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ANALYSIS OF THE SUITABILITY OF SNORKELING TOURISM LOCATIONS AS MARINE TOURISM DEVELOPMENT AT PENIMBANGAN BEACH, BULELENG

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ABSTRACT
This research is in Penimbangan Beach, Baktiseraga Village, Singaraja District, Bali. Data was collected in August and September 2023 at two sites, one repetition. Used the underwater photo transect (UPT) method for coral data and the underwater visual census (UVC) method for fish. It is a unique coastal area with various ecosystem potential and has developed into a destination for marine activity. This beach has a natural coral reef ecosystem with great potential to develop into a marine tourism destination, especially for snorkeling. The determination as a snorkeling tourist area uses a tourism suitability index (TSI) matrix analysis by considering ecological parameters and water quality. The parameters measured in field observations are coral community cover, lifeform type, reef fish type, visibility, depth, current speed, and width of coral flatbeds. The coral community cover value at both sites was less than 25%, 19 types of lifeforms were found, and the flat area was around 80m^2. The types of coral fish found were 52 species (site 1) and 48 species (site 2), with a total of 651 individuals divided into 17 families. High water visibility is 100%, and current speed is 0 cm/sec. The depth of the reef is between 3 m and 5 m. The tourism suitability index (TSI) for the snorkeling category is included in the unsuitable category; the scores for each site are 1.725 (site 1) and 1.495 (site 2).

KEY WORDS
Tourism suitability, weighing waters, snorkeling, coral, coral fish.

As a tropical country, Indonesia has high underwater biodiversity, and its beauty has excellent potential to be developed into marine tourism. Tourism development depends on investment to fulfil infrastructure supporting tourism activities [1]. Marine ecotourism has long been understood as tourism activities related to nature. Ecotourism is not only limited to tourism that interacts with nature or the primary service offered to the environment, but ecotourism is responsible travel to natural areas by preserving the environment, improving the welfare of local communities, and providing educational value. One of the efforts to protect the environment in tourism activities is to pay attention to suitability for resource sustainability [2].

Tourism in the Bali area is the most advanced and developing sector, but it still can be developed more modernly. Natural beach tourism attractions in Bali are no less than in other countries. The beauty of the coastal landscape, with all its potential, can be utilized for further tourism development. One of the areas in Bali with the longest coastline is Buleleng Regency [3]. Buleleng has become one of the most famous marine ecotourism destinations in Bali, focusing on snorkeling and diving for domestic and foreign tourists. Buleleng areas are divided into three utilization areas: East Buleleng as a conservation area, Central Buleleng as an activity area, and West Buleleng as a cultivation area. West Buleleng has completely developed its coastal tourism, especially underwater tourism, which are Penimbangan Beach is in the central Buleleng area; tourism that has developed is beach tourism, fishing, and seeing dolphins in their habitat. The Penimbangan coastal area has clean black sand and relatively calm waves. The beauty of the underwater panorama, such as the presence of

coral reefs and ornamental fish scattered, has excellent potential to develop into tourism destinations, especially coastal tourism, such as snorkeling/diving [5]. The seas of Penimbangan Beach are calm and clear, and the beauty of the underwater world has great potential to be developed as a snorkeling location. However, it is necessary to carry out a scientific study regarding the suitability of the possibility of developing marine tourism and how suitable it is for Penimbangan Beach to be used as a location for snorkeling tourism.

METHODS OF RESEARCH

The research was conducted in Penimbangan Beach, Penimbangan village, Singaraja district of Buleleng Regency, Bali Island. The length of the Penimbangan beach is 768 m. The map location of the research is presented in Figure 1. Research data collection was carried out in August and September 2023. Tools used in this study are scuba diving equipment, GPS, underwater camera, meter roll, secchi disk, lagrange current meter, and dive comp. Materials used in this study are aquatic resources, including coral reefs and coral fish.

Figure 1 – Location of Penimbangan Beach, Buleleng

Data was collected by direct observation at the research location and interviews with stakeholders. Observations were carried out at three sites determined as the most potential locations. Data collection was carried out in one repetition. The observation method will be used for the underwater photo transect (UPT) method for coral data and the underwater visual census (UVC) method for fish. The underwater visual census method developed by English et al. [6], is a data collection method for monitoring the richness and abundance of reef fish. Meanwhile, the Underwater Photo Transect method is a coral reef counting method that utilizes technological developments in digital camera technology and computer software technology [7].

Interviews are conducted so that researchers obtain more data, understand social and cultural situations/conditions through the language and expressions of the parties being interviewed, and clarify unknown things [8]. Interview respondents were key informants, including community groups such as tourism managers, related agencies (tourism and fisheries dinar services), and tourists.

The tourism suitability index (TSI) for snorkeling is, according to Yulianda [9], divided into seven parameters. The results of assessments in the site's research in all parameters will grouped based on category and scored. Parameters have been grouped and calculated using the tourism Suitability Index formula under Table 1.

Table 1 – Marine tourism suitability matrix for the snorkeling tourism category

Parameter	Weight	Category	Score
Coral Community Cover (%)	0.375	>75	3
		>50-75	2
		25-50	1
		<25	0
Types of Coral Lifeforms	0.145	>12	3
		<7-12	2
		4-7	1
		<4	0
Types of coral fish	0.140	>50	3
		30-50	2
		10-<30	1
		<10	0
Water visibility (%)	0.100	100	3
		80-<100	2
		20-<80	1
		<20	0
Coral reef depth (m)	0.100	1-3	3
		>3-6	2
		>6-10	1
		>10	0
Current speed (cm/s)	0.070	0-15	3
		>15-30	2
		>30-50	1
		>50	0
Width of coral flatbed (m)	0.070	>500	3
		>100-500	2
		20-100	1
		<20	0

Source: Yulianda [9].

