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Priority Strategy Of Tourism Development Of Siau Tagulandang Biaro Island Regency

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Abstract: The recovery of the tourism industry requires the Siau Tagulandang Biaro Islands Regency to reevaluate its strategy by identifying critical development priorities. That is the aim of the study, which applies the Analytic Hierarchy Process (AHP) and fuzzy-AHP methods. The analysis would serve to identify the key factors and establish strategic recommendations. The results show that facilities are the highest criterion (thirty-four point seven per cent AHP; thirty-four point four per cent Fuzzy-AHP). The global weight calculation shows that Maintaining the ecosystem and cleanliness of beaches/lakes/hot springs are priority elements (eight point six per cent AHP; eight point five per cent Fuzzy-AHP). The sensitivity analysis shows that the results could be more robust, consistent, and stable. These results indicate no significant difference between the AHP and Fuzzy-AHP methods. The tourism development strategy for Siau Tagulandang Biaro Regency must prioritise improving the cleanliness and health of tourist destinations. This research answers an essential problem for the Siau Islands Regency government, Tagulandang Biaro.
Keywords: Siau Tagulandang Biaro; AHP; Fuzzy; Tourism; Cleanliness.

Abstrak: Pemulihan industri pariwisata mengharuskan Kabupaten Kepulauan Siau Tagulandang Biaro mengevaluasi kembali strategi mereka dengan mengidentifikasi prioritas pembangunan yang penting. Hal itulah yang menjadi tujuan penelitian dengan menerapkan metode Analytic Hierarchy Process (AHP) dan fuzzy-AHP. Analisis ini akan berfungsi untuk mengidentifikasi faktor-faktor kunci dan menetapkan rekomendasi strategis. Hasil penelitian menunjukkan bahwa fasilitas menjadi kriteria tertinggi (tiga puluh empat koma tujuh persen AHP; tiga puluh empat koma empat persen Fuzzy-AHP). Perhitungan bobot global menunjukkan bahwa menjaga ekosistem dan kebersihan pantai/danau/mata air panas menjadi elemen prioritas (delapan koma enam persen AHP; delapan koma lima persen Fuzzy-AHP). Analisis sensitivitas menunjukkan bahwa hasilnya tidak kuat, tidak konsisten, dan tidak stabil. Hasil tersebut menunjukkan tidak adanya perbedaan yang signifikan antara metode AHP dan Fuzzy-AHP. Strategi pengembangan pariwisata Kabupaten Siau Tagulandang Biaro harus mengutamakan peningkatan kebersihan dan kesehatan destinasi wisata. Penelitian ini menjawab permasalahan esensial bagi pemerintah Kabupaten Kepulauan Siau, Tagulandang Biaro.
Kata kunci: Siau Tagulandang Biaro; AHP; Fuzzy; Turisme; Kebersihan.

INTRODUCTION

Tourism is one of the mainstays of regional economic development in the Siau Tagulandang Biaro Islands Regency. According to (Campos C et al., 2022), tourism contributes 10.400 per cent of the gross domestic product (GDP). It was added that before the Covid 19 pandemic, tourism growth was estimated at 4.000 per cent per year (Campos et al., 2022).

The island area holds great promise of being transformed into a sought-after vacation destination. This is evident from the examples of the Pacific and Greek islands. People can

see the same pattern in the islands near Singapore's shore and the Marshall Islands. The main attraction of island tourism is the beach and sea. The ocean and its environment draw millions of tourists and recreation worldwide. (Suarez-Rojas, 2023) adds that in the last few decades, marine recreation has become increasingly popular and in demand (Suárez-Rojas et al., 2023). Beach recreation, such as rowing, canoeing, sailing, and surfing, is in great demand for island tourism visitors because it helps reduce stress and improves the tourists' mental health by offering a sense of calm and revitalisation. (Román et al., 2022a). The tendency of tourists to visit the Archipelago, with its unique ecosystem, continues to increase as the area offers a calm atmosphere away from the hustle and bustle of big cities. Therefore, beach safety and cleanliness are severe concerns (Campos et al., 2022a).

The academic studies of island tourism focus on four major themes. First, several studies focus on the island's condition, wealth, ecosystem, environment, flora and fauna, and the people who interact and live on the island. The second is the culture and tourism products found on these islands, as seen in the lifestyle of the people and the island's landscape. The third is cultural heritage, art, and artefacts, which are ancestral heritage in the area and have a historical value that interests tourists. The fourth is issues related to the planning, development, and management of island tourism so that the natural environment is maintained, water sources and other natural resources are guaranteed, and people's lives remain safe while also increasing the income and standard of living of the inhabitants of these islands.

Island tourism has several obstacles, including the need for integrated development planning, shared vision among policymakers, limited qualified human resources, and a need for intellectually reliable leaders to develop island tourism. (Leelawat et al., 2022) added that tourism problems are mainly related to environmental, social, and cultural sustainability (Leelawat et al., 2022).

Tourism, hospitality, and restaurant activities have virtually stopped worldwide. To prevent the spread of Covid 19, governments have imposed travel restrictions, closed government offices, suspended domestic and international flights, and restricted the size of crowds or cancelled festivals, entertainment venues, and sports activities. Private agencies followed this government policy and consequently reduced tourist visits. Reports in the news about the number of people and communities infected with COVID-19 have made many people avoid travelling (Chansuk et al., 2022a). He added that travel activity fell significantly. Domestic visitors' expenditure decreased, while a decrease substantially occurred in the expenditure of international tourists. It was the first time something like this had happened (Burbano et al., 2022).

The COVID-19 pandemic, which caused a global and unprecedented crisis, exacerbated the tourism situation for the Archipelago. The Island district areas depend heavily on tourism and have been struck by the COVID-19 pandemic. Workers involved in the tourism industry have lost their jobs, with no alternative sources of income (Kato-Huerta & Geneletti, 2023).

As the pandemic declines, tourism is entering a new stage. Tourism development is starting to get exciting again. Travel restrictions were lifted, the aviation industry started to get busy, and hotels and restaurants were again filled with visitors. Despite the health crisis, tourism remains one of the most significant socioeconomic drivers (Campos et al., 2022). Even though tourism activities have grown since the COVID-19 pandemic, travel safety, health, and pandemic-free destinations remain essential priorities for tourists in

choosing their destinations (Hyytiainem et al., 2022). For this reason, the right strategy is needed to develop island tourism.

In the world of tourism, strategy plays a vital role. The strategy opens new insights into the future by defining and formulating necessary actions, setting priorities for their implementation, and opening the door for the flow of resources and facilities (Tribe & Paddison, 2023).

Siau Tagulandang Biaro Islands Regency has excellent tourism potential with tourist attractions, such as beaches, volcanoes, hot springs, and the best nutmeg plantations in the world. One of the key tourist destinations in this area is Karangetang Beach and the volcano. The number of tourist visits to this area was significantly reduced throughout the coronavirus outbreak, but during the post-pandemic period, tourist visits increased. Tourists can reach Siau Tagulandang Biaro regency by air via a direct flight from the provincial capital of Manado to Siau, which takes approximately 30 minutes. There is also a sea transportation mode using a fast boat from Manado, which takes about four hours of travel.

Tourism development for the Siau Tagulan Biaro Islands Regency requires careful planning to attract as many tourists as possible. The planning program that is very urgent for regional tourism development after the COVID-19 pandemic is determining the priority factors for development planning.

This study aims to establish the most significant priority factors for tourism development in the Siau Tagulandang Biaro Islands Regency. The research problem is: Which are the priority factors for the tourism development of the Siau Tagulandang Biaro Islands Regency? The research findings will significantly assist the government and tourism observers in developing local tourism, especially in the post-COVID-19 periods.

The uniqueness of this study stems from its innovative approach and concentration on the tourism sector. In terms of the approach, this research pioneers the application of both AHP and Fuzzy AHP techniques within the realm of tourism development research. These techniques offer a more detailed and advanced analysis than the conventional method, which strongly emphasises quantitative measurement. They deliver a distinct prioritisation that is more accurate and objective, yielding practical insights for local government to aid in the revival of the tourism industry. The practical ramifications of this research render it not only academically fresh but also highly pertinent for policy formulation.

THEORETICAL REVIEW

Potentialities of The Islands Regency. The Islands Regency is one of the most promising tourist destinations. (Bulchand-Gidumal, 2022) writes that the economy of the Islands Regency has increased because it is supported by tourism, such as the Canaries, Balearic, Sardinia, and Sicily islands (Bulchand-Gidumal, 2022). The Archipelago as a tourist destination has been introduced previously. An archipelago area is a place for tourists to isolate themselves from the crowds and seek peace and a sense of timelessness while enjoying the fresh air. Due to its isolation and fame, many islands use tourism as their primary economic growth tool. The Isle of Capri has been a vacation spot for the Romans for thousands of years. Vacationing on the Islands has become a long tradition and continues to this day.

Several factors support island tourism; first is the matter of clear territorial boundaries that allow for control of the territory and are easily managed only through airports and seaports. The second is remoteness, a dream for travellers who want to enjoy solitude and independence and can enjoy healthy air. The third is that the environment is small, just an island, so there is a more intense interaction between visitors and the local community so that tourists can understand the lifestyle of the local people. Fourth, the islands, with a small population, are somewhat separated, reducing the pandemic threat (Telesford, 2021).

