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The Implementation of The Analytical Hierarchy Process Method to Determine the Potential for Tourism Village Development

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Abstract

The province of South Kalimantan currently lacks an information system capable of managing and mapping data related to tourism village potential in the region. However, if properly utilized, this data can offer valuable insights into the cultural and locally inspired tourist attractions in South Kalimantan. This research aims to develop a web-based decision support system that utilizes the Analytical Hierarchy Process (AHP) method to gather and map data on tourism villages, providing recommendations for tourism purposes. By integrating the AHP method into the decision support system, users can identify and choose potential areas with the capacity to be developed into regional tourist destinations in South Kalimantan. The accuracy of the system's calculations was validated by comparing them with manual calculations using the AHP method, yielding precise results. The top recommendation, with a weight value of 0.51, was Tiwingan Lama, followed by Loksado in second place with a weight value of 0.36, and Tiwingan Baru in third place with a weight value of 0.2. Utilizing the AHP method for suggesting tourism potentials can enhance the objectivity of the decision-making process, optimize the use of resources, and maximize the advantages for all stakeholders involved in the tourism sector.

Keywords: AHP, Decision Support System, Tourism Village.

1 Introduction

Tourism in South Kalimantan is considered one of the priority sectors for development. South Kalimantan has a diverse range of tourism potentials, including rivers, beaches, forests, mountains, and religious tourism with historical sites that can be utilized as attractive tourist destinations. In addition to that, with its rich local culture, South Kalimantan also has great potential to be developed as a cultural tourism destination, religious tourism destination, as well as culinary tourism destination [1].

The South Kalimantan provincial government has drafted a regional regulation (Raperda) on Village Tourism Empowerment. This draft regulation is formulated to empower the local community in South Kalimantan by optimizing village tourism programs to be developed as tourism commodities based on the local community's potential.

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To develop tourism villages optimally, it is necessary to have data that can be further analyzed to provide information needed by decision-makers. Proper management of this data has the potential to provide valuable recommendations regarding the cultural and local wisdom aspects, making them attractive tourist attractions in South Kalimantan [2].

This presents an opportunity for local government to conduct mapping and prioritize studies on the areas that have potential for improvement based on priorities as tourist villages. Several criteria must be met to become a tourist village as issued by the Ministry of Tourism and Creative Economy. These criteria include tourism activities that must be based on rural resources, which accommodate all village potentials to support tourism activities [3].

The Analytical Hierarchy Process (AHP) method is a relevant approach that incorporates consistency calculations to determine the priority levels of criteria. This method was created by mathematician Thomas L. Saaty. According to Saaty, the AHP method aids in resolving intricate problems by constructing a hierarchical structure of criteria, stakeholders, and outcomes, while considering multiple factors to establish weights or priorities [4].

The objective of this research is to create a web-based decision support system that enables the identification and analysis of tourism villages with the highest potential for development based on priority criteria. The system will employ the Analytical Hierarchy Process (AHP) method for this purpose.

2 Related Works

Here are some studies that have been conducted on the application of the AHP method in decision support systems, specifically to support tourism recommendations.

Table 1: The Study on The Application of The AHP Method to Support Tourism Recommendations

Author	Article Title	Methods	Object
Suhandi et al. [5]	Rancang Bangun Sistem Informasi Geografis Rekomendasi Cagar Budaya Menggunakan Metode Analytic Hierarchy Process	AHP	SIG Web applications
E. Irawan [6]	Sistem Pendukung Keputusan Pemilihan Obyek Wisata Alam Kabupaten Simalungun	AHP	Web application
Rohandi et al. [7]	Sistem Pendukung Keputusan dalam Penentuan Prioritas Pengembangan Kawasan Wisata Bawah Laut	AHP	Decision support system
E. Maria, and Y. Yulianto [8]	Sistem Pendukung Keputusan Pemilihan Lokasi Objek Wisata Di Yogyakarta Dengan AHP (Analytical Hierarchy Process)	AHP	Decision support system
Anwar et al. [9]	Sistem Pendukung Keputusan Pemilihan Objek Wisata Menggunakan Metode AHP	AHP	Decision support system

The previous studies have similarities in that they all discuss the utilization or application of the AHP method to aid in the analysis process for tourism recommendations. Another similarity among the studies listed in Table I is their application, where the output of these studies is a web-based decision support system.

