of each criterion are reflected in their rank and weight. RR can provide a clear view of relative preferences between alternatives, providing a more informed decision in situations where explicit preferences for weights cannot be easily determined. The RR method is calculated using the following equation.

$$W_i = \frac{\frac{1}{i}}{\sum_{j=1}^{n}\frac{1}{j}} \tag{1}$$

d. A decision matrix is a tool used to organize and analyze information related to the selection of attractions or other alternatives. This matrix usually consists of rows representing alternatives and columns representing the criteria being assessed. Each cell in the matrix will contain a value or weight that indicates the relative performance of each alternative against each criterion. With decision matrices, decision makers can visualize and compare the relative performance of different alternatives and use them as a basis for better decision making. The decision matrix in the MOORA method is created using the following equation.

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

e. Matrix normalization is the process of converting every element in the matrix into the same range or having a uniform scale. The goal is to obtain a more balanced or standardized distribution of values to make it easier to compare or process further. The normalization of the natural matrix of the MOORA method uses the following equation.

$$X_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \tag{3}$$

f. The preference result in the MOORA Method is a representation of the assessment relative to each alternative based on predefined criteria. This process involves normalizing the decision matrix, calculating the relative preference value for each alternative against each criterion, and determining the weighted relative preference value. After these steps, the preference results can be evaluated to determine which alternative is the most optimal or has the highest MOORA value. These preference results provide a comprehensive view of how each alternative meets predefined criteria, thus aiding in more informed and effective decision making. The preference result in the MOORA Method is calculated using the following equation.

$$Y_i^* = \sum_{j=1}^{g} w_j * x_{ij} - \sum_{j=g+1}^{n} w_j * x_{ij} \tag{4}$$

3. RESULT AND DISCUSSION

The Decision Support System (DSS) for Tourist Attraction Recommendations that uses a combination of Reciprocal Rank and MOORA is a platform that utilizes technology to present optimal tourist attraction recommendations to users. By utilizing Reciprocal Rank, the system can adjust recommendations based on user preferences and history, improving the quality of personalized recommendations, while MOORA allows simultaneous evaluation of more than one criterion. This combination ensures that the recommendations generated match the user's individual preferences and take into account various relevant factors in the selection of attractions, thus improving the user experience in planning their trips. Using the Reciprocal Rank method, the system can take into account the user's individual preferences based on previous interactions with attractions, thereby increasing the level of relevance and user

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satisfaction. Meanwhile, the MOORA approach allows the system to optimize recommendations by considering various aspects, resulting in recommendations that are more holistic and in accordance with user needs. This system not only provides personalized and relevant recommendations, but also ensures a more satisfying travel experience for users by considering various factors that are important in trip planning.

3.1 Determination of Criteria Weights Using Rank Reciprocal

Determining the weight of criteria using Reciprocal Rank is an approach that relies on user preferences for various criteria in the selection of attractions. In this method, the weighting for each criterion is determined based on the reciprocal rating of the user's preference for the criteria of the evaluated attraction, where the criteria that are more prioritized by the user will have a higher rating. This approach gives more weight to the user's individual wants and preferences, and ensures that the criteria that are most important to the user are given higher weight in the decision-making process. The calculation of the weight of the criterion uses reciprocal rank using (1), the calculation results for the location weight are as follows.

$$W_1 = \frac{\frac{1}{i_1}}{\frac{1}{i_1}+\frac{1}{i_2}+\frac{1}{i_3}+\frac{1}{i_4}+\frac{1}{i_5}+\frac{1}{i_6}}$$

$$W_1 = \frac{\frac{1}{1}}{\frac{1}{1}+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}+\frac{1}{6}} = \frac{1}{2.45} = 0.408$$

The calculation results for the facilities weight are as follows.

$$W_2 = \frac{\frac{1}{i_2}}{\frac{1}{i_1}+\frac{1}{i_2}+\frac{1}{i_3}+\frac{1}{i_4}+\frac{1}{i_5}+\frac{1}{i_6}}$$

$$W_1 = \frac{\frac{1}{2}}{\frac{1}{1}+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}+\frac{1}{6}} = \frac{0.5}{2.45} = 0.204$$

The calculation results for the admission fee weight are as follows.