The problems faced by island tourism are governance, human resources, and development planning. The needs of the ArchipelagoArchipelago are generally supplied from outside by sea transportation, which causes the price of goods to become more expensive (McLeod et al., 2021). There are twelve challenges faced by island tourism. These challenges include (1) extreme population dynamics; (2) low potential for economic diversification; (3) negative impact of land development; (4) seawater quality; (5) water status; (6) waste management challenges due to its small size and remoteness; (7) tourism pressure; (8) pettiness and peripherals; (9) the decline of agriculture and fisheries; (10) degradation of natural resources and loss of biodiversity; (11) the high cost and impact of energy use; and (12) low levels of Education and Training (Moncada et al., 2016).

Several vital issues must be addressed by island tourism; namely, first, finding a balance between tourism demands and the protection of nature and the environment. The second is clarifying the role of the government and institutions involved in developing island tourism. The third priority is maintaining economic stability and enhancing infrastructure support. The fourth issue concerns the supply of materials and the cost of goods. Fifth is population growth and decline. The last one is sustaining the indigenous population and culture. Archipelagic tourism development can have positive and negative impacts, requiring careful arrangement and planning.

Analytical Hierarchy Process (AHP). The Analytical Hierarchy Process (AHP) is one of the methods used in multiple-criteria decision-making (MCDM). The AHP method uses a pairwise comparison technique in data collection. Each criterion and sub-criterion is evaluated using an importance scale ranging from 1 to 9, making it easy for respondents to choose because they only determine one answer from the two available options (Raco & Krejci, 2022).

This approach employs a hierarchical structure to streamline the problem-solving process. Saaty defines a hierarchy as a framework that organises complex issues into multiple levels, starting with the primary objective at the top, followed by layers of factors, criteria, sub-criteria, and, ultimately, the alternatives at the bottom. By grouping and arranging the elements in a hierarchical format, complex problems can be made more structured and systematic (Saaty, 1987).

The AHP method is efficient and flexible in determining tourism development priorities that involve various complex criteria. (Raco et al., 2022) mentioned several advantages of AHP, such as the ability to quantify subjective perceptions and arrange them in a hierarchical form so they are easy to solve. This method has proven to be very effective for decision-makers in formulating policies. This method has been extensively applied in scientific studies by various disciplines. This method can also solve intangible criteria such as experience, subjective preferences, and intuition from various people. The mathematical formula used is easy to understand and analyse.

Although AHP is considered superior in determining the priority of multi-complex criteria, its application has several problems. One problem is that the AHP method uses crisp or single numbers, even though we all know that a person's perception or experience is subjective and cannot be indicated by a single number. Therefore, the researchers combined AHP with fuzzy AHP. To help respondents answer more precisely, the researchers used linguistic terms that reduce ambiguity.

Fuzzy-AHP. The fuzzy-AHP method was then developed to reduce uncertainty and grey from the human subjective perception, which cannot be determined using crisp numbers. The AHP limits the inconsistency ratio of pairwise comparisons to smaller than 1.000. However, it is rather difficult to ascertain the overall uncertainty due to the subjective nature of the respondent's determination. Then, a new way to produce a unique fuzzy number for the weight applies to cases of missing data and multiple estimates. A new method of performing fuzzy hierarchical analysis fuzzifies Saaty's Lamda-Max method. Their studies show that this method can handle any fuzzy number used for pairwise comparisons. The triangular-shaped fuzzy number, used in estimator hypothesis testing, generates a fuzzy test statistic and fuzzy critical values, offering an alternative approach to traditional crisp hypothesis testing (Buckley, 2005). (Sadeghi et al., 2022) added that the classical AHP method could not properly and correctly satisfy the fuzziness of human subjective judgments. Therefore, a firmer way to capture their subjective perception is to use linguistic terms to minimise ambiguity(Sadeghi et al., 2022). The advantage of fuzzy AHP is that it uses a vague number instead of a crisp number to determine the relative value of an attribute or criterion. Fuzzy-AHP uses fuzzy triangular numbers to reduce uncertainty. Fuzzy numbers play a vital role in the application of decision-making (Joudar et al., 2023).

Sensitivity Analysis. Sensitivity analysis is a technique in Multi-Criteria Decision-Making to determine whether the priorities obtained are stable, consistent, and robust. Performing a sensitivity analysis is essential for decision-makers to ascertain whether the decisions to be prioritised in policy are robust. Researchers usually conduct sensitivity analysis by increasing the value at a certain percentage of the other criteria and then seeing whether increasing the percentage of the other criteria will affect the change in the priority criteria. If there is a change, the priority criteria are manageable, consistent, and robust. Thus, decision-makers must be careful in determining their policies because there will be a fundamental change in the priority scale with the slightest change in the other criteria.

Sensitivity analysis is often also referred to as 'what if analysis.' That means that the final result will change if there is a change in the weight of the other criteria. (Raco & Krejci, 2022) emphasised that the more sensitive a parameter is, the more fragile the criterion is to be prioritised (Raco & Krejci, 2022). Policymakers must carry out a sensitivity analysis before determining the policy to be taken.

Sensitivity analysis also shows the dynamic nature of a decision. That means an initial assessment is needed in sufficient time to determine a policy priority because even the slightest change in other factors will affect it. Sensitivity analysis helps decision-makers determine the strength of the decision to be made.

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METHODS

The researchers follow some steps below (**Figure 1**). The **first** step is to determine the research objectives. This study aims to determine the priority factors for tourism development in the Siau Tagulandang Biaro Islands Regency.

The **second** step is to define the criteria and sub-criteria. Researchers identify several criteria and sub-criteria taken from previous studies. These criteria and sub-criteria were then discussed in a Focus Group Discussion (FGD). Through the FGD, the researchers hope to gain relevant and more in-depth input from the participants on the study topic. In addition, FGDs allow researchers to involve more groups of observers of island tourism, especially in determining criteria and sub-criteria.

Eighteen people attended the focus group discussion. They are local government officials with an average of more than five years of experience in tourism and are considered experts in the field. This FGD aims to get input from the participants to enrich the results obtained from previous research. The FGD also aims to obtain criteria and sub-criteria appropriate to the local context as experienced, understood, and lived by the local community concerning the development of their regional tourism. The input from the FGD participants was recorded and then analysed by the researchers. The results of this FGD contain valuable information for researchers to determine the priority factors for tourism development in the area.

Five criteria result from this FGD: human resources, Infrastructure, facilities, community behaviour, and place/destination of tourism.

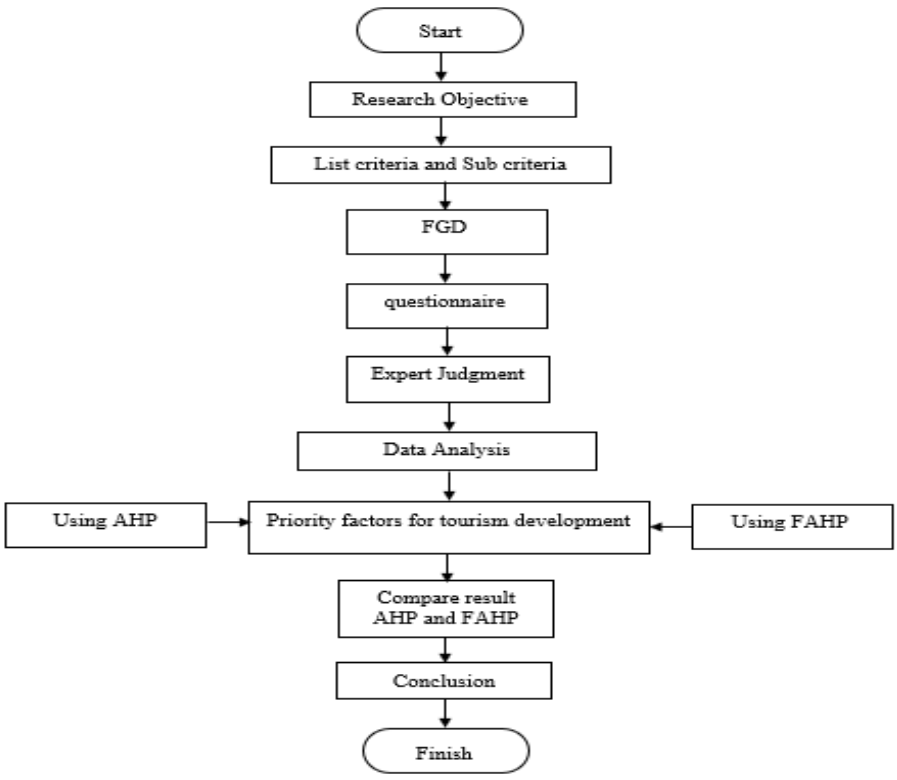

Figure 1. Research Steps
Source: From the author's development

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Human resources are the level of Education and training in the local communities or those from outside the area that can help visiting tourists. Infrastructure is the availability of roads/bridges, piers/harbours, airports, and evacuation paths to support regional tourism growth. Facilities include clean water, electricity, waste treatment, accommodation/hotel/lodging, communication network/internet/WIFI, and hospital/medical doctors and other specialists to support the needs of the tourists. Community behaviour is defined as welcoming people toward tourism, surrounding security, cleanness, and healthy surroundings/community. Place and destination of tourism are defined as efforts to maintain the ecosystem and cleanliness of beaches/lakes/hot springs, promote cultural events, and protect the area's cultural sites and historical heritage. The results of this definition then form sub-criteria.

