MULTIDISCIPLINARY SCIENCE JOURNAL

RESEARCHE ARTICLE
Published Online: November 16, 2023
https://doi.org/10.31893/multiscience.2024067

Analysis of the beautiful value of marine tourism attractive objects in the coral reef rehabilitation area of Badi Island, Pangkep Regency

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Abstract The marine tourist attraction has been one of the most important concerns for tourism. The diversity of biota in this coral reef ecosystem has the potential for the development of marine ecotourism. The aim of the research was to reveal the potential of coral the rehabilitation areas in the Badi, Pangkajene and Archipelago for a good tourist destination, especially as a dive site and restoration of coral reef ecosystems, based on the categories of tourism object value and attraction. This research was carried out in March-December 2022 with several stages, including preparation, initial survey, and field data collection. This study includes the suitability matrix for diving activities, and the Scenic Beauty Estimate (SBE) used to determine the quality and the beauty of coral reefs. The results showed that Station 2 and Station 3 were in the very suitable category, while Station 1 and Station 4 were included in the appropriate category because at 6 parameters the appropriate value parameters were calculated for diving tourism. The results of the SBE calculation show that the image with the highest value is Number 4 which is in the transplant location 2 and number 1 is in the transplant location 1 with an SBE value of 97 and 93, respectively. Meanwhile, figure Number 2 is in the natural location 1 and image Number 9 is in the Natural 2 location with SBE values of 0 and 8, respectively. In conclusion, most people are interested in the healing world, and the coral reef rehabilitation object has various types and is rich in coral reefs.

Keywords: coral rehabilitation, suitability for diving, scenic beauty estimate (sbe), badi island

1. Introduction

Effective management of coral reef ecosystems requires strategies that can help protect coral reefs from damage caused by human activities. Biodiversity, especially coral reef ecosystems, has experienced extensive degradation in recent years. Damage to coral reefs is caused by the natural environment and human activities Riniwati et al. (2019). In 2016, 13.49% of the coral reef cover on Badi Island was in the damaged category, 26.58% of the coral reef cover was in the moderate category, and 59.93% of the coral reef cover was in good condition Arsyad (2016).

The high damage experienced by coral reef ecosystems needs to be minimized by various transplantation methods. The aim is to improve the quality of coral reefs, such as increasing live coral cover, biodiversity, and the uniqueness of coral topography. The coral transplantation process has been carried out for the last ten years on Badi Island. This coral transplant has been carried out by PT Mars Symbioscience since 2011 on Badi Island using the spider skeleton method (Cahyani, 2021).

One of the potentials of coastal and marine biodiversity is the coral reef ecosystem. Coral reef ecosystems have high ecological and aesthetic values and are rich in biodiversity. The beauty and diversity of biota in coral reef ecosystems can potentially develop marine ecotourism Cesar et al. (2003). Therefore, the Strategy is in development sustainable marine ecotourism is expected to guarantee economic and social sustainability and culture, as well as the environment Arismayanti (2019).

Maritime tourism attraction has become one of the most important concerns for tourism. The biota beauty and diversity in the coral reef ecosystem has the potential for maritime ecotourism development. This research aims to investigate biophysical condition transplantation and reveal the coral reef potential in the rehabilitation areas of Badi Area, Pangkajene and Kepulauan.

2. Materials and Methods

This research was conducted in March-August 2022 on Badi Island, Spermonde Waters, Pangkajene Regency, and the Archipelago. The research location can be seen in Figure 1.