$$W_3 = \frac{\frac{1}{i_3}}{\frac{1}{i_1}+\frac{1}{i_2}+\frac{1}{i_3}+\frac{1}{i_4}+\frac{1}{i_5}+\frac{1}{i_6}}$$

$$W_3 = \frac{\frac{1}{3}}{\frac{1}{1}+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}+\frac{1}{6}} = \frac{0.333}{2.45} = 0.136$$

The calculation results for the admission fee weight are as follows.

$$W_4 = \frac{\frac{1}{i_4}}{\frac{1}{i_1}+\frac{1}{i_2}+\frac{1}{i_3}+\frac{1}{i_4}+\frac{1}{i_5}+\frac{1}{i_6}}$$

$$W_4 = \frac{\frac{1}{4}}{\frac{1}{1}+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}+\frac{1}{6}} = \frac{0.25}{2.45} = 0.102$$

The calculation results for the higiene weight are as follows.

$$W_5 = \frac{\frac{1}{i_5}}{\frac{1}{i_1}+\frac{1}{i_2}+\frac{1}{i_3}+\frac{1}{i_4}+\frac{1}{i_5}+\frac{1}{i_6}}$$

$$W_5 = \frac{\frac{1}{5}}{\frac{1}{1}+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}+\frac{1}{6}} = \frac{0.2}{2.45} = 0.082$$

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The calculation results for the visitor review weight are as follows.

$$W_6 = \frac{\frac{1}{i_6}}{\frac{1}{i_1}+\frac{1}{i_2}+\frac{1}{i_3}+\frac{1}{i_4}+\frac{1}{i_5}+\frac{1}{i_6}}$$

$$W_6 = \frac{\frac{1}{5}}{\frac{1}{1}+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}+\frac{1}{6}} = \frac{0.167}{2.45} = 0.068$$

Visualization of the results of determining the weight of criteria using reciprocal rank as shown in figure 3.

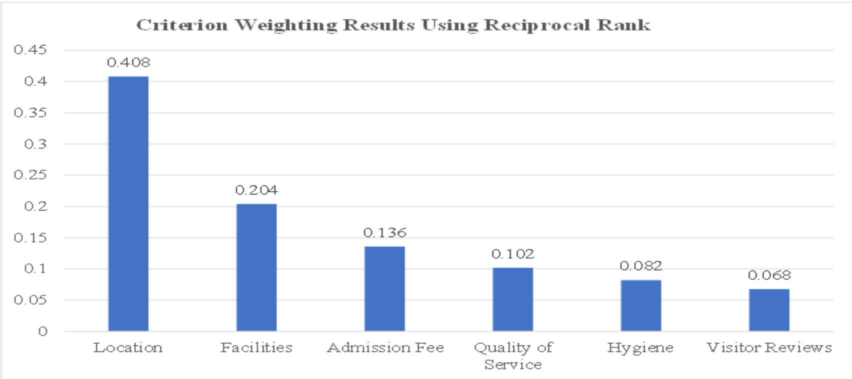

Figure 3. Criteria Weighting Result using Reciprocal Rank

The weighting results of figure 3 criteria show that the location criteria have a weight of 0.408, the facilities criteria have a weight of 0.204, the admission fee criteria have a weight of 0.136, the quality of service criteria have a weight of 0.102, the hygiene criteria have a weight of 0.082, and the visitor review criteria have a weight of 0.068.

3.2 Recommended Tourist Attractions Using the MOORA Method

Recommendation of tourist attractions using the MOORA Method is an approach that utilizes ratio analysis to select the most optimal tourist attractions based on several predetermined criteria. Using MOORA, the system can generate recommendations that combine user preferences with practical aspects such as location, cost, and service quality, thus assisting users in making informed decisions according to their preferences in planning a trip. By applying the MOORA Method, the system can provide more comprehensive and detailed recommendations for tourist attractions, as it not only considers one criterion, but also takes into account various important aspects in decision making. In addition, MOORA allows the system to optimize recommendations by weighing the relative importance of each different criterion, resulting in a more balanced and reliable solution. Thus, users can obtain recommendations of tourist attractions that not only meet their personal preferences, but also take into account certain limitations or preferences that they may have, thus enhancing their experience in planning a satisfactory tourist trip. The recommendations generated by the system using the MOORA Method can be a valuable guide for users in planning a satisfactory trip, increasing satisfaction and overall travel experience.
The first stage in the MOORA method is to make a decision matrix based on the assessment data in table 2 using (2), the decision matrix of tourist attraction recommendations as follows.