3 Methodology

3.1 System Requirement Analysis

The system architecture has a front end and a back end side. The front end is located on the side of the user who inputs data from each region according to the criteria determined by the management. The back end is managed by the admin who manages the server and manages data processing. For data processing the decision support system uses a web-based interface, where the data used include the criteria used and the objects used as alternatives. The general analysis of the system can be seen in Figure 1.

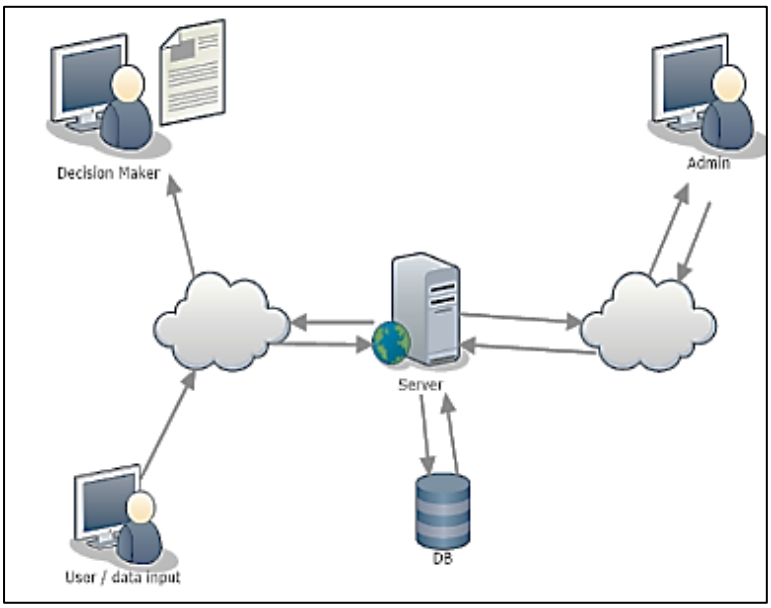

Figure 1: System Architecture

3.2 Data Modelling

Data collection was then analyzed using the Analytic Hierarchy Process (AHP) method. Modeling data on criteria and alternatives: There are eight criteria used in the tourism village recommendation decision support system as an assessment of tourism recommendations :

C1 = Human Resources
C2 = Natural Resources
C3 = Social Assets
C4 = Spiritual Culture
C5 = Financial
C6 = Infrastructure Availability
C7 = Information Resources

C8 = Network.

Three alternatives are used as samples for determining tourism recommendations, namely:
A1 = Tiwingan Lama
A2 = Tiwingan Baru
A3 = Loksado

3.3 AHP Method Data Analysis

The system analysis phase is essential in the early stages of system design and development as it helps identify the requirements of the detection system to be constructed. At this stage, data analysis of the AHP method is carried out to determine the priority of potential development of tourism village as a tourism business recommendation [10], [11].

The working principle of AHP is to simplify a complex problem that is unstructured and objective [12], [13]. Basically, the steps in the AHP method include:

a. Arranging a hierarchy of problems encountered (decomposition).
b. Criteria Assessment
   This stage means assessing the relative importance of two elements at a certain level concerning one level above. The criteria used include human resources (SDM), natural resources (SDA), social assets (AS), spiritual culture (SB), financial (F), physical infrastructure (KI), information resources (SDI), and network (J).
c. Synthesis of priority
   From each pairwise comparison matrix, the eigenvectors are then searched to obtain local priority with the following steps:
   1) Create a pairwise comparison table based on the assessment criteria.
   2) Sum the scores from the comparisons for each criterion.
   3) Create a normalized table by dividing each element by the result of the sum of each column in the previous stage.
   4) Find the average of each criterion to get Priority.
d. Logical consistency
   is an important characteristic in the AHP process. This is achieved by aggregating all eigenvectors obtained from various hierarchical levels and then obtaining a weighted composite vector that produces a decision-making sequence. Here are the steps to calculate the consistency ratio (CR) matrix:
   1) Multiplying the value of the comparison matrix with the results of the Local Priority divided by the average per row so that the value of is obtained.
   2) Calculating the value of λmax.
   3) Calculate the CI value.
   4) Calculating CR. If the CR result is less than 0.1, then the results can be said to be consistent. If inconsistent, the comparison matrix must be repeated to create.