 Received: July 1, 2023 | Accepted: October 14, 2023

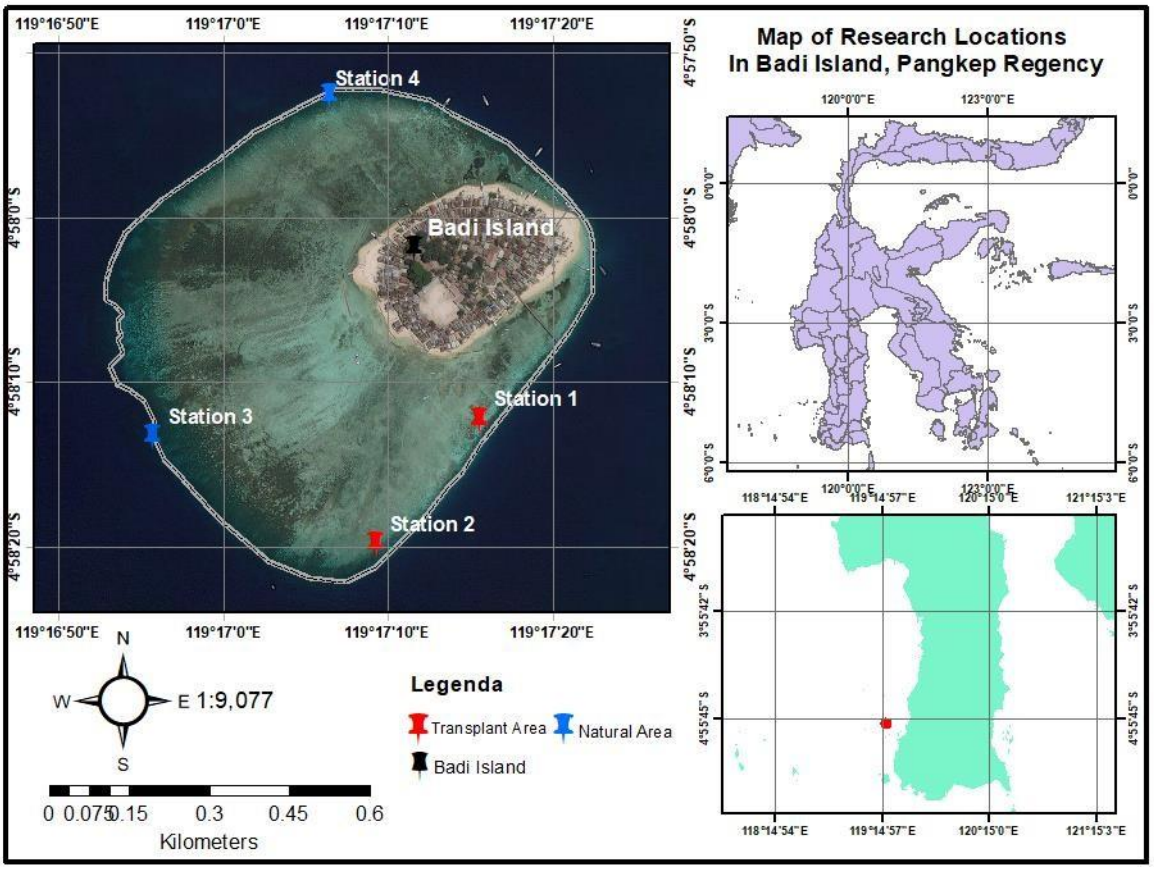

Figure 1 Map of the Research Location on Badi Island, Pangkep Regency.

2.1. Data Collection

This research determined 4 areas based on the existence of the transplant area and the activities around it. The transplant areas are at stations 1 and 2, while stations 3 and 4 are in natural coral areas. Retrieval of data on the percentage value of coral community cover by observing coral growth forms or types of life forms using the Line Intercept Transect (LIT) method Isdianto & Luthfi (2020). The life forms observed were hard coral Acropora, hard coral non-Acropora, dead Scleractinia, algae, other fauna, and abiotics. The work procedure for this study was to draw a roll meter (transect) parallel to the shoreline for 30 meters Manzanaris et al. (2018). In each area, five transects (replicates) of 30 meters were placed with distances of 10, 20, 30 and 40 meters. The transect is placed at a depth of 2-5 meters, and then data collection begins using the Line Intercept Transect (LIT) method by recording the lifeforms of coral reef cover that pass under the transect in cm units. This can be seen in Table 1.