The **third** step is compiling and distributing the questionnaire. The questionnaire was prepared through pairwise comparisons using Saaty's comparative scale (Saaty, 1980) in **Table 1.**

Table 1. Saaty's comparative scale

The Intensity of Importance on an Absolute Scale	Definition	Explanation
1	Equal Importance	Two activities contribute equally to the objective
3	Moderate Importance of one over another	Experience and judgment strongly favour one activity over another
5	Essential or strong Importance	Experience and judgment strongly favour one activity over another
7	Extreme Importance	Activity is strongly favoured, and its dominance is demonstrated in practice.
9	Extreme Importance	The evidence favouring one activity over another is of the highest possible order of affirmation.
2, 4, 6, 8	Intermediate values between the two adjacent judgments	When compromise is needed

Source: (Saaty, 1980)

The **fourth** step is that this questionnaire was compiled using the Google Forms platform and sent to eighteen respondents. The respondents were considered tourism experts. They are decision-makers and tourism actors with five years of experience in the Siau Tagulandang Biaro Islands tourism sector. The researchers analysed the questionnaire responses by aggregating individual judgments and manually calculating the results using the geometric mean (as shown in Equation 1). The geometric mean effectively synthesises expert judgments in reciprocal matrices (Raco & Krejci, 2022).

The **fifth** step is normality analysis, which determines the eigenvectors, index consistency, and consistency ratio. The analysis results must meet the assessment consistency, namely, smaller than 0.100.

The sixth step is to use consistent AHP results and calculate Fuzzy-AHP. The seventh step is to investigate the results of AHP and Fuzzy-AHP to determine whether there is a significant difference between them.

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The AHP analysis steps are carried out in stages as follows. Questionnaires that experts have answered are then calculated and analysed in aggregate using **Equation 1**,

$$GM = \sqrt[n]{(x_1)(x_2)\dots(x_n)} \quad \dots\dots (1)$$

The results that have been aggregated are then arranged in the form of a pairwise comparison matrix (Saaty, 1980) following **Equation 2**,

$$A = [a_{ij}], a_{ij} = w_i/w_j, a_{ji} = 1/a_{ij}, a_{ii} = 1 \quad \dots\dots (2)$$

Then, the pairwise comparison matrix is normalised using **Equation 3**,

$$b_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} \quad \dots\dots (3)$$

Next, the calculation of the priority value is carried out using **Equation 4**,

$$w_i = \frac{\sum_{j=1}^{n} b_{ij}}{n} \quad \dots\dots (4)$$

The next step is to calculate the consistency index. The consistency index analysis begins by calculating the maximum eigenvalue using **Equation 5**,

$$\lambda_{max} = \sum_{i=1}^{n} \frac{(Aw)_i}{nw_i} \quad \dots\dots (5)$$

Then, calculate the consistency index using **Equation 6**,

$$CI = \frac{\lambda_{max} - n}{n-1} \quad \dots\dots (6)$$

After the consistency index results are obtained, the researchers proceed with the calculation of the consistency ratio with **Equation 7**,

$$CR = \frac{CI}{RI} \quad \dots\dots (7)$$

The ratio index for every *n* object is shown in **Table 2**.

Table 2. Ratio index value

N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0.000	0.000	0.580	0.900	1.120	1.240	1.320	1.410	1.450	1.490	1.510	1.480	1.560	1.570	1.590

Source: (Saaty, 1980)

After obtaining the AHP analysis's consistency ratio, the researchers compiled a fuzzy-AHP pairwise comparison.

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Table 3. Scale AHP and Fuzzy-AHP

Linguistic variables	AHP Scale	Fuzzy AHP Scale	
		TFNs	Reciprocal TFNs
Equal Importance	1	(1, 1, 1) diagonal	(1, 1, 1)
Intermediate	2	(1, 2, 3)	(1/3, 1/2, 1)
Moderately more important	3	(2, 3, 4)	(1/4, 1/3, 1/2)
Intermediate	4	(3, 4, 5)	(1/5, 1/4, 1/3)
Strongly more important	5	(4, 5, 6)	(1/6, 1/5, 1/4)
Intermediate	6	(5, 6, 7)	(1/7, 1/6, 1/5)
Very strongly more important	7	(6, 7, 8)	(1/8, 1/7, 1/6)
Intermediate	8	(7, 8, 9)	(1/9, 1/8, 1/7)
Extremely more important	9	(8, 9,9)	(1/9, 1/9,1/8)

Source: (Zaid et al., 2024)

The next step is determining the respondents' perceived value using the Buckley version of the Fuzzy-AHP (Buckley, 1985).

Step 1. Compile a pairwise comparison matrix of criteria and sub-criteria as follows:

$$\tilde{A} = \begin{bmatrix} 1 & \tilde{a}_{12} & \cdots & \tilde{a}_{1n} \\ \tilde{a}_{21} & 1 & \cdots & \tilde{a}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{a}_{n1} & \tilde{a}_{n2} & \ldots & 1 \end{bmatrix} = \begin{bmatrix} 1 & \tilde{a}_{12} & \cdots & \tilde{a}_{1n} \\ 1/\tilde{a}_{12} & 1 & \cdots & \tilde{a}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ 1/\tilde{a}_{1n} & 1/\tilde{a}_{2n} & \cdots & 1 \end{bmatrix} \quad \text{..... (8)}$$

with,

$$\tilde{a}_{ij} = \begin{cases} \tilde{1}, \tilde{3}, \tilde{5}, \tilde{7}, \tilde{9}, criterion\ i\ is\ relative\ Importance\ to\ criterion\ j \\ 1, \ i = j \\ \tilde{1}^{-1}, \tilde{3}^{-1}, \tilde{5}^{-1}, \tilde{7}^{-1}, \tilde{9}^{-1}, criterion\ i\ is\ relative\ less\ Importance\ to\ criterion\ j \end{cases}$$

Step 2. Calculating the geometric mean of fuzzy comparison value of criterion I to each criterion using **Equation 9**,

$$\tilde{r}_i = (\tilde{a}_{i1} \otimes \tilde{a}_{i2} \otimes \cdots \otimes \tilde{a}_{in})^{1/n} \quad \text{..... (9)}$$

Where $\tilde{a}_{in}$ is a fuzzy comparison value of criterion *i* to criterion *n*.

Step 3. Determining the fuzzy weight of each criterion indicated by the triangular fuzzy number,

$$\tilde{w}_i = \tilde{r}_i \otimes (\tilde{r}_1 \oplus \cdots \oplus \tilde{r}_n)^{-1} \quad \text{..... (10)}$$

Where $\tilde{w}_i$ is the fuzzy weight of the *i*th criterion and can be indicated using a triangular fuzzy number, $\tilde{w}_i = (Lw_i, Mw_i, Uw_i)$, $Lw_i, Mw_i\ and\ Uw_i$ meant the lower, middle, and upper values of the fuzzy weight of the *i*th criterion.

Step 4. The defuzzification process employed the Centre of Area method to determine the weight of the Best Nonfuzzy Performance (BNP) by utilising **Equation 11**,

$$BNP_{w_i} = [(Uw_i - Lw_i) + (Mw_i - Lw_i)]/3 + Lw_i \quad \text{..... (11)}$$

The following step is a sensitivity analysis to see whether the priority criteria obtained are stable, consistent, and robust.

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RESULTS

This research aims to reveal the priority factors for tourism development in the Siau Tagulandang Biaro Islands Regency. This study applies the AHP and Fuzzy-AHP methods, usually used in multiple criteria decision-making. In addition, this study also aims to investigate whether the results obtained using AHP are significantly different from those obtained through Fuzzy-AHP analysis. Determination of criteria and sub-criteria are carried out through FGD activities involving decision makers related to tourism in Siau Tagulandang Biaro Islands Regency, with the results in **Figure 2.**