For AHP, the inconsistency level is still acceptable at 10% down. So if the value of $CR \leq 0.1$, then the result is quite good preference and vice versa, if $CR > 0.1$ results of the AHP process and should be held invalid because the level of inconsistency repair assessment is too large which can lead to an error [14].

3.4 System Design

Use case diagrams represent the relationship between a system and actors. The design of a use case diagram for a tourism village recommendation decision support system is made based on the identification of previously defined needs. The system design can be seen in Figure 2.

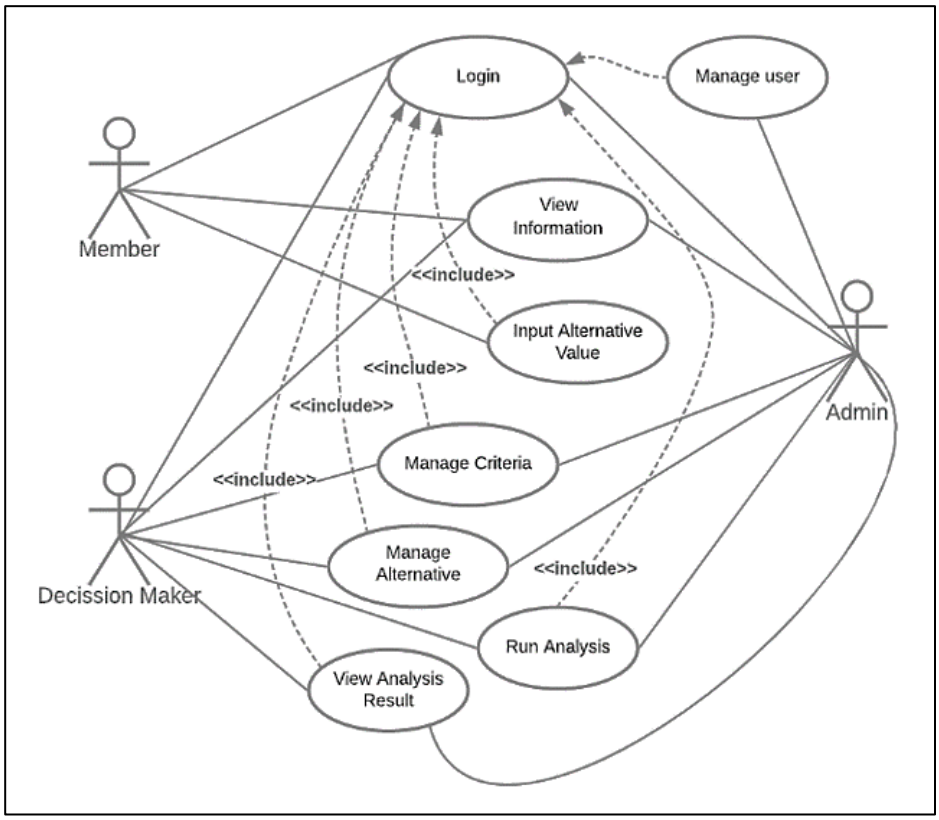

Figure 2: System Use Case Diagram

3.5 Implementation

The implementation phase is a step to transform system design into program code. The system that has been developed utilizes Hypertext Pre-Processor (PHP) with the implementation of Object-Oriented Programming (OOP) concepts and utilizes the codeigniter framework. In addition, this system uses a local server and database as a storage place for required data that can be accessed anytime. The local server uses XAMPP application that supports Apache for building web-based applications, while the database uses MySql. Once the system is successfully implemented, the database will be uploaded to hosting, allowing the application to be accessed online

3.6 Testing

Following the completion of the implementation process, the subsequent stage is system testing. In this study, a single system testing method was employed, namely black box testing. Black box testing focuses on evaluating system functionality in order to obtain the desired outcomes [15].

4 Result And Discussion

This study uses applied research to analyze and develop a web-based decision support system for mapping a tourism recommendation using the Analytical Hierarchy Process (AHP) method. The method used in the development of decision support systems is the software lifecycle development by adopting the waterfall model.