Table 1 Parameters observed in coral reef data collection.

No	Data type	Data methods	Data category
1	Coral reef cover	Line Intercept Transect (LIT)	Primary and Secondary
2	The richness of coral reefs growth		
3	Fish species communities	Underwater Visual Census	Primer
4	Depth measurement	Field observation	Primer
5	Water clarity	Field observation	Primer
6	Current velocity	Field observation	Primer
7	Estimation of the beauty value	SBE	Primer

Source: Yulianda (2019)

In addition to the existence of coral reefs, which are an important parameter for the suitability of diving tourism, the types of reef fish are also important to observe. The number of coral fish species has a significant influence on the suitability of the location for diving tourism activities. Observations made in collecting fish abundance data used SCUBA equipment and the underwater visual census (UVC) method of Hasler & Ott (2008). The first thing to do in collecting fish abundance data is to stretch a 210 m long transect, which is divided into 3 replicates of 70 m each with a width of 2.5 m to the left and 2.5 m to

the right of the transect line at a depth of 3-7 m. Data collection was carried out approximately 5-15 minutes after the transect line was installed so that the fish that had previously avoided the roll master or transecter position returned to their original position.

Observation of water quality data was carried out on several parameters, namely, the depth of coral reefs, the brightness of the waters, and the speed of the currents. Retrieval of depth data using a map sounder tool. The purpose of collecting depth data is to determine the appropriate depth for diving tourist attractions because depths below 3 meters will make it very difficult for tourists to use diving equipment and will damage coral due to the diving equipment used. Data collection for measuring the brightness of the waters was performed using a Secchi disc. The aim of collecting data on water brightness is to determine the level of water brightness. The higher the level of brightness is, the better the conditions and level of safety for tourists who are active in these waters. The current meter is used to retrieve current speed data. The purpose of collecting current data is to see the safe level of current speed if strong currents will affect the diver's movement to maintain balance and buoyancy (bouncy) and disrupt the comfort and safety of the diver himself.

2.2. Data Analysis

In the suitability analysis for diving tourism, quantitative analysis is used or with mathematical rules for numerical data. This analysis was used to obtain ecological data on coral reefs and reef fish based on observational plots, which were processed using the diving tourism suitability matrix. The matrix was used as a reference point for the use of the tourism suitability index to determine the suitability of a tourist location using the following equation. This can be seen in Table 2 and Equation 1.

Information:
IKW = Travel suitability index;
Bi = Weight of the i-th parameter;
Si = Score of the i-Parameter.

To determine the suitability category class of an area, it can be seen in Table 3.

Table 2 Diving Tourism Suitability Matrix.

No	Parameter	Weight	Class	Score
1	Coral community cover (%)	0,375	>75	3
			>50 – 75	2
			25 – 50	1
			<25	0
2	Water clarity (%)	0,150	>80	3
			50 – 80	2
			20 - <50	1
			<20	0
3	Depth of coral reefs (m)	0,150	6 – 15	3
			>15-20, 3-<6	2
			>20 – 30	1
			>30, <3	0
4	Type of *Lifeform*	0,135	>12	3
			>7 – 12	2
			4 – 7	1
			<4	0
5	Type of coral fishes	0,120	>100	3
			50 – 100	2
			20 - <50	1
			<20	0
6	Current velocity (cm/secon)	0,070	0 – 15	3
			>15 – 30	2
			>30 – 50	1
			>50	0

Source: Yulianda (2019).

The scenic beauty estimation (SBE) method was used to estimate the value of natural beauty. Data processing uses a Z value, namely, the value given by visitors who are respondents to a photo or image of an object, where each object is taken from one point of view of taking a photo or image. For each image, the frequency (f), cumulative frequency (ef), cumulative probability (cp), z value for each photo or image and the average z value are calculated. The potential comparator in this SBE calculation is the object that has the smallest average z value. Furthermore, the SBE value of a photo or image is calculated using the following formula Daniel & Boster (1976): This can be seen in Equation 2.