$$X = \begin{bmatrix} 5 & 4.3 & 0 & 4.4 & 4.7 & 4.2 \\ 4.3 & 4.3 & 25000 & 4.3 & 4.5 & 3.5 \\ 4.8 & 4.4 & 25000 & 4.4 & 4.6 & 4 \\ 4.5 & 4.3 & 0 & 4.2 & 4.4 & 4 \\ 4.6 & 4.4 & 10000 & 4.5 & 4.4 & 4 \\ 4 & 4 & 10000 & 4.2 & 4 & 3 \end{bmatrix}$$

The second stage in the MOORA method is to calculate the normalization of the matrix based on the decision matrix that has been made using (3), normalizing the tourist attraction recommendation matrix as follows.

$$X_{11} = \frac{x_{11}}{\sqrt{x_{11}^2 + x_{12}^2 + x_{13}^2 + x_{14}^2 + x_{15}^2 + x_{15}^2}}$$

$$X_{11} = \frac{5}{\sqrt{5^2 + 4.3^2 + 4.8^2 + 4.5^2 + 4.6^2 + 4^2}}$$

$$X_{11} = \frac{5}{\sqrt{123.94}} = \frac{5}{11.132} = 0.4491$$

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$$X_{12} = \frac{x_{12}}{\sqrt{x_{11}^2 + x_{12}^2 + x_{13}^2 + x_{14}^2 + x_{15}^2 + x_{15}^2}}$$

$$X_{12} = \frac{4.3}{\sqrt{5^2 + 4.3^2 + 4.8^2 + 4.5^2 + 4.6^2 + 4^2}}$$

$$X_{12} = \frac{4.3}{\sqrt{123.94}} = \frac{4.3}{11.132} = 0.3862$$

$$X_{13} = \frac{x_{13}}{\sqrt{x_{11}^2 + x_{12}^2 + x_{13}^2 + x_{14}^2 + x_{15}^2 + x_{15}^2}}$$

$$X_{13} = \frac{4.8}{\sqrt{5^2 + 4.3^2 + 4.8^2 + 4.5^2 + 4.6^2 + 4^2}}$$

$$X_{13} = \frac{4.8}{\sqrt{123.94}} = \frac{4.8}{11.132} = 0.4312$$

$$X_{14} = \frac{x_{14}}{\sqrt{x_{11}^2 + x_{12}^2 + x_{13}^2 + x_{14}^2 + x_{15}^2 + x_{15}^2}}$$

$$X_{14} = \frac{4.5}{\sqrt{5^2 + 4.3^2 + 4.8^2 + 4.5^2 + 4.6^2 + 4^2}}$$

$$X_{14} = \frac{4.5}{\sqrt{123.94}} = \frac{4.5}{11.132} = 0.4042$$

$$X_{15} = \frac{x_{15}}{\sqrt{x_{11}^2 + x_{12}^2 + x_{13}^2 + x_{14}^2 + x_{15}^2 + x_{15}^2}}$$

$$X_{15} = \frac{4.6}{\sqrt{5^2 + 4.3^2 + 4.8^2 + 4.5^2 + 4.6^2 + 4^2}}$$

$$X_{15} = \frac{4.6}{\sqrt{123.94}} = \frac{4.6}{11.132} = 0.4132$$

$$X_{16} = \frac{x_{15}}{\sqrt{x_{11}^2 + x_{12}^2 + x_{13}^2 + x_{14}^2 + x_{15}^2 + x_{15}^2}}$$

$$X_{16} = \frac{4}{\sqrt{5^2 + 4.3^2 + 4.8^2 + 4.5^2 + 4.6^2 + 4^2}}$$

$$X_{16} = \frac{4}{\sqrt{123.94}} = \frac{4}{11.132} = 0.2593$$

$$X_{21} = \frac{x_{21}}{\sqrt{x_{21}^2 + x_{22}^2 + x_{23}^2 + x_{24}^2 + x_{25}^2 + x_{26}^2}}$$