4.1 PairWise Comparisons Matrix Normalization

From the value of criteria, the next step is to calculate the weight of the criteria from a pairwise comparison matrix between criteria so that it can be obtained as Table 2.

Table 2: Matrix Pair Wise

	SDM (C1)	SDA (C2)	AS (C3)	SB (C4)	F (C5)	KI (C6)	SDI (C7)	J (C8)
SDM (C1)	1,0	3,0	2,0	1,0	3,0	2,0	2,0	3,0
SDA (C2)	0,3	1,0	1,0	1,0	2,0	2,0	2,0	0,5
AS (C3)	0,5	1,0	1,0	3,0	2,0	2,0	2,0	2,0
SB (C4)	1,0	1,0	0,3	1,0	2,0	1,0	0,5	0,3
F (C5)	0,3	0,5	0,5	0,5	1,0	1,0	0,3	0,3
KI (C6)	0,5	0,5	0,5	1,0	1,0	1,0	0,3	1,0
SDI (C7)	0,5	0,5	0,5	2,0	3,0	3,0	1,0	0,3
J (C8)	0,3	2,0	0,5	3,0	3,0	1,0	3,0	1,0
Total	4,5	9,5	6,3	12,5	17,0	13,0	11,2	8,5

Table 3: Normalisation Matrix Pair Wise

	C1	C2	C3	C4	C5	C6	C7	C8	Total
C1	0,22	0,32	0,32	0,08	0,18	0,15	0,18	0,35	1,80
C2	0,07	0,11	0,16	0,08	0,12	0,15	0,18	0,06	0,93
C3	0,11	0,11	0,16	0,24	0,12	0,15	0,18	0,24	1,30
C4	0,22	0,11	0,05	0,08	0,12	0,08	0,04	0,04	0,74
C5	0,07	0,05	0,08	0,04	0,06	0,08	0,03	0,04	0,45
C6	0,11	0,05	0,08	0,08	0,06	0,08	0,03	0,12	0,61
C7	0,11	0,05	0,08	0,16	0,18	0,23	0,09	0,04	0,94
C8	0,07	0,21	0,08	0,24	0,18	0,08	0,27	0,12	1,24
Total	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	8,0

Table 4: Calculation Of Eigen Value Table

	Eigen Value	Consistency Measure
C1	0,22	8,96
C2	0,12	8,82
C3	0,16	9,09
C4	0,09	8,51
C5	0,06	8,58
C6	0,08	8,85
C7	0,12	8,53
C8	0,16	9,12
Total	1,0	70,46

4.2 Calculate the CR (Consistency Ratio)

From the calculation of Table 4, the next step is to calculate the weight. By using equation Consistency Measure values are obtained as can be seen in Table 1, then by using equations to find λmax and obtained CI (Consistency Index) value:

$$\lambda max = \frac{\text{Total CM}}{n} \quad (1)$$

Using equation (1) then λmax is 70,46/8 = 8,81.

Next is to calculate the CI (Consistency Index) value obtained by the formula:

$$CI = \frac{\lambda max - n}{n-1} \quad (2)$$

So, CI (Consistency Index) is (8,81 – 8) / 7 = 0,1239

Next is to calculate the RI (Ratio Index), based on the theory of Saaty the value of the Ratio Index has been determined based on the order of the matrix (number of criteria. Then it can be seen from Table 1 that for the size of the matrix (n) = 8 then the RI (Random Index) used is 1.41.

$$CR = \frac{CI}{RI} \quad (3)$$

So, CR = 0,1239 / 1,41 = 0,088. With CR (Consistency Ratio) generated is less than 0.1 or CR ≤ 0.1, then the result of the calculation can be expressed correctly and can proceed to the next step and conclude that the process of comparison between the criteria was done consistently.

4.3 Calculating alternative weights

After getting the value of the weighting of the criteria, the next step is to calculate the alternative weighting in each criteria [3]. There is three alternatives:

A1 : Tiwingan Lama

A2 : Tiwingan Baru

A3 : Loksado

Table 3 is the result of a pairwise comparison for the alternative matrix of human resource criteria. The alternative pairwise comparison matrix table of all criteria is shown in table 5 until table 12.