Information:
SBE-X: The estimated value of the x-th scenic beauty;
ZLS-x: The average z value for the xth image or photo;
ZLS-p: The average of the z values for the comparison image or photo.

The end result of each SBE is a quantitative value of the scenic beauty for a photo or image. Furthermore, the beauty that has been assessed is grouped into three levels of beauty, namely, high, medium, and low beauty levels, using the median value and standard deviation as follows Saputra & Setiawan (2014). This can be seen in Equation 3.

Information:
$\bar{Y}$: Mean value;
Yi: The value of the i-th observation;
n: Number of observations.

Information:
S: Standard deviation;
$\bar{Y}$: Mean value;
Yi: The value of the i-th observation;
n: The number of observations.

Photos or images that have an SBE value > (Y + s) are categorized as having high beauty, an SBE value between (Y – s) and (Y + s) has moderate beauty, and an SBE value < (Y – s) has low beauty. This can be seen in Equation 4.

Table 3 Suitability Category Class.

No	Category	Suitability class
1	Very Suitable	IKW ≥ 2,5
2	Suitable	2,0 ≤ IKW < 2,5
3	No Suitable	1 ≤ IKW < 2,0
4	Very inappropriate	IKW < 1

Source: Yulianda (2019)

2.3. Equations and mathematical contends

$$IKW = \sum_{i=1}^{n} (Bi \times Si) \quad (1)$$

SBEx = (ZLS-x – ZLS-p) X 100 (2)

$$\bar{Y} \frac{\sum_{i}^{n} Yi}{n} \quad (3)$$

$$s = \sqrt{\sum \frac{(Yi - \bar{y})2}{n-1}} \quad (4)$$

3. Results and Discussion

3.1. Tourism Suitability Index

The calculation of the suitability index for diving tourism showed that the four research stations fall into the very appropriate category. The suitability index analysis for diving tourism is presented in Table 4. Determination of suitability for diving tourism is based on several parameters, including coral community cover, lifeform types, reef fish species, water brightness, coral reef depth, and current velocity.

The results of measuring data in the field showed that coral community cover at station 1 was 59.8%, and at station 4, it was 74.02%, which was in the appropriate category, while at stations 2 and 3, the coral community cover values were 82.05% and 84, respectively. A total of 4% fell into the very suitable category (Figure 2 and Table 2). The two areas that have the highest level of live coral cover are in natural areas because in the transplant area, there are human activities that seriously threaten the coral reef ecosystem. The most significant local threats to coral reef ecosystems are overfishing and damage (Huang & Coelho, 2017).

Based on water brightness data at 4 stations, the water brightness level of Badi Island is 100%, which is in the very suitable category. According to Yulianda (2019), the brightness of waters that are very suitable for diving activities ranges from >80-100%. Widhianingrum et al. (2013) added that the higher the brightness level is, the better the conditions and level of safety for tourists who are active in these waters.

The depth of the waters at the four stations ranged from 6.1-10.4 m, which is in the very suitable category. According to Yulianda (2019), the depth of coral reefs, which is very suitable for diving activities, ranges from 6-15 meters. Zulfikar et al.

(2009) stated that the depth for diving tourism is more than 3 meters, where the purpose of diving tourism is that tourists can see underwater beauty from deep in the waters with SCUBA equipment.

Table 4 Results of diving tourism suitability index analysis (SIA).