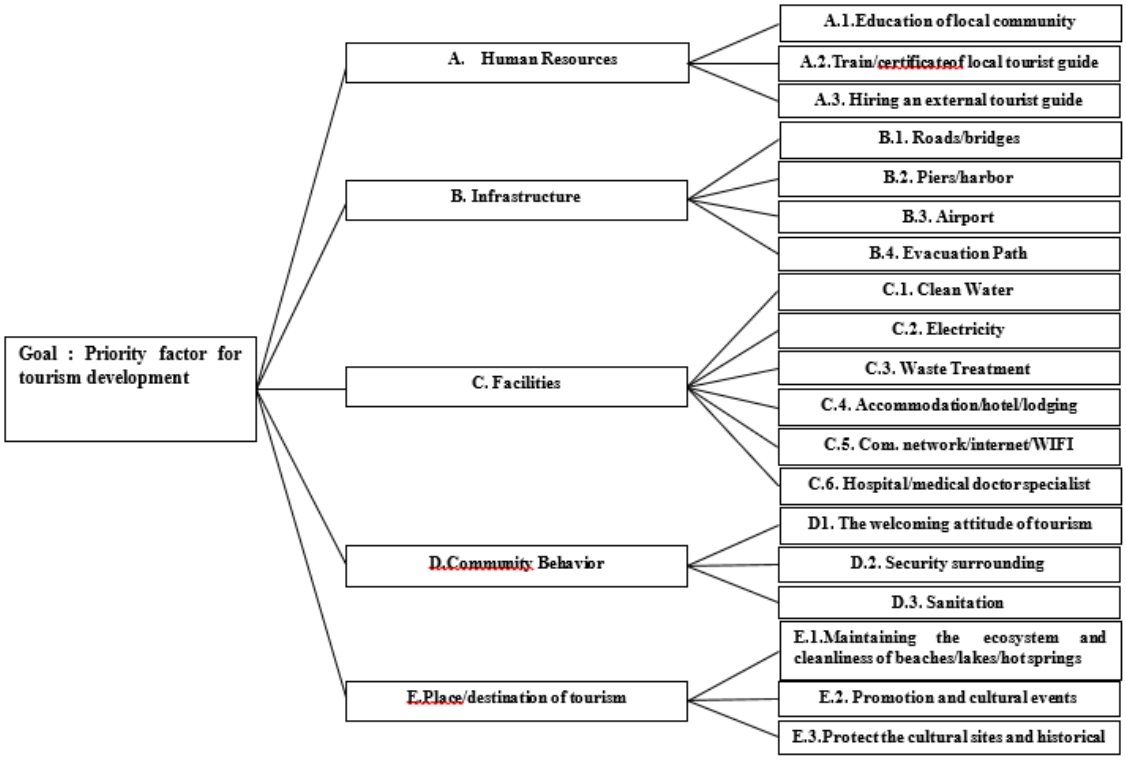

Figure 2. The Hierarchy chart
Source: From the author's development

Perception of Weighting Using The AHP Method. Data processing to obtain the weight of the criteria and sub-criteria uses the AHP method based on equations 1 to 7 the data processing results for the criteria listed in **Table 4.**

Table 4. Pairwise comparison matrix and priority weight of the criteria

	A	B	C	D	E	Priority Weight
A	1.000	0.793	0.466	0.753	0.604	0.133
B	1.261	1.000	0.436	0.889	1.208	0.169
C	2.144	2.293	1.000	1.653	2.593	0.347
D	1.329	1.125	0.605	1.000	0.898	0.181
E	1.655	0.828	0.386	1.114	1.000	0.172
	$\lambda \max = 5.054,$		$CI = 0.013,$		$CR = 0.012$	

Source: Primary data processed

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According to **Table 4,** A stands for Human resources, B for Infrastructure, C for Facilities, D for Community behaviour, and E for Place or destination of tourism.

The results of the criteria weighting show that the criteria for facilities are the most significant weight (34.700 per cent). The consistency ratio of criteria to goals is 0.012. This result is smaller than 0.100. This means the results of calculating these criteria are consistent (**Table 4**).

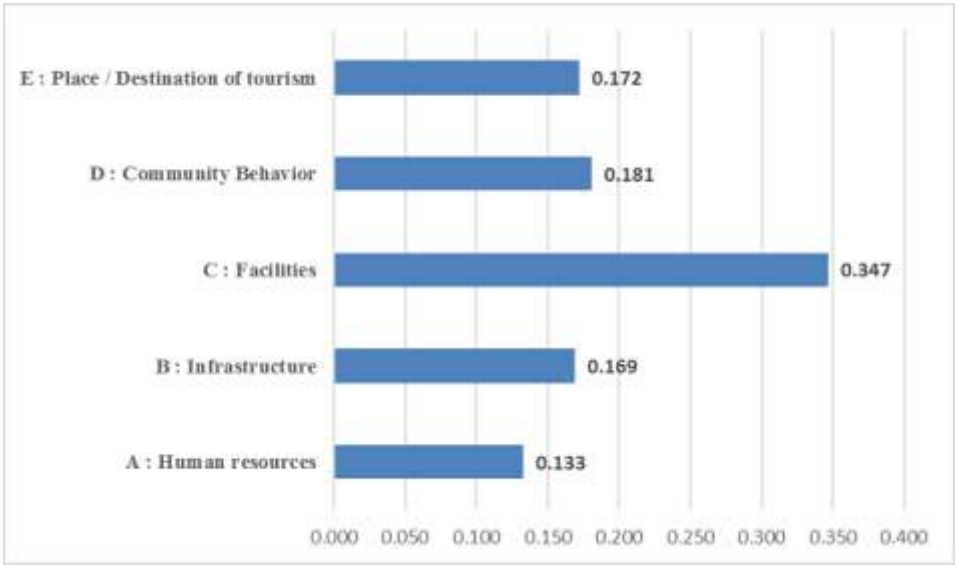

Figure 3. Weight of the criteria
Source: Primary data processed

The weight of the analysis results criteria successively, starting from the largest, is Facilities (34.700 per cent), Community behaviour (18.100 per cent), Place/destination of tourism (17.200 per cent), Infrastructure (16.900 per cent), and Human resources (13.300 per cent) (**Figure 3**).

The pairwise comparison matrix and the weight of the sub-criteria human resources are shown in **Table 5**.

Table 5. Pairwise comparison matrix and priority weight of sub-criteria human resources

	A1	A2	A3	Priority Weight
A1	1.000	0.557	2.847	0.330
A2	1.795	1.000	3.977	0.544
A3	0.351	0.251	1.000	0.126
	$\lambda \max = 3.007,$	$CI = 0.004,$	$CR = 0.006$	

Source: Primary data processed

Information in **Table 5** is as follows: A1 stands for Education of the local community, A2 stands for training and certification of a local tourist guide, and A3 stands for Hiring an External tourist guide.

The Consistency Ratio value was 0.006, smaller than 0.100, which means the results are consistent (**Table 5**).

The pairwise comparison matrix and the weight of the sub-criteria Infrastructure are presented in **Table 6**.

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Table 6. Pairwise comparison matrix and priority weight of the sub-criteria Infrastructure

	B1	B2	B3	B4	Priority Weight
B1	1.000	1.508	0.800	0.702	0.242
B2	0.663	1.000	1.078	1.612	0.263
B3	1.250	0.928	1.000	0.905	0.246
B4	1.424	0.620	1.105	1.000	0.249
	λ max = 4.147,		$CI = 0.049$,		$CR = 0.054$

Source: Primary data processed

The information from **Table 6** is as follows: B1 stands for Roads and Bridges; B2 stands for Piers and Harbor; B3 stands for Airport; and B4 stands for Evacuation Path.

The value of the Consistency Ratio was 0.054, smaller than 0.100, which indicates that the respondents' perception was consistent (**Table 6**).

The pairwise comparison matrix and the weight of the sub-criteria facilities are displayed in **Table 7**.

Table 7. Pairwise comparison matrix and priority weight of the sub-criteria facilities

	C1	C2	C3	C4	C5	C6	Priority Weight
C1	1.000	1.531	0.699	0.929	1.006	0.531	0.151
C2	0.653	1.000	1.152	1.102	1.144	0.739	0.157
C3	1.432	0.868	1.000	0.993	0.624	0.870	0.155
C4	1.076	0.907	1.007	1.000	0.708	0.865	0.150
C5	0.994	0.874	1.603	1.413	1.000	0.778	0.178
C6	1.884	1.354	1.150	1.156	1.285	1.000	0.209
		λ max = 6.127,		$CI = 0.025$,		$CR = 0.021$	

Source: Primary data processed

Information of **Table 7** shows is as follows: C1 stands for C; Clean Water; C2 stands for Electricity; C3 stands for Waste Treatment; C4 stands for Accommodation, Hotel and Lodging; C5 stands for Communication Network, Internet and Wife; and C6 stands for Hospital and Medical Doctor Specialists.

The consistency ratio value was 0.021, smaller than 0.100, meaning the result was consistent (**Table 7**).

The pairwise comparison matrix and the weight of the sub-criteria community behaviour appear in **Table 8**.

Table 8. Pairwise comparison matrix and priority weight of the sub-criteria community behaviour

	D1	D2	D3	Priority Weight
D1	1.000	1.303	0.655	0.306
D2	0.768	1.000	0.551	0.242
D3	1.528	1.816	1.000	0.453
	λ max = 3.001,		$CI = 0.001$,	$CR = 0.001$

Source: Primary data processed

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Information in **Table 8** is as follows: D1 stands for The Welcoming Attitude, D2 stands for Security Surrounding, and D3 stands for Sanitation.

The Consistency Ratio was 0.001, smaller than 0.100, so the result was consistent (**Table 8**).

A pairwise comparison matrix and the weight of the sub-criteria place/destination of tourism are in **Table 9**.

Table 9. Pairwise comparison matrix and priority weight of the sub-criteria place/ destination of tourism

	E1	E2	E3	Priority Weight
E1	1.000	2.418	1.680	0.500
E2	0.414	1.000	1.220	0.252
E3	0.595	0.819	1.000	0.249
	$\lambda \max = 3.035,$	$CI = 0.018,$	$CR = 0.031$	

Source: Primary data processed

The information in **Table 9** is as follows: E1 stands for Maintaining Ecosystems, E2 stands for promotion and cultural events, and E3 stands for protecting cultural and Historical Sites.

The Consistency Ratio was 0.031, smaller than 0.100, so the result was consistent (**Table 9**).