Table 5: Pairwise Comparison Alternative Matrix Of Human Resource Criteria

	A1	A2	A3	Total	Priority	CM
A1	0,74	0,64	0,79	2,17	0,72	3,14
A2	0,11	0,09	0,05	0,25	0,08	3,01
A3	0,15	0,27	0,16	0,58	0,19	3,04
	1,00	1,00	1,00	3,00	1,00	9,20

Table 6: Pairwise Comparison Alternative Matrix Of Natural Resource Criteria

	A1	A2	A3	Total	Priority	CM
A1	0,74	0,09	0,05	0,89	0,30	3,12
A2	0,74	0,09	0,16	0,99	0,33	4,58
A3	2,23	0,27	0,16	2,66	0,89	3,12
	3,72	0,45	0,37	4,55	1,52	10,81

Table 7: Pairwise Comparison Alternative Matrix Of Social Asset Criteria

	A1	A2	A3	Total	Priority	CM
A1	0,74	0,27	0,16	1,18	0,39	4,27
A2	0,74	0,09	0,05	0,89	0,30	2,76
A3	0,74	0,27	0,16	1,18	0,39	4,27
	2,23	0,64	0,37	3,24	1,08	11,30

Table 8: Pairwise Comparison Alternative Matrix Of Cultural Spiritual Criteria

	A1	A2	A3	Total	Priority	CM
A1	0,74	0,27	0,05	1,07	0,36	2,93
A2	0,25	0,09	0,05	0,39	0,13	4,18
A3	2,23	0,27	0,16	2,66	0,89	2,65
	3,23	0,64	0,26	4,13	1,38	9,75

Table 9: Pairwise Comparison Alternative Matrix Of Financial Criteria

	A1	A2	A3	Total	Priority	CM
A1	0,74	0,27	0,16	1,18	0,39	3,00
A2	0,25	0,09	0,05	0,39	0,13	3,00
A3	0,74	0,27	0,16	1,18	0,39	3,00
	1,74	0,64	0,37	2,74	0,91	9,00

Table 10: Pairwise Comparison Alternative Matrix of Infrastructure Criteria

	A1	A2	A3	Total	Priority	CM
A1	0,74	0,27	0,47	1,49	0,50	3,51
A2	0,25	0,09	0,47	0,81	0,27	3,22
A3	0,25	0,03	0,16	0,44	0,15	2,76
	1,24	0,39	1,11	2,74	0,91	9,50

Table 11: Pairwise Comparison Alternative Matrix Of Information Resource Criteria

	A1	A2	A3	Total	Priority	CM
A1	0,74	0,27	0,47	1,49	0,50	3,00
A2	0,25	0,09	0,16	0,50	0,17	3,00
A3	0,25	0,09	0,16	0,50	0,17	3,00
	1,24	0,45	0,79	2,49	0,83	9,00

Table 12: Pairwise Comparison Alternative Matrix Of Network Criteria

	A1	A2	A3	Total	Priority	CM
A1	0,74	0,45	0,79	1,99	0,66	3,64
A2	0,15	0,09	0,47	0,71	0,24	2,97
A3	0,15	0,03	0,16	0,34	0,11	2,89
	1,04	0,58	1,42	3,04	1,01	9,50

4.4 Calculate the weighted average rating for each decision alternative

In the last phase, calculations are carried out to get the final value. The final scores for each system are determined by multiplying the weights assigned to each criterion by the ratings given to the decision alternatives for that criterion, and then summing up the resulting products. The result is shown in Table 13.

Table 13: Total Score And Ranking

Alternative	Priority	A1	A2	A3
C1	0,22	0,72	0,08	0,19
C2	0,12	0,30	0,33	0,89
C3	0,16	0,39	0,30	0,39
C4	0,09	0,36	0,13	0,89
C5	0,06	0,39	0,13	0,39
C6	0,08	0,50	0,27	0,15
C7	0,12	0,50	0,17	0,17
C8	0,16	0,66	0,24	0,11
Value		0,51	0,20	0,36
Rank		1	3	2

4.5 Implementation

The next stage after conducting the AHP case study is the implementation of a decision support system for recommendations for tourism village potential. For the value weighting data used in the AHP calculation menu, the value from the previous case study will be used as can be seen in Figure. 3 until Figure. 5.