$$X_{21} = \frac{4.3}{\sqrt{4.3^2 + 4.3^2 + 4.4^2 + 4.3^2 + 4.4^2 + 4^2}}$$

$$X_{21} = \frac{4.3}{\sqrt{110.19}} = \frac{4.3}{10.497} = 0.4096$$

$$X_{22} = \frac{x_{22}}{\sqrt{x_{21}^2 + x_{22}^2 + x_{23}^2 + x_{24}^2 + x_{25}^2 + x_{26}^2}}$$

$$X_{22} = \frac{4.3}{\sqrt{4.3^2 + 4.3^2 + 4.4^2 + 4.3^2 + 4.4^2 + 4^2}}$$

$$X_{22} = \frac{4.3}{\sqrt{110.19}} = \frac{4.3}{10.497} = 0.4096$$

$$X_{23} = \frac{x_{21}}{\sqrt{x_{21}^2 + x_{22}^2 + x_{23}^2 + x_{24}^2 + x_{25}^2 + x_{26}^2}}$$

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$$X_{23} = \frac{4.4}{\sqrt{4.3^2 + 4.3^2 + 4.4^2 + 4.3^2 + 4.4^2 + 4^2}}$$

$$X_{23} = \frac{4.4}{\sqrt{110.19}} = \frac{4.4}{10.497} = 0.4192$$

$$X_{24} = \frac{x_{24}}{\sqrt{x_{21}^2 + x_{22}^2 + x_{23}^2 + x_{24}^2 + x_{25}^2 + x_{26}^2}}$$

$$X_{24} = \frac{4.3}{\sqrt{4.3^2 + 4.3^2 + 4.4^2 + 4.3^2 + 4.4^2 + 4^2}}$$

$$X_{24} = \frac{4.3}{\sqrt{110.19}} = \frac{4.3}{10.497} = 0.4096$$

$$X_{25} = \frac{x_{25}}{\sqrt{x_{21}^2 + x_{22}^2 + x_{23}^2 + x_{24}^2 + x_{25}^2 + x_{26}^2}}$$

$$X_{25} = \frac{4.4}{\sqrt{4.3^2 + 4.3^2 + 4.4^2 + 4.3^2 + 4.4^2 + 4^2}}$$

$$X_{25} = \frac{4.4}{\sqrt{110.19}} = \frac{4.4}{10.497} = 0.4192$$

$$X_{26} = \frac{x_{26}}{\sqrt{x_{21}^2 + x_{22}^2 + x_{23}^2 + x_{24}^2 + x_{25}^2 + x_{26}^2}}$$

$$X_{26} = \frac{4}{\sqrt{4.3^2 + 4.3^2 + 4.4^2 + 4.3^2 + 4.4^2 + 4^2}}$$

$$X_{26} = \frac{4}{\sqrt{110.19}} = \frac{4}{10.497} = 0.3811$$

$$X_{31} = \frac{x_{31}}{\sqrt{x_{31}^2 + x_{32}^2 + x_{33}^2 + x_{34}^2 + x_{35}^2 + x_{36}^2}}$$

$$X_{31} = \frac{0}{\sqrt{0^2 + 25000^2 + 25000^2 + 0^2 + 10000^2 + 10000^2}}$$

$$X_{31} = \frac{0}{\sqrt{125200000000}} = \frac{0}{353836.12} = 0$$

$$X_{32} = \frac{x_{32}}{\sqrt{x_{31}^2 + x_{32}^2 + x_{33}^2 + x_{34}^2 + x_{35}^2 + x_{36}^2}}$$

$$X_{32} = \frac{25000}{\sqrt{0^2 + 25000^2 + 25000^2 + 0^2 + 10000^2 + 10000^2}}$$

$$X_{32} = \frac{25000}{\sqrt{125200000000}} = \frac{25000}{353836.12} = 0.7065$$

$$X_{33} = \frac{x_{33}}{\sqrt{x_{31}^2 + x_{32}^2 + x_{33}^2 + x_{34}^2 + x_{35}^2 + x_{36}^2}}$$