Perception weighting using Fuzzy – AHP. The weight of the criteria and sub-criteria was analysed using the fuzzy AHP method based on equations 8 to 11. Respondents' perceptions of the criteria were arranged in a fuzzy pairwise comparison matrix previously aggregated using geometric mean. The results are listed in **Table 10**.

Table 10. Fuzzy pairwise comparison matrix of criteria

	A			B			C			D			E		
	L	**M**	**U**	**L**	**M**	**U**	**L**	**M**	**U**	**L**	**M**	**U**	**L**	**M**	**U**
A	1.000	1.000	1.000	0.678	0.793	0.924	0.403	0.466	0.570	0.648	0.753	0.932	0.520	0.604	0.726
B	1.082	1.261	1.475	1.000	1.000	1.000	0.392	0.436	0.507	0.777	0.889	1.004	0.994	1.208	1.452
C	1.754	2.144	2.480	1.973	2.293	2.549	1.000	1.000	1.000	1.445	1.653	1.875	2.163	2.593	2.999
D	1.073	1.329	1.543	0.996	1.125	1.286	0.533	0.605	0.692	1.000	1.000	1.000	0.789	0.898	1.036
E	1.378	1.655	1.922	0.689	0.828	1.006	0.333	0.386	0.462	0.965	1.114	1.267	1.000	1.000	1.000

Source: Primary data processed

Information in **Table 10** is as follows: A stands for Human Resources, B stands for Infrastructure, C stands for Facilities, D stands for Community Behavior, and E stands for Place and Destination of Tourism.

The geometric mean value of the fuzzy comparison value is calculated using **Equation 9** as follows,

$$\tilde{r}_A = (\tilde{a}_{11} \otimes \tilde{a}_{12} \otimes \tilde{a}_{13} \otimes \tilde{a}_{i4} \otimes \tilde{a}_{15})^{1/5}$$

$$= ((1 \times 0.678 \times 0.403 \times 0.648 \times 0.520)^{\frac{1}{5}}, (1 \times 0.793 \times 0.466 \times 0.753 \times 0.604)^{\frac{1}{5}}, (1 \times 0.924 \times 0.570 \times 0.932 \times 0.726)^{\frac{1}{5}}).$$

$$= (0.621, 0.700, 0.814)$$

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The geometric mean fuzzy comparison value for other criteria is calculated similarly, and the results are as follows.

$\tilde{r}_B = (0.800, 0.900, 1.017)$
$\tilde{r}_C = (1.610, 1.840, 2.042)$
$\tilde{r}_D = (0.852, 0.959, 1.073)$
$\tilde{r}_E = (0.789, 0.899, 1.025)$

Determine the weight of each criterion using **Equation 10**,

$\tilde{w}_A = \tilde{r}_A \otimes (\tilde{r}_A \oplus \tilde{r}_B \oplus \tilde{r}_C \oplus \tilde{r}_D \oplus \tilde{r}_E)^{-1}$
$\tilde{w}_A = (0.621, 0.700, 0.814) \otimes (1/(0.814 + 1.017 + 2.042 + 1.073 + 1.025), 1/(0.700 + 0.900 + 1.840 + 0.959 + 0.899), 1/(0.621 + 0.800 + 1.610 + 0.852 + 0.789))$
$= (0.104, 0.132, 0.174)$

The other criteria weights are obtained in the same way, and the results are as follows,

$\tilde{w}_B = (0.134, 0.170, 0.218)$
$\tilde{w}_C = (0.270, 0.347, 0.437)$
$\tilde{w}_D = (0.143, 0.181, 0.230)$
$\tilde{w}_E = (0.132, 0.170, 0.219)$

Then, determine the best nonfuzzy performance (BNP) value using **Equation 11**,

$BNP_A = [(Uw_A - Lw_A) + (Mw_A - Lw_A)]/3 + Lw_A$
$BNP_A = [(0.174 - 0.104) + (0.132 - 0.104)]/3 + 0.104$
$= 0.137$

By using the same way, we got the value of other criteria,

$BNP_B = 0.174$
$BNP_C = 0.351$
$BNP_D = 0.184$
$BNP_E = 0.174$

The full results of the criteria weighting using fuzzy-AHP are listed in **Table 11.**

Table 11. The criteria using fuzzy–AHP

Criteria	Weight	
	Fuzzy	BNP normalised
A. Human resources	(0.104, 0.132, 0.174)	0.134
B. Infrastructure	(0.134, 0.170, 0.218)	0.170
C. Facilities	(0.270, 0.347, 0.437)	0.344
D. Community Behavior	(0.143, 0.181, 0.230)	0.181
E. Place / Destination of tourism	(0.132, 0.170, 0.219)	0.170

Source: Primary data processed

The successive criteria weights, starting from the most significant and going through to the lowest, are as follows: facilities (34.400 per cent), Community Behavior (18.100 per cent), Infrastructure and Place/Destination of the same tourism weight (17.000 per cent), and finally human resources (13.400 per cent) (**Table 11**).

Each subcriteria's weight is calculated similarly to the criteria, and the results are listed in **Table 12.**

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Table 12. The weight of fuzzy and nonfuzzy for every sub-criteria

Criteria	Weight	
	Fuzzy	BNP normalised
A1. Education of local community	(0.261, 0.330, 0.427)	0.333
A2. Training / Certificate of local tourist guide	(0.418, 0.544, 0.687)	0.539
A3. Hiring an external tourist guide	(0.103, 0.126, 0.165)	0.129
B1. Roads/bridges	(0.193, 0.240, 0.303)	0.241
B2. Piers/harbour	(0.210, 0.259, 0.321)	0.259
B3 .Airport	(0.199, 0.253, 0.319)	0.253
B4. Evacuation path	(0.197, 0.248, 0.309)	0.247
C1. Clean water	(0.122, 0.149, 0.182)	0.149
C2. Electricity	(0.128, 0.156, 0.191)	0.156
C3. Waste treatment	(0.125, 0.155, 0.195)	0.156
C4. Accommodation/hotel/lodging	(0.122, 0.152, 0.189)	0.152
C5. Communication network/internet/WIFI	(0.144, 0.178, 0.217)	0.177
C6. Hospital/medical doctor specialist	(0.174, 0.211, 0.253)	0.210
D1. The welcoming attitude of tourism	(0.258, 0.306, 0.356)	0.304
D2. Security surrounding	(0.208, 0.242, 0.284)	0.243
D3. Sanitation	(0.387, 0.453, 0.532)	0.453
E1. Maintaining the ecosystem and cleanliness of beaches/lakes/hot springs	(0.425, 0.502, 0.582)	0.499
E2. Promotion and cultural events	(0.216, 0.250, 0.296)	0.252
E3. Protect the cultural sites and historical heritage of the area	(0.214, 0.248, 0.291)	0.249

Source: Primary data processed

Table 13 compares the results of weighting respondents' perceptions about the criteria using the AHP and Fuzzy AHP methods.

Table 13. Comparison of the results of the criteria using AHP and Fuzzy-AHP

Criteria	Weight	
	AHP	F-AHP
A. Human resources	0.133	0.134
B. Infrastructure	0.169	0.170
C. Facilities	0.347	0.344
D. Community Behavior	0.181	0.181
E. Place / Destination of tourism	0.172	0.170

Source: Primary data processed

Table 13 illustrates that the facility criteria are the highest, namely 34.700 per cent for AHP and 34.400 per cent for Fuzzy-AHP. Then follows community behaviour (18.100 per cent AHP; 18.100 per cent Fuzzy-AHP), tourist attractions/destinations, Infrastructure, and human resources.

The results in **Table 13** can be shown in chart form in **Figure 4**

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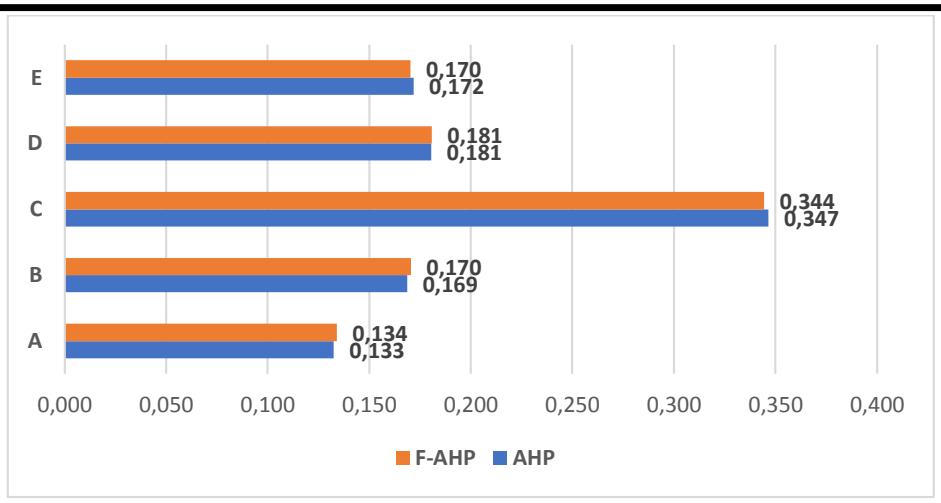

Figure 4. Comparison of the results of the analysis of perception weight of criteria between AHP and Fuzzy-AHP
Source: Primary data processed

The comparison of the results of the perceptual weighting of the analysis results for each sub-criteria. The process uses the AHP and Fuzzy-AHP methods in **Table 14** and **Figure 5**.