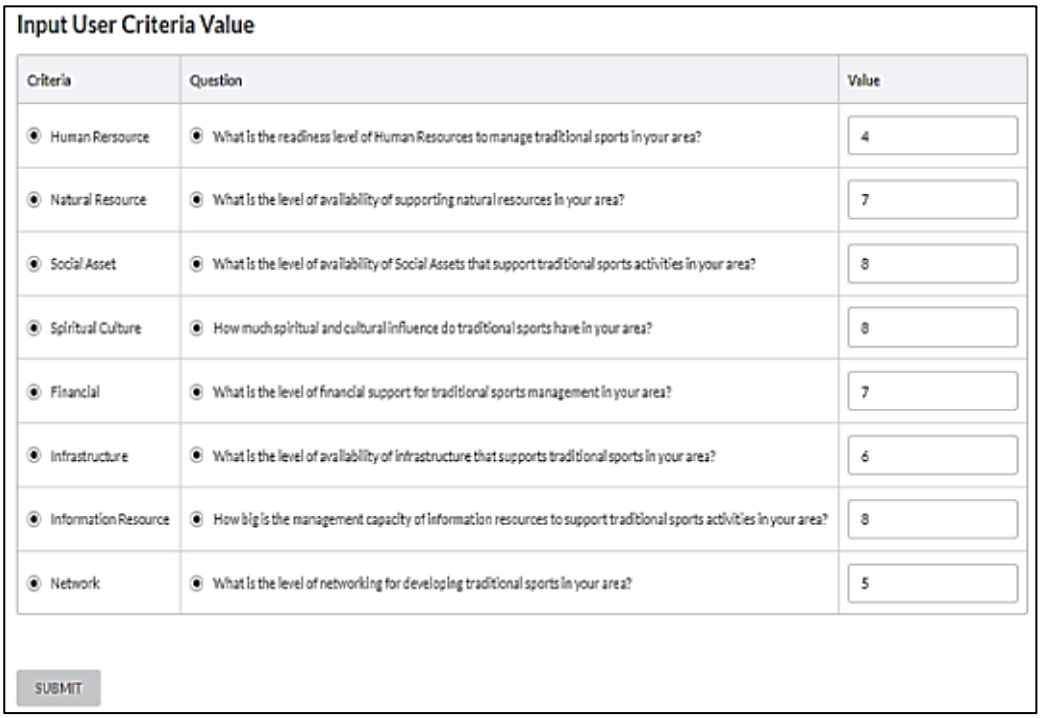

Figure 3: Input Criteria Value for User

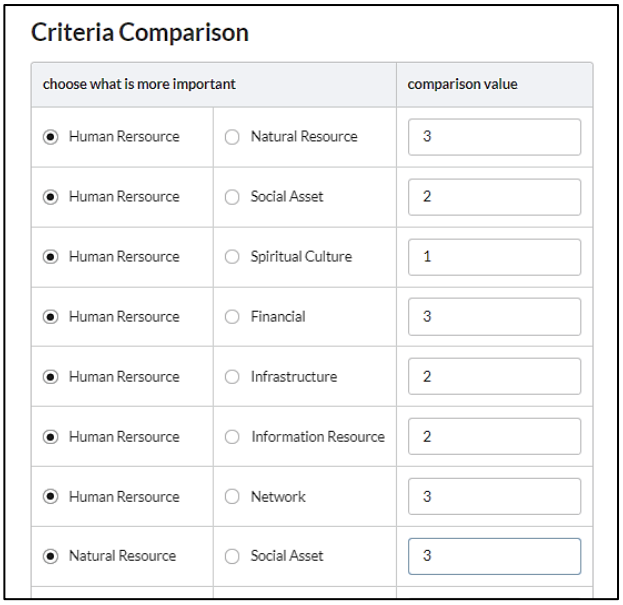

Figure 4: Criteria Comparison

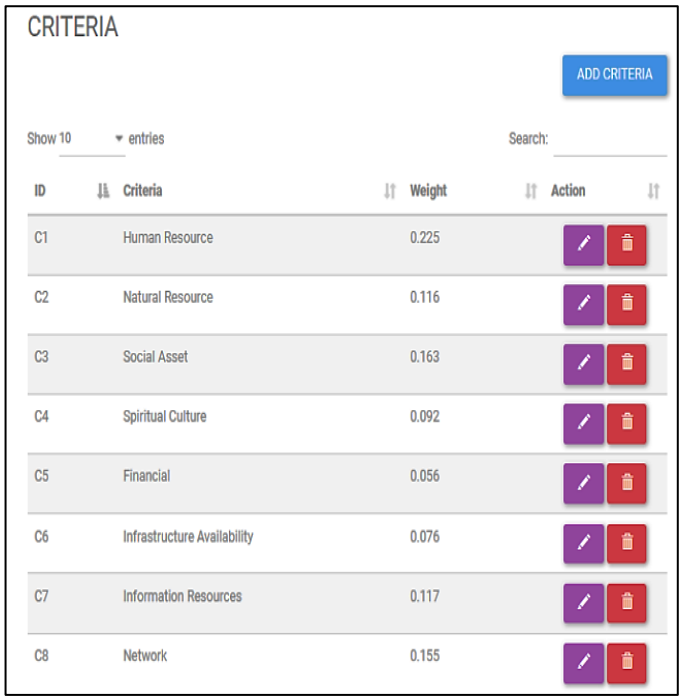

Figure 5: Criteria Weight

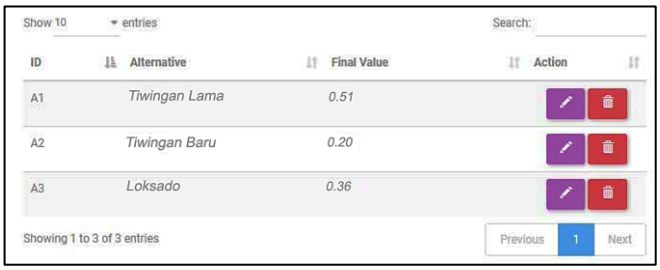

Figure 6: Final Result

The data that has been entered by the user from each region is then analyzed by the manager. After the analysis value is entered, the system will then perform an analysis using the AHP method. The results of the analysis will be displayed by id. The determination of the value for each alternative can be seen in Table 13.
The results of the analysis of decision support system can be seen in Figure 6, where it can be seen that each alternative has a different value.

4.6 Testing

In knowing whether the system is running according to the flow that has been made and so that there are no issues or bugs in the system, then the system is tested. The purpose of testing the features of the system is to find out whether the information stored, processed, and displayed is as expected. The test results on the features of a web-based decision support system can be seen in Table 14.

Table 14: Test Case

#	Test Case	Expected Results	Test Result
1	Admin and Decision Maker manages criteria data (add, edit and delete)	The system will record changes to the criteria data.	The system record changes to the criteria data.
2	Admin and Decision Maker manages alternative data (add, edit and delete)	The system will record changes to alternative data	The system record changes to alternative data
3	User input criteria values for every area	data is stored in database	The system will store data to a database