$$X_{33} = \frac{25000}{\sqrt{0^2 + 25000^2 + 25000^2 + 0^2 + 10000^2 + 10000^2}}$$

$$X_{33} = \frac{25000}{\sqrt{125200000000}} = \frac{25000}{353836.12} = 0.7065$$

$$X_{34} = \frac{x_{34}}{\sqrt{x_{31}^2 + x_{32}^2 + x_{33}^2 + x_{34}^2 + x_{35}^2 + x_{36}^2}}$$

$$X_{34} = \frac{0}{\sqrt{0^2 + 25000^2 + 25000^2 + 0^2 + 10000^2 + 10000^2}}$$

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$$X_{34} = \frac{0}{\sqrt{125200000000}} = \frac{0}{353836.12} = 0$$

$$X_{35} = \frac{x_{35}}{\sqrt{x_{31}^2 + x_{32}^2 + x_{33}^2 + x_{34}^2 + x_{35}^2 + x_{36}^2}}$$

$$X_{35} = \frac{10000}{\sqrt{0^2 + 25000^2 + 25000^2 + 0^2 + 10000^2 + 10000^2}}$$

$$X_{35} = \frac{10000}{\sqrt{125200000000}} = \frac{10000}{353836.12} = 0.0283$$

$$X_{36} = \frac{x_{36}}{\sqrt{x_{31}^2 + x_{32}^2 + x_{33}^2 + x_{34}^2 + x_{35}^2 + x_{36}^2}}$$

$$X_{36} = \frac{10000}{\sqrt{0^2 + 25000^2 + 25000^2 + 0^2 + 10000^2 + 10000^2}}$$

$$X_{36} = \frac{10000}{\sqrt{125200000000}} = \frac{10000}{353836.12} = 0.0283$$

$$X_{41} = \frac{x_{41}}{\sqrt{x_{41}^2 + x_{42}^2 + x_{43}^2 + x_{44}^2 + x_{45}^2 + x_{46}^2}}$$

$$X_{41} = \frac{4.4}{\sqrt{4.4^2 + 4.3^2 + 4.4^2 + 4.2^2 + 4.5^2 + 4.2^2}}$$

$$X_{41} = \frac{4.4}{\sqrt{112.74}} = \frac{4.4}{10.618} = 0.4144$$

$$X_{42} = \frac{x_{42}}{\sqrt{x_{41}^2 + x_{42}^2 + x_{43}^2 + x_{44}^2 + x_{45}^2 + x_{46}^2}}$$

$$X_{42} = \frac{4.3}{\sqrt{4.4^2 + 4.3^2 + 4.4^2 + 4.2^2 + 4.5^2 + 4.2^2}}$$

$$X_{42} = \frac{4.3}{\sqrt{112.74}} = \frac{4.3}{10.618} = 0.4050$$

$$X_{43} = \frac{x_{43}}{\sqrt{x_{41}^2 + x_{42}^2 + x_{43}^2 + x_{44}^2 + x_{45}^2 + x_{46}^2}}$$

$$X_{43} = \frac{4.4}{\sqrt{4.4^2 + 4.3^2 + 4.4^2 + 4.2^2 + 4.5^2 + 4.2^2}}$$

$$X_{43} = \frac{4.4}{\sqrt{112.74}} = \frac{4.4}{10.618} = 0.4144$$

$$X_{44} = \frac{x_{44}}{\sqrt{x_{41}^2 + x_{42}^2 + x_{43}^2 + x_{44}^2 + x_{45}^2 + x_{46}^2}}$$

$$X_{44} = \frac{4.2}{\sqrt{4.4^2 + 4.3^2 + 4.4^2 + 4.2^2 + 4.5^2 + 4.2^2}}$$

$$X_{44} = \frac{4.2}{\sqrt{112.74}} = \frac{4.2}{10.618} = 0.3956$$

$$X_{45} = \frac{x_{45}}{\sqrt{x_{41}^2 + x_{42}^2 + x_{43}^2 + x_{44}^2 + x_{45}^2 + x_{46}^2}}$$