Table 14. Comparison of AHP and Fuzzy-AHP on the weight of perception of the sub-criteria human resources

Criteria	Weight	
	AHP	F – AHP
A1. Education of local community	0.330	0.333
A2. Training / Certificate of local tourist guide	0.544	0.539
A3. Hiring an external tourist guide	0.126	0.129

Source: Primary data processed

Table 14 indicates that the highest values are for Training and Certificate of Local Tourist Guide, with 0.544 for AHP and 0.539 for fuzzy-AHP. Education of the local community and Hiring external tourist guides follow this.

Figure 5 clearly shows the contrast in the outcomes of the AHP and Fuzzy-AHP evaluation regarding the perceived significance of the human resources sub-criteria.

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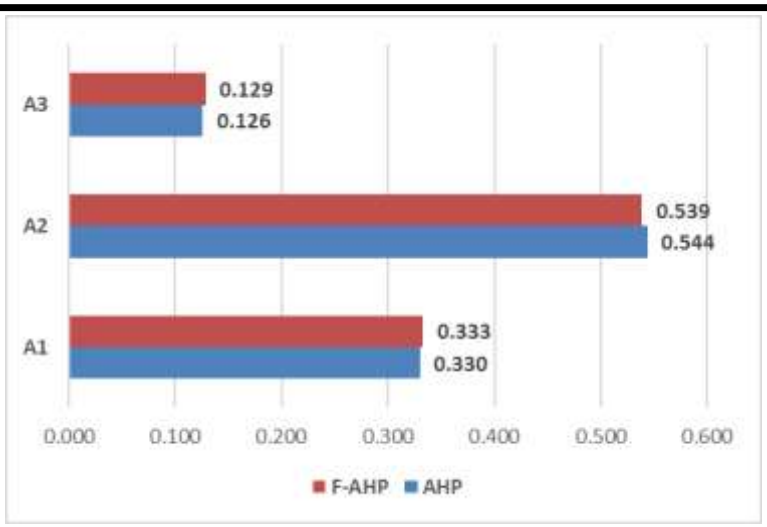

Figure 5. The different outcomes of AHP and Fuzzy-AHP weight of perception of the sub-criteria human resources
Source: Primary data processed

Table 15 reveals that Pier and Harbor have the highest values, precisely 0.263 for AHP and 0.259 for Fuzzy-AHP. The Evacuation Path comes next, followed by the Airport and Roads/Bridges.

Table 15. Comparison of the perceived weight of sub-criteria Infrastructure

Criteria	Weight	
	AHP	FAHP
B1. Roads/bridges	0.242	0.241
B2. Piers/harbour	0.263	0.259
B3. Airport	0.246	0.253
B4. Evacuation path	0.249	0.247

Source: Primary data processed

Figure 6 depicts the differences in the AHP and fuzzy-AHP analysis results regarding the perceived significance of the sub-criteria Infrastructure.

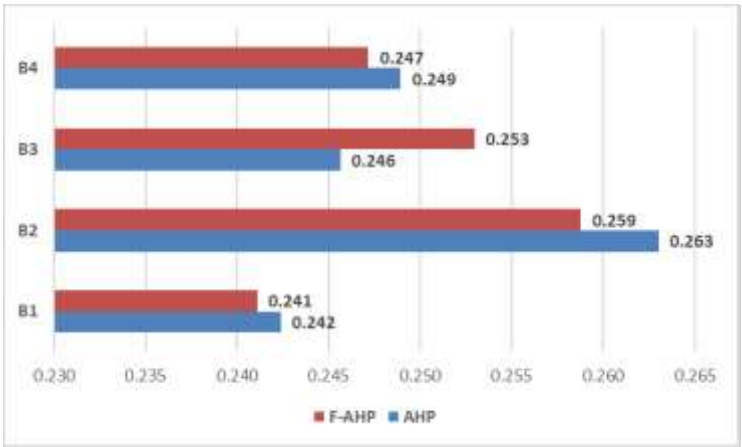

Figure 6. Differences in the perceived weight of sub-criteria Infrastructure
Source: Primary data processed

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Table 16. Comparison of perception weight of sub-criteria of facilities

Criteria	Weight	
	AHP	FAHP
C1. Clean water	0.151	0.149
C2. Electricity	0.157	0.156
C3. Waste treatment	0.155	0.156
C4. Accommodation/hotel/lodging	0.150	0.152
C5. Communication network/internet/WIFI	0.178	0.177
C6. Hospital/medical doctor specialist	0.209	0.210

Source: Primary data processed

Table 16 shows that the highest values are attributed to Hospitals and Medical doctors, with 0.209 for AHP and 0.210 for fuzzy-AHP. This is followed in order by Communication Networks/Internet/WIFI, Electricity, Waste Treatment, Clean Water, and Accommodation/Hotel/Lodging.

Figure 7 visually represents the contrasting outcomes of the AHP and Fuzzy-AHP analysis regarding the perceived significance of the Facilities sub-criteria.

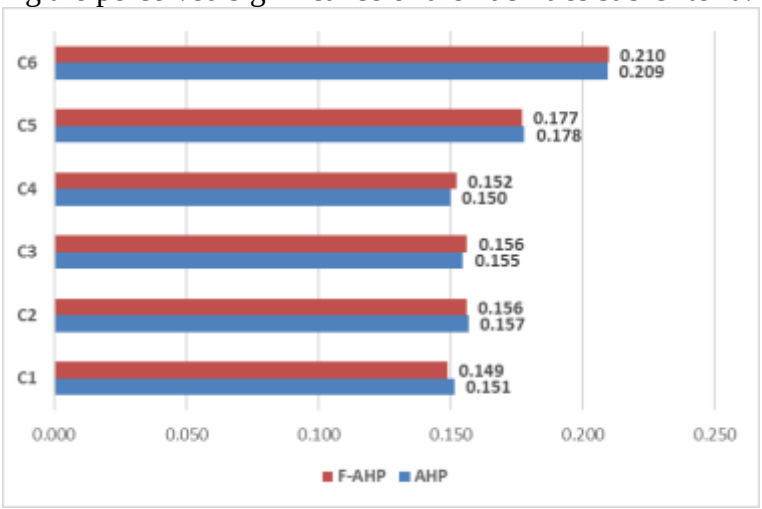

Figure 7. Differences in perception weight of sub-criteria facilities
Source: Primary data processed

Table 17 illustrates that Sanitation has the highest values, precisely 0.453 for AHP and 0.453 for fuzzy-AHP. Welcoming Attitude and Finally Security Surrounding follow it.

Table 17. Comparison perception of the weight of sub-criteria of community behaviour

Criteria	Weight	
	AHP	FAHP
D1. The welcoming attitude of tourism	0.306	0.304
D2. Security surrounding	0.242	0.243
D3. Sanitation	0.453	0.453

Source: Primary data processed

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Figure 8 visually depicts the perceived significance of the Community Behavior sub-criteria, showing the contrasting outcomes of the AHP and fuzzy-AHP analyses.

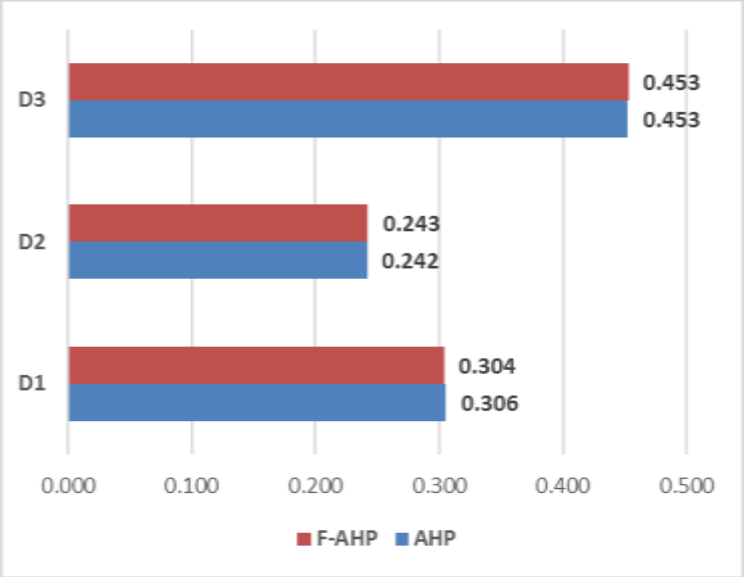

Figure 8. Differences in perception weight of sub-criteria community behaviour
Source: Primary data processed

Table 18 highlights that Maintaining the Ecosystem and Cleanliness have the highest values, with 0.500 for AHP and 0.499 for fuzzy-AHP. Following this are promotion, cultural events, and protection of cultural and historical sites.

Table 18. Comparison Of Perception Weight Of Sub-Criteria Place/Destination Of Tourism

Criteria	Weight	
	AHP	FAHP
E1. Maintaining the ecosystem and cleanliness of beaches/lakes/hot springs	0.500	0.499
E2. Promotion and cultural events	0.252	0.252
E3. Protect the cultural sites and historical heritage of the area	0.249	0.249

Source: Primary data processed

Figure 9 shows visually illustrates the contrasting outcomes of the AHP and fuzzy-AHP analysis in terms of the perceived significance of the Place and Destination sub-criteria.