No	Parameter	Weight (B)	Score per Station (S)								Suitable value (B x S)			
			N	S I	N	S II	N	S III	N	S IV	St I	St II	St III	St IV
1	Coral communities (%)	0.375	59.86	2	82.05	3	84.40	3	74.02	2	0.750	1.125	1.125	0.750
2	Water clarity(%)	0.150	100	3	100	3	100	3	100	3	0.450	0.450	0.450	0.450
3	Coral reefs depth (m)	0.150	10.4	3	7.9	3	6.1	3	6.4	3	0.450	0.450	0.450	0.450
4	Type of Lifeform	0.135	10	2	6	1	8	2	13	3	0.270	0.135	0.270	0.405
5	Type of coral fishes	0.120	90	2	110	3	110	3	75	2	0.240	0.360	0.360	0.240
6	Current velocity (cm/secon)	0.070	28	2	16	2	22	2	21	2	0.140	0.140	0.140	0.140
SIA of Badi Island for diving tourist destination											2.300 S	2.660 SS	2.795 SS	2.435 S

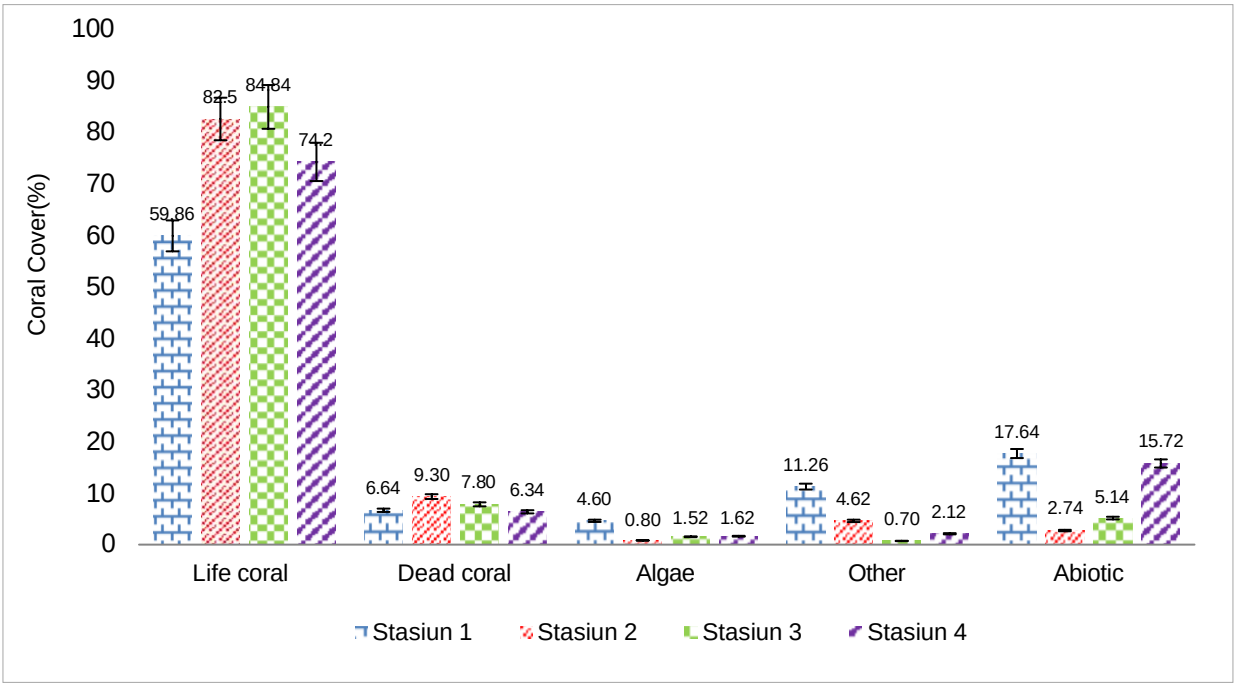

Figure 2 Percentage of coral cover on Badi Island.

The form of coral growth at each observation station ranged from 6-13 species in the very suitable category. Various forms of growth of coral reefs are interesting for visitors and divers to enjoy the beauty of the growth forms of the coral itself. so divers truly determine the quality and quantity of marine life on coral reefs as criteria for selecting dive sites Giglio et al. (2020)

The types of reef fish on Badi Island at each observation station ranged from 75 to 110 species. The highest number of reef fish species was found at Station 2 and Station 3, and the lowest was found at Station 4. This indicates that stations 2 and 3 are in the appropriate category, while Stations 1 and 4 are in the appropriate category. There is no effect of diving on the number of reef fish species, but reef fish are threatened with extinction if the decline in coral cover continues, impacting the tourism suitability value of Hasler & Ott (2008). This can be seen in Figure 3.