4	User weights values using inconsistent values	The system will display a warning that the value-weighted is inconsistent.	The system raises a warning that the values are weighted inconsistently
5	The user does not fill in multiple value weighting fields	The system will display a warning that the value cannot be empty	The system raises a warning that the value cannot be empty
6	The user fills in the weighting values according to the format then presses the submit button	The system will display the assessment results page with calculations according to the AHP formula	The system displays the assessment results page with calculations according to the AHP formula

5 Conclusions

The implementation of a decision support system for Tourism Village recommendations offers a solution for identifying potential tourism areas in South Kalimantan. By utilizing the analytical hierarchy process (AHP) method within the decision support system, users can select areas with the capacity to be developed into regional tourism destinations in South Kalimantan. Furthermore, the comparison between manual AHP calculations and the system's calculations demonstrated accurate results. The top-ranked recommendation, with a weight value of 0.51, was Tiwingan Lama. Loksado secured the second rank with a weight value of 0.36, while Tiwingan Baru obtained the third rank with a weight value of 0.2. The system testing confirmed that all system functions provided accurate information and operated smoothly. Utilizing the AHP method for suggesting tourism potentials can enhance the objectivity of the decision-making process, optimize the use of resources, and maximize the advantages for all stakeholders involved in the tourism sector.

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