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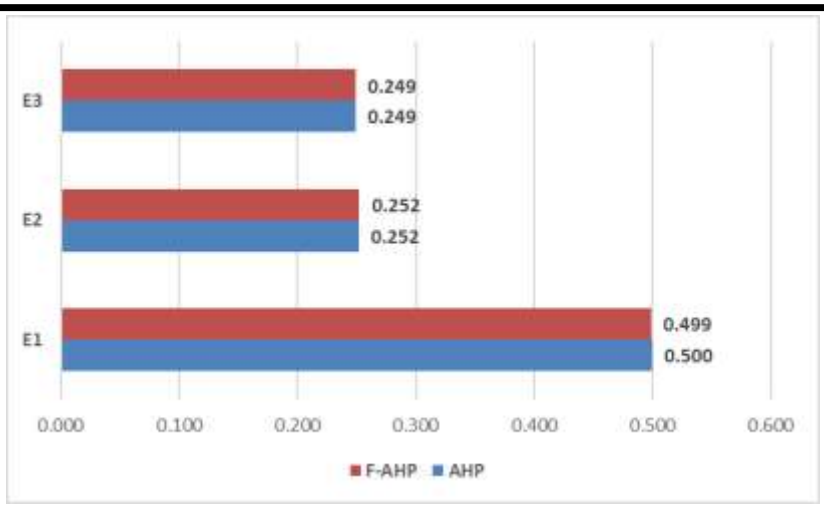

Figure 9. Differences in perception weight of sub-criteria place/ destination of tourism
Source: Primary data processed

Calculation of the results of the global weight in **Table 19**.

Table 19. The Global weight calculation

Criteria / Sub Criteria		Local Weight		Global Weight	
		AHP	FAHP	AHP	FAHP
Human resources	A			0.133	0.134
Infrastructure	B			0.169	0.170
Facilities	C			0.347	0.344
Community Behavior	D			0.181	0.181
Place / Destination of tourism	E			0.172	0.170
	SUM			**1.000**	**1.000**
Education of local community	A1	0.330	0.333	0.044	0.045
Training / Certificate of local tourist guide	A2	0.544	0.539	**0.072**	**0.072**
Hiring an external tourist guide	A3	0.126	0.129	0.017	0.017
	SUM	**1.000**	**1.000**	**0.133**	**0.134**
Roads/bridges	B1	0.242	0.241	0.041	0.041
Piers/harbour	B2	0.263	0.259	0.044	0.044
Airport	B3	0.246	0.253	0.041	0.043
Evacuation path	B4	0.249	0.247	0.042	0.042
	SUM	**1.000**	**1.000**	**0.169**	**0.170**
Clean water	C1	0.151	0.149	0.052	0.051
Electricity	C2	0.157	0.156	0.054	0.054
Waste treatment	C3	0.155	0.156	0.054	0.054
Accommodation/hotel/lodging	C4	0.150	0.152	0.052	0.052
Communication network/internet/WIFI	C5	0.178	0.177	0.062	0.061
Hospital/medical doctor specialist	C6	0.209	0.210	**0.073**	**0.072**
	SUM	**1.000**	**1.000**	**0.347**	**0.344**
The welcoming attitude of tourism	D1	0.306	0.304	0.055	0.055
Security surrounding	D2	0.242	0.243	0.044	0.044

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Criteria / Sub Criteria		Local Weight		Global Weight	
		AHP	FAHP	AHP	FAHP
Sanitation	D3	0.453	0.453	**0.082**	**0.082**
	SUM	**1.000**	**1.000**	**0.181**	**0.181**
Maintaining the ecosystem and cleanliness of beaches/lakes/hot springs	E1	0.500	0.499	**0.086**	**0.085**
Promotion and cultural events	E2	0.252	0.252	0.043	0.043
Protect the cultural sites and historical heritage of the area	E3	0.249	0.249	0.043	0.042
	SUM	**1.000**	**1.000**	**0.172**	**0.170**

Source: Primary data processed

Figure 10 visually presents the divergent outcomes of the AHP and Fuzzy-AHP analysis concerning the Global Weight of the sub-criteria.

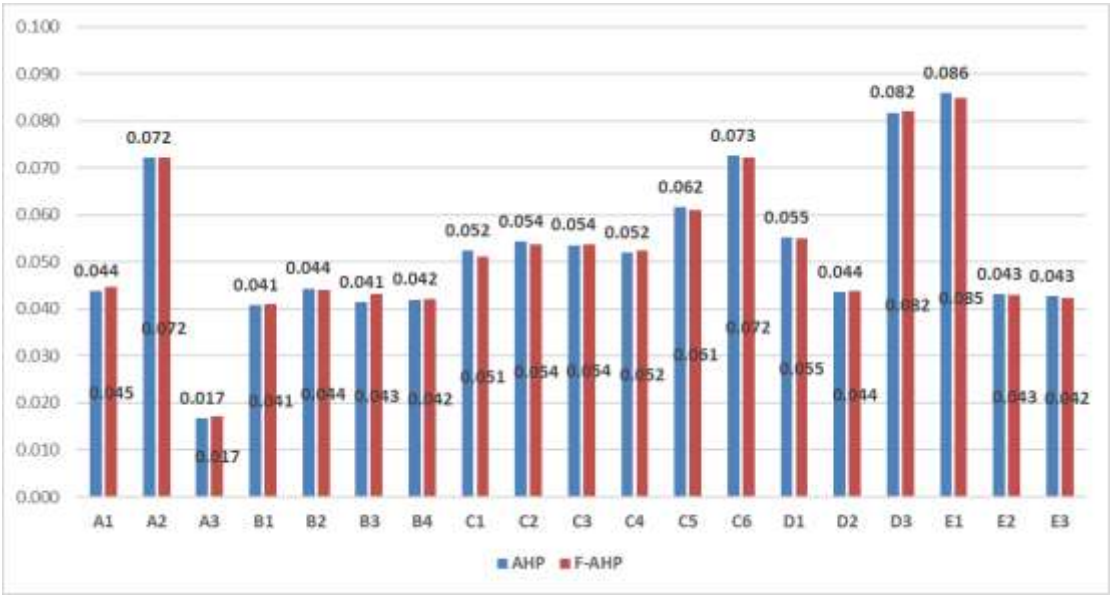

Figure 10. Global weight of sub-criteria
Source: Primary data processed

The results of the global weight calculation indicate that overall, the highest priority factor is maintaining the ecosystem and cleanliness of beaches/lakes/hot springs (8.600 per cent AHP; 8.500 per cent Fuzzy-AHP), followed by Sanitation at 8.200 per cent AHP and 8.200 per cent Fuzzy- AHP.

Sensitivity Analysis. After calculating the criteria, sub-criteria, and global weight, the researcher calculated the sensitivity of the analysis in **Table 20**.

Sensitivity analysis is performed by comparing the initial findings with the designed scenario. In the original results, the criteria weights, starting from the largest, are facilities (C) at 34.700 per cent, community behaviour (D) at 18.100 per cent, tourist destinations (E) at 17.200 per cent, Infrastructure (B) at 16.900 per cent, human resources (A) 13.300 per cent. At the same time, the global weight of the biggest sub-criteria is maintaining ecosystems and cleanliness of beaches/lakes/hot springs (E1) of 8.600 per cent.

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Scenario 1: All criteria are weighted equally. The result is the global weight of the most prominent sub-criteria, Local tour guide training/certification (A2), of 10.900 per cent.

Table 20. Calculating the sensitivity analysis

Criteria / Sub Criteria		Weight		
		Original	Scenario 1	Scenario 2
Human resources	A	0.133	0.200	0.133
Infrastructure	B	0.169	0.200	0.169
Facilities	C	0.347	0.200	0.247
Community Behavior	D	0.181	0.200	0.281
Place / Destination of tourism	E	0.172	0.200	0.172
Education of local community	A1	0.044	0.066	0.044
Training / Certificate of local tourist guide	A2	0.072	**0.109**	0.072
Hiring an external tourist guide	A3	0.017	0.025	0.017
Roads/bridges	B1	0.041	0.048	0.041
Piers/harbour	B2	0.044	0.053	0.044
Airport	B3	0.041	0.049	0.042
Evacuation path	B4	0.042	0.050	0.042
Clean water	C1	0.052	0.030	0.037
Electricity	C2	0.054	0.031	0.039
Waste treatment	C3	0.054	0.031	0.038
Accommodation/hotel/lodging	C4	0.052	0.030	0.037
Communication network/internet/WIFI	C5	0.062	0.036	0.044
Hospital/medical doctor specialist	C6	**0.073**	0.042	0.052
The welcoming attitude of tourism	D1	0.055	0.061	**0.086**
Security surrounding	D2	0.044	0.048	0.068
Sanitation	D3	**0.082**	**0.091**	**0.127**
Maintaining the ecosystem and cleanliness of beaches/lakes/hot springs	E1	**0.086**	**0.100**	**0.086**
Promotion and cultural events	E2	0.043	0.050	0.043
Protect the cultural sites and historical heritage of the area	E3	0.043	0.050	0.043

Source: Primary data processed

In scenario 2, the weight of the most significant criterion in the original result is reduced by 10 per cent. In comparison, the weight of the second largest criterion is increased by 10 per cent. In this case, the weight of the Facility criteria (C) is reduced by 10 per cent, and that of the Community Behavior criteria (D) is increased by 10 per cent. The results for the most significant global weight sub-criteria were Sanitation at 12.700 per cent.