$$X_{45} = \frac{4.5}{\sqrt{4.4^2 + 4.3^2 + 4.4^2 + 4.2^2 + 4.5^2 + 4.2^2}}$$

$$X_{45} = \frac{4.5}{\sqrt{112.74}} = \frac{4.5}{10.618} = 0.4238$$

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$$X_{46} = \frac{x_{46}}{\sqrt{x_{41}^2 + x_{42}^2 + x_{43}^2 + x_{44}^2 + x_{45}^2 + x_{46}^2}}$$

$$X_{46} = \frac{4.2}{\sqrt{4.4^2 + 4.3^2 + 4.4^2 + 4.2^2 + 4.5^2 + 4.2^2}}$$

$$X_{46} = \frac{4.2}{\sqrt{112.74}} = \frac{4.2}{10.618} = 0.3956$$

$$X_{51} = \frac{x_{51}}{\sqrt{x_{51}^2 + x_{52}^2 + x_{53}^2 + x_{54}^2 + x_{55}^2 + x_{56}^2}}$$

$$X_{51} = \frac{4.7}{\sqrt{4.7^2 + 4.5^2 + 4.6^2 + 4.4^2 + 4.4^2 + 4^2}}$$

$$X_{51} = \frac{4.7}{\sqrt{118.22}} = \frac{4.7}{10.873} = 0.4324$$

$$X_{52} = \frac{x_{52}}{\sqrt{x_{51}^2 + x_{52}^2 + x_{53}^2 + x_{54}^2 + x_{55}^2 + x_{56}^2}}$$

$$X_{52} = \frac{4.5}{\sqrt{4.7^2 + 4.5^2 + 4.6^2 + 4.4^2 + 4.4^2 + 4^2}}$$

$$X_{52} = \frac{4.5}{\sqrt{118.22}} = \frac{4.5}{10.873} = 0.4139$$

$$X_{53} = \frac{x_{53}}{\sqrt{x_{51}^2 + x_{52}^2 + x_{53}^2 + x_{54}^2 + x_{55}^2 + x_{56}^2}}$$

$$X_{53} = \frac{4.6}{\sqrt{4.7^2 + 4.5^2 + 4.6^2 + 4.4^2 + 4.4^2 + 4^2}}$$

$$X_{53} = \frac{4.6}{\sqrt{118.22}} = \frac{4.6}{10.873} = 0.4231$$

$$X_{54} = \frac{x_{54}}{\sqrt{x_{51}^2 + x_{52}^2 + x_{53}^2 + x_{54}^2 + x_{55}^2 + x_{56}^2}}$$

$$X_{54} = \frac{4.4}{\sqrt{4.7^2 + 4.5^2 + 4.6^2 + 4.4^2 + 4.4^2 + 4^2}}$$

$$X_{54} = \frac{4.4}{\sqrt{118.22}} = \frac{4.4}{10.873} = 0.4047$$

$$X_{55} = \frac{x_{55}}{\sqrt{x_{51}^2 + x_{52}^2 + x_{53}^2 + x_{54}^2 + x_{55}^2 + x_{56}^2}}$$

$$X_{55} = \frac{4.4}{\sqrt{4.7^2 + 4.5^2 + 4.6^2 + 4.4^2 + 4.4^2 + 4^2}}$$

$$X_{55} = \frac{4.4}{\sqrt{118.22}} = \frac{4.4}{10.873} = 0.4047$$

$$X_{56} = \frac{x_{56}}{\sqrt{x_{51}^2 + x_{52}^2 + x_{53}^2 + x_{54}^2 + x_{55}^2 + x_{56}^2}}$$

$$X_{56} = \frac{4}{\sqrt{4.7^2 + 4.5^2 + 4.6^2 + 4.4^2 + 4.4^2 + 4^2}}$$

$$X_{56} = \frac{4}{\sqrt{118.22}} = \frac{4}{10.873} = 0.3679$$

$$X_{61} = \frac{x_{61}}{\sqrt{x_{61}^2 + x_{62}^2 + x_{63}^2 + x_{64}^2 + x_{65}^2 + x_{66}^2}}$$