The results showed that current velocity measurements from four stations ranged from 16 m/s - 28 m/s with the appropriate category. Waters with fast currents are not suitable for dive tourism, which can be dangerous for tourist safety. Factors that significantly affect the resilience of open waters, such as weather, waves, current speed, tide tides, river

currents, and winds, must be considered in tourist attractions, as these conditions can increase the risk of drowning with hypothermic effects and respiratory failure Ariefianda et al. (2019).

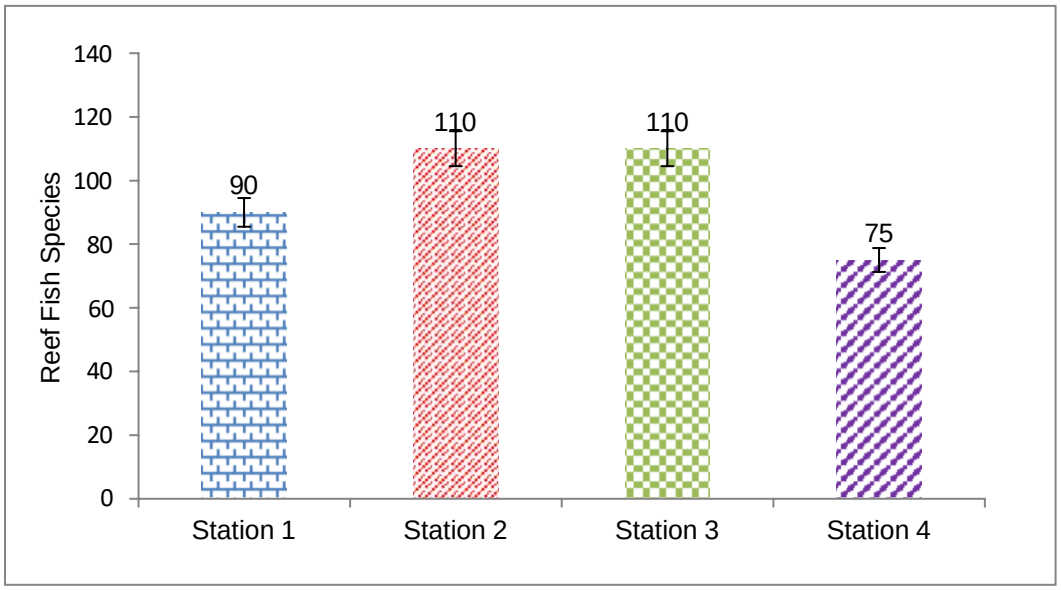

Figure 3 Percentage of reef fish species.

3.2. Estimation of the Beauty Value of Diving Attractions

Based on the results of SBE calculations, 10 images from dive tourism on Badi Island have different values. The picture with the highest score was number 4 with an SBE value of 97. The image with the lowest value was image number 2 with an SBE value of 0. This can be seen in Figures 4 and 5.