DISCUSSION

The Analytic Hierarchy Process (AHP) is a frequently employed approach for ranking various options based on intricate criteria. In practical scenarios, the traditional AHP typically relies on precise expert judgments and employs precise numerical values, often overlooking the uncertainty stemming from linguistic variables. On the other hand,

fuzzy logic addresses situations characterised by vagueness or unclear definitions and provides a quantified outcome.

In this study, an investigation was carried out between AHP and fuzzy AHP to justify whether the results obtained by both methods are significantly different.

Several studies have shown that the choice between AHP and fuzzy AHP should consider the level of uncertainty and imprecision in the decision problem. If the decision criteria and data are well-defined and precise, standard AHP may suffice. However, the data deals with vague or uncertain information, and fuzzy AHP offers a way to capture and model that uncertainty. This shows that neither AHP nor fuzzy AHP is universally better than the other; it depends on the specific needs of the decision-making situation.

Nevertheless, the results obtained from our study indicate that both AHP and fuzzy AHP methods have non-significant differences. Therefore, traditional AHP is adequate and comparable enough to solve detossolveing problems where the criteria and data are well-defined and precise and where the problem has inherent uncertainty or vagueness**.**

This study uses the AHP method to determine the percentage of each criterion and sub-criteria. The AHP method uses crisp numbers, while a single number cannot fully capture respondents' perceptions and subjective experiences. Therefore, the researcher completes the study by applying the fuzzy-AHP method to capture ambiguity and vagueness using training fuzzy numbers.

The study findings reveal that the facilities criterion ranks the highest (AHP 34.700 per cent; Fuzzy-AHP 34.400 per cent), followed by community behaviour, tourist destinations, Infrastructure, and human resources.

Analysis of the results also showed no significant differences between AHP and Fuzzy-AHP; the results were the same for the two methods.

The AHP depends on accurate expert assessment and employs exact numerical values. However, it frequently neglects the uncertainty stemming from linguistic variables. Fuzzy AHP addresses situations marked by ambiguity or lack of clarity and yields a quantitative result. The research revealed that the differences between the two methods were not significant. Similarly, (Ohwo, 2018) discovered negligible differences between AHP and Fuzzy AHP, asserting that his research findings demonstrated no statistical variance between the AHP and Fuzzy AHP (Ohwo, 2018). (Abdullah A. et al., 2021) echoed this sentiment in their study, stating that their results indicated no significant discrepancy in decision-making between AHP and Fuzzy AHP (Abdullah et al., 2021).

The AHP operates on exact numerical values and expert opinions, making it ideal for situations where the criteria and data are clear and precise. However, it often needs to account for the uncertainty arising from linguistic variables. It is where the fuzzy AHP comes into the picture. Fuzzy AHP is engineered to manage scenarios marked by ambiguity or unclear definitions, offering a quantified result that encapsulates and models the uncertainty the traditional AHP might overlook. The research findings also indicate inconsistent sensitivity analysis results and a need for robustness. It can be attributed to the fact that both AHP and Fuzzy AHP handle subjective judgments based on respondents' perceptions, which may be devoid of bias as the outcome is grounded in the respondents' comprehension and judgment (Raco et al., 2021). The research is also highly contextual, with high sensitivity fluctuating rapidly across different times and locations.

The global weight analysis indicates that sub-criterion E1, which focuses on maintaining the cleanliness of beaches and tourist facilities, holds the highest Importance (AHP 8.600 per cent; Fuzzy-AHP 8.500 per cent) and following D3, Sanitation (AHP

8.200 per cent; Fuzzy -AHP 8.200 per cent). These global weight calculation results are the same for both AHP and Fuzzy-AHP. This shows that tourism development in the Siau Tagulandang Biaro Islands Regency must pay attention to environmental hygiene and health.

Several researchers in tourism have shown that nature tourism is increasing in demand by visitors. One aspect that must be considered in the development of nature tourism is the aspect of cleanliness and safety. Tourism's main demands include avoiding overcrowded destinations (Campos et al., 2022a). (Campos et al., 2022) added that cleanliness and health are the principal demands of tourists who wish to enjoy nature (Campos et al., 2022b). Previous researchers, namely (Suarez-Rojas et al., 2023), have also confirmed this indication that cleanliness is essential for marine tourism. Hence, efforts to clean the sea of trash are significant (Suarez-Rojas, Leon, & Lam-Gonzalez, 2023). Plastic waste is one of the most common types in coastal areas. Some regions have implemented legal sanctions against plastic waste pollution to keep tourist destinations clean (Aguiar-Quintana et al., 2022).

(Kari Hyytiainen, 2022) emphasises that maintaining clean island beaches is essential for attracting tourists (Hyytiainen et al., 2022b). Similarly, (Cristina Román, 2022) argues that achieving sustainability in island tourism requires a well-integrated approach, combining ecosystem management and environmental cleanliness, particularly of beaches (Román et al., 2022b). A survey in the Netherlands supports these views, revealing that tourists prioritise cleanliness when selecting beach destinations (Bettencourt et al., 2023). (Chanittha Chansuk, 2022) emphasised that cleanliness and health are critical for tourism development (Chansuk et al., 2022b), including minimising the use of hazardous substances or replacing them with less hazardous products (Couto et al., 2021)

Although cleanliness is essential, other aspects must also be considered because combining other aspects significantly influences the development of Siau Tagulandang Biaro island tourism.

The most common issue, recognised by all participants and particularly felt by those on the smaller islands, was the perceived lack of adequate attention from central and provincial governments towards developing tourist facilities. Larger islands and those close to the government tend to receive more focus. Connectivity also emerged as a critical theme, given its impact on daily life and the tourism potential of the islands. The primary contention, voiced most emphatically by tourism stakeholders, was that adequate inter island connectivity tends to steer tourists towards only the larger islands in the Archipelago (Agius & Chaperon, 2023).

Regarding collaboration, tourism stakeholders throughout the study area quickly highlighted a noticeable lack of eagerness to cooperate, inconsistency and many conflicts of interest (Hovelsrud et al., 2023)

The sensitivity analysis results indicate that the decision lacks robustness. This suggests that any change in the weight of one criterion would significantly affect the priority sub-criteria weights. It was found that the criterion with the highest weight is facilities (34.700 per cent), with the highest sub-criteria weighting maintaining ecosystems and cleanliness of beaches/lakes/hot springs (E1) at 8.600 per cent. In the first scenario, all criteria were assigned equal weights of 20 per cent each. The sub-criterion with the highest weight was Local tour guide training/certification (A2), which reached 10.900 per cent. In scenario 2, the weight of the first and second most significant criteria is exchanged by 10 per cent and Sanitation by 12.700 per cent.

The findings of this research have implications for a range of stakeholders, including the government, society, local communities, business entities, and entrepreneurs. The study's outcomes can guide governmental decision-making, especially in tourism development. The research's emphasis on cleanliness in nature tourism bears implications for society and local communities. It could also inspire local communities to actively preserve the cleanliness of beaches, amenities, and other tourism-related areas. The research outcomes can steer business entities and entrepreneurs in the tourism sector. Grasping the criteria and sub-criteria prioritised by both AHP and Fuzzy AHP can assist them in aligning their strategies and services accordingly. This alignment could enhance competitive customer satisfaction and stimulate business expansion.

CONCLUSION

This study identifies a tourism development strategy for the Siau Tagulandang Biaro Islands by applying AHP and fuzzy-AHP methodologies.

The study results show that the facilities are the highest criterion, followed by community behaviour criteria, then place/destination of tourism, and next was Infrastructure. The last was the human resources criteria.

The global weight calculation reveals that hygiene and health are key priorities. Cleanliness and the health standards of tourist destinations rank the highest and should be prioritised in regional tourism development policies.

The results of the sensitivity analysis indicate that the outcomes are not stable. This implies that even a minor adjustment in the weight of the criteria can lead to significant changes in the sub-criteria.

The calculation results between the AHP and fuzzy-AHP methods are the same. The traditional AHP method is considered adequate to solve problems related to the decision-making process, provided that the criteria and sub-criteria are defined well and precisely, thereby reducing the uncertainty or ambiguity inherent in the problem.

Even though the facility criterion is the highest, other criteria must still be considered because the difference with other criteria is not too significant. Sensitivity analysis has shown that the facility criteria could be more robust, consistent, and stable. That means if there is the slightest change in the other criteria, then the priority criteria will also change, and the priority in the global weight will also change. The results of the analysis of this study require that follow-up studies be carried out regularly because changes occur so quickly and are very dynamic that they will affect the determination of policy priorities.

The results of this study show that attention to facility cleanliness must be an essential part of the tourism development planning and policy of the Siau Tagulandang Biaro Islands Regency.

The researcher recommends future research, namely the integration of tourism in the Siau Tagulandang Biaro Islands Regency, including beaches, sea, volcanoes, flora, and fauna, to increase the area's attractiveness and number of visitors.

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