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$$X_{61}=\frac{4.2}{\sqrt{4.2^2+3.5^2+4^2+4^2+4^2+3^2}}$$

$$X_{61}=\frac{4.2}{\sqrt{86.89}}=\frac{4.2}{9.321}=0.4506$$

$$X_{62}=\frac{x_{62}}{\sqrt{x_{61}^2+x_{62}^2+x_{63}^2+x_{64}^2+x_{65}^2+x_{66}^2}}$$

$$X_{62}=\frac{3.5}{\sqrt{4.2^2+3.5^2+4^2+4^2+4^2+3^2}}$$

$$X_{62}=\frac{3.5}{\sqrt{86.89}}=\frac{3.5}{9.321}=0.3755$$

$$X_{63}=\frac{x_{63}}{\sqrt{x_{61}^2+x_{62}^2+x_{63}^2+x_{64}^2+x_{65}^2+x_{66}^2}}$$

$$X_{63}=\frac{4}{\sqrt{4.2^2+3.5^2+4^2+4^2+4^2+3^2}}$$

$$X_{63}=\frac{4}{\sqrt{86.89}}=\frac{4}{9.321}=0.4291$$

$$X_{64}=\frac{x_{64}}{\sqrt{x_{61}^2+x_{62}^2+x_{63}^2+x_{64}^2+x_{65}^2+x_{66}^2}}$$

$$X_{64}=\frac{4}{\sqrt{4.2^2+3.5^2+4^2+4^2+4^2+3^2}}$$

$$X_{64}=\frac{4}{\sqrt{86.89}}=\frac{4}{9.321}=0.4291$$

$$X_{65}=\frac{x_{65}}{\sqrt{x_{61}^2+x_{62}^2+x_{63}^2+x_{64}^2+x_{65}^2+x_{66}^2}}$$

$$X_{65}=\frac{4}{\sqrt{4.2^2+3.5^2+4^2+4^2+4^2+3^2}}$$

$$X_{65}=\frac{4}{\sqrt{86.89}}=\frac{4}{9.321}=0.4291$$

$$X_{66}=\frac{x_{66}}{\sqrt{x_{61}^2+x_{62}^2+x_{63}^2+x_{64}^2+x_{65}^2+x_{66}^2}}$$

$$X_{66}=\frac{3}{\sqrt{4.2^2+3.5^2+4^2+4^2+4^2+3^2}}$$

$$X_{66}=\frac{3}{\sqrt{86.89}}=\frac{3}{9.321}=0.3281$$

The last step in the MOORA method is to calculate the value of alternative preferences using (4), including alternative preferences for tourist attraction recommendations as follows.

$$Y_1^*=\big((w_1*x_{11})+(w_2*x_{21})+(w_4*x_{41})+(w_5*x_{51})+(w_6*x_{61})\big)-(w_3*x_{31})$$
$$Y_1^*=\big((0.408*0.4491)+(0.204*0.4096)+(0.102*0.4144)+(0.082*0.4323)+(0.068*0.4506)\big)-(0.136*0)$$
$$Y_1^*=0.3752-0=0.3752$$
$$Y_2^*=\big((w_1*x_{12})+(w_2*x_{22})+(w_4*x_{42})+(w_5*x_{52})+(w_6*x_{62})\big)-(w_3*x_{32})$$
$$Y_2^*=\big((0.408*0.3862)+(0.204*0.4096)+(0.102*0.4050)+(0.082*0.4139)+(0.068*0.3755)\big)-(0.136*0.7065)$$
$$Y_2^*=0.3419-0.0961=0.2458$$
$$Y_3^*=\big((w_1*x_{13})+(w_2*x_{23})+(w_4*x_{43})+(w_5*x_{53})+(w_6*x_{63})\big)-(w_3*x_{33})$$
$$Y_3^*=\big((0.408*0.4312)+(0.204*0.4192)+(0.102*0.4144)+(0.082*0.4231)+(0.068*0.4291)\big)-(0.136*0.7065)$$