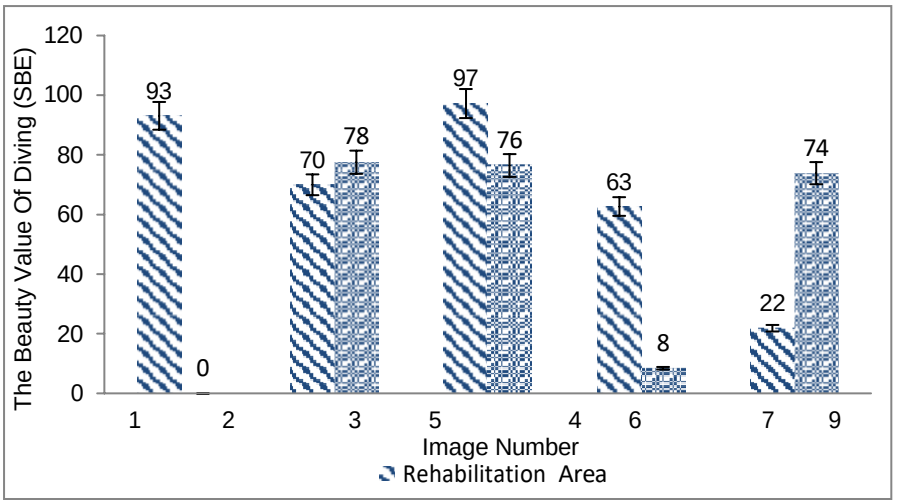

Figure 4 SBE Value Potential and Attraction of Badi Island as Diving Tourism.

The images with the highest scores are Number 4 and Number 1 with SBE values (Appendix 5) of 97 and 93, respectively. Figure 4 is a combination of the natural beauty of the blue sea and the enchantment of being surrounded by hordes of different types of reef fish, ages and sizes. Figure 6 is obtained from the location of Station 2 with the suitability value for diving tourism in the very suitable category, and Image number 1 is at Station 1 with the suitability value for diving tourism in the appropriate category. Number 1 is a picture of the relationship between nemo fish and anemones. Nemo fish live side by side with anemones and benefit each other (symbiotic mutualism). This can be seen in Figure 5.

The images with the lowest scores are number 2 and 9 with SBE values of 0 and 8, respectively. Figure 7 is a picture of Tridacna crocea (Kima Lubang), which is a type of clam from the smallest class of the family Tridancnidae, with a size of up to 15 cm, with a very bright coat color usually green, blue, purple, brown and orange at Station 3 with a suitability score for diving tourism in the very suitable category. Meanwhile, picture Number 9 picture of the Big Kima (Tridacna maxima) with a smaller shell size than other types of clams (25-35 cm). This clam lives firmly in the substrate with a bright coat color (blue, green and brown) at Station 4 with a suitability value for diving tourism in the appropriate category. As shown in Figure 5:

The coral reef lifeform is a prominent aspect of revealing beautiful visuals and a variety of colors and types of coral that are very suitable for marine tourism activities. For the uniqueness of reef fish, the diversity of types, uniqueness, and colors of various types of reef fish is the main attraction for respondents Zulfikar et al. (2009). What makes the high SBE value is the very high visual appearance of a photo object with a very suitable category for tourism Khakim (2008).

Figure 5 10 Images of Potential Value and Diving Attraction of Badi Island.

Figure 6 Highest Rated Object.

Figure 7 Lowest Object Value.

4. Conclusions

The results of the calculation of the suitability index for diving tourism on Badi Island show that IKW at stations 2 and 3 fall into the very suitable category. Meanwhile, stations 1 and 4 are included in the category according to the values of 2.30 and 2.43. Potential and tourist attraction with SBE value is the classification assumption with the highest beauty value. The results in the field show that the image with the highest score depicts the natural beauty of the blue sea with diversity surrounded by groups of reef fish species with different species, ages and sizes with an SBE value of 97 located at Station 1, and an object with an SBE value of 93 depicts the interaction of nemo fish. and anemones, while there are 2 images of objects with the lowest values depicting clams sticking to coral reefs surrounded by substrate with SBE values of 0 and 8. It can be concluded that respondents visually prefer the colorful types of reef fish, and various other types of biota found in coral reef ecosystems are the main attraction for respondents.

Acknowledgment

The author expresses his deepest gratitude to Nasrun Nurma, Muhammad Yusuf Satria, Ammar, and Radita, who helped collect data in the field. Thanks to Dr. Mahatma Lanuru and Muhammad Yafei Rahmat, who helped translate my journal.

Ethical considerations

Not applicable.

Conflict of Interest

The authors declare no conflicts of interest.

Funding

This research receive any financial support by Mega Buana Palopo university.

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