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$Y_3^* = 0.3676 - 0.0961 = 0.2715$
$Y_4^* = \big((w_1 * x_{14}) + (w_2 * x_{24}) + (w_4 * x_{44}) + (w_5 * x_{54}) + (w_6 * x_{64})\big) - (w_3 * x_{34})$
$Y_4^* = \big((0.408 * 0.4042) + (0.204 * 0.4096) + (0.102 * 0.3956) + (0.082 * 0.4047) + (0.068 * 0.4291)\big) - (0.136 * 0)$
$Y_4^* = 0.3512 - 0 = 0.3512$
$Y_5^* = \big((w_1 * x_{15}) + (w_2 * x_{25}) + (w_4 * x_{45}) + (w_5 * x_{55}) + (w_6 * x_{65})\big) - (w_3 * x_{35})$
$Y_5^* = \big((0.408 * 0.4132) + (0.204 * 0.4192) + (0.102 * 0.4238) + (0.082 * 0.3679) + (0.068 * 0.4291)\big) - (0.136 * 0.0283)$
$Y_5^* = 0.3597 - 0.0038 = 0.3558$
$Y_6^* = \big((w_1 * x_{16}) + (w_2 * x_{26}) + (w_4 * x_{46}) + (w_5 * x_{56}) + (w_6 * x_{66})\big) - (w_3 * x_{36})$
$Y_6^* = \big((0.408 * 0.3593) + (0.204 * 0.3811) + (0.102 * 0.3956) + (0.082 * 0.3679) + (0.068 * 0.3218)\big) - (0.136 * 0.0283)$
$Y_6^* = 0.3167 - 0.0038 = 0.3129$

The above results are the final results in the recommendation of tourist attractions by applying the MOORA method.

3.3 Ranking Results of Tourist Attraction Recommendations

The results of ranking tourist attraction recommendations are a representation of the evaluation of each tourist attraction based on criteria that have been set in the decision-making process. After the analysis process using various methods such as Reciprocal Rank or MOORA Method is carried out, the attractions are ranked based on their level of match with the user's preferences and needs. This rating allows users to quickly understand which attractions best suit their wishes and specified criteria. The results of this ranking can also provide users with valuable insights in planning their trips, ensuring that they can choose the most satisfying attractions that suit their preferences. These rankings not only enhance users' travel planning experience, but can also optimize the time and resources they invest in their trips, thus ensuring a satisfying and memorable vacation experience. The ranking results are as shown in Figure 4.

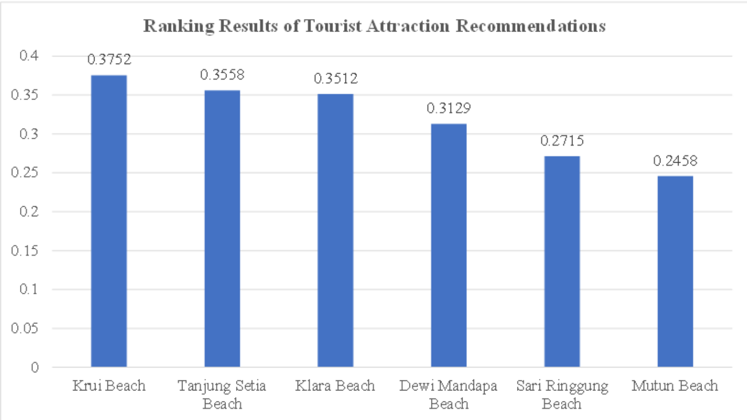

Figure 4. Ranking Results of Tourist Attraction Recommendations

The ranking results of figure 4 provide recommendations for alternative krui beach with a final value of 0.3752 to get rank 1, alternative tanjung setia beach with a final value of 0.3558 to rank 2, alternative klara beach with a final value of 0.3512 to rank 3, alternative dewi mandapa beach with a final value of 0.3129 to rank 4, alternative sari ringgung beach with a final value of 0.2715 to get rank 5, and the alternative mutun beach with a final value of 0.2458 ranked 6.

4. CONCLUSION

The research objective of the Attraction Recommendation Decision Support System Using Reciprocal Rank and MOORA is to develop a system that can provide optimal attraction recommendations to users based on their preferences against diverse criteria, such as distance, cost, travel time, and cleanliness level. By using the Reciprocal Rank approach to take into account the user's subjective preferences towards each criterion. Meanwhile, by applying MOORA, this study aims to optimize the relative performance of alternative attractions based on the relationship between criteria. Thus, this research is to provide useful tools for users to make better and more informed decisions. The ranking results provide recommendations for alternative krui beach with a final value of 0.3752 to rank 1, alternative tanjung setia beach with a final value of 0.3558 to rank 2, alternative klara beach with a final value of 0.3512 to rank 3.

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