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

Where: TSI - Tourism suitability index; Bi - Weight of the ith parameter; Si - Score of the ith parameter.

The results of the formula will be put into this category. TSI Category:

- TSI ≥ 2.5: Very suitable;
- 2.0≤ TSI <2.5: Suitable;
- 1≤ TSI <2.0: Not suitable;
- TSI <1: Very unsuitable.

RESULTS AND DISCUSSION

Conditions at each observation location illustrate the growth of coral and the biodiversities. Overall, the ecosystem on Penimbangan beach is quite complex, divided into three ecological types, namely sand sediment 47 ha (57%), coral reef 26 ha (32%), and seagrass 9 ha (11%). The coral clusters can be seen above the water at the lowest low tide beach conditions, rarely 150 m from the shoreline. The value suitability index for snorkeling locations on Penimbangan Beach consists of seven parameters, as seen in Table 2.

The results of calculating the tourist suitability index (TSI) for snorkeling activities show a figure of 1,725 at site 1 and 1,495 at site 2. TSI assessment category, this figure is classified as not suitable with the value range 1≤ TSI <2.0 [9]. Snorkeling tourism satisfaction is positively and directly related to water transparency, percentage of live coral reef cover, number of lifeforms, richness of coral fish species, coral reef area (area available for tourists), and distance to the front of the coral reef.

The coral community covers at site 1 and site 2 has an area difference that is not too significant. Site 1, at a depth of 3m, has an area of 24.6%. Likewise, site 2, with a depth of 5m, has an area of around 24.13%. Coral community cover at both sites is in the very unsuitable category, with an area of less than 25%. The inappropriate coral cover category

values range from 50%-70% [9]. Coral community cover has an essential effect on the species diversity, abundance, and species composition of reef fish [11].

Table 2 – Snorkeling Tourism Suitability Index

Parameter	Measurement results	Ni (B x S)
Sites 1		
Coral Community Cover (%)	24.60	0
Types of Coral Lifeforms	16	0.435
Types of coral fish	52	0.420
Visibility (%)	100	0.300
Coral reef depth (m)	3	0.300
Current speed (cm/s)	0	0.210
Width of coral flatbed (m)	86	0.070
Number of Values		1,725
Sites 2		
Coral Community Cover (%)	24.13	0
Types of Coral Lifeforms	16	0.435
Types of coral fish	48	0.280
Visibility (%)	100	0.300
Coral reef depth (m)	5	0.200
Current speed (cm/s)	0	0.210
Width of coral flatbed (m)	78	0.070
Number of Values		1,495

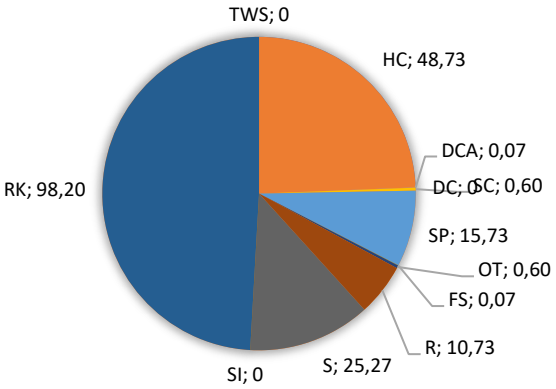

Figure 2 – Substrate cover in Penimbangan waters

Coral species richness has a stronger positive relationship with fish species richness. In contrast, coral community cover strongly correlates with total abundance or the number of individual fish [11]. Hard coral community cover at both sites was 48.73%, which was divided into 19 types of lifeforms. Reef types in the coastal area of Buleleng Regency are almost surrounded by fringing coral reefs [5].

The health of the coral reef or the percentage of living coral cover influences the presence of coralfish in coral reef areas. The complexity of a habitat type is directly proportional to the biodiversity of the biota within it due to the abundant availability of life-supporting capacity [12]. Highly complex environments allow habitats to have many species.

The availability of particular coral species drives the abundance of some fish species. Total fish abundance had a significant linear relationship with coral species richness. According to Kuffner et al. [13], coral reef fish are more related to coral communities than to physical variables of the aquatic environment.

The observations showed that there were 17 families spread across two observation locations. The tourism suitability index assessment shows that the sites are in the very suitable category with more than 50 fish species, while site 2 is in the proper type because less than 50 fish species were found (Table 2). Most fish came from Pomacentridae, Chaetodontidae, Labridae, Acanthuridae, and Scaridae. The lowest fish abundance was in the Plotosidae family, which found only one species and one coral fish.

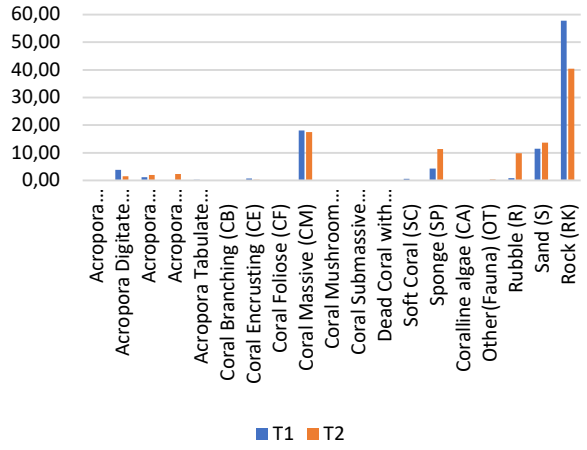

Figure 3 – Coral Lifeform (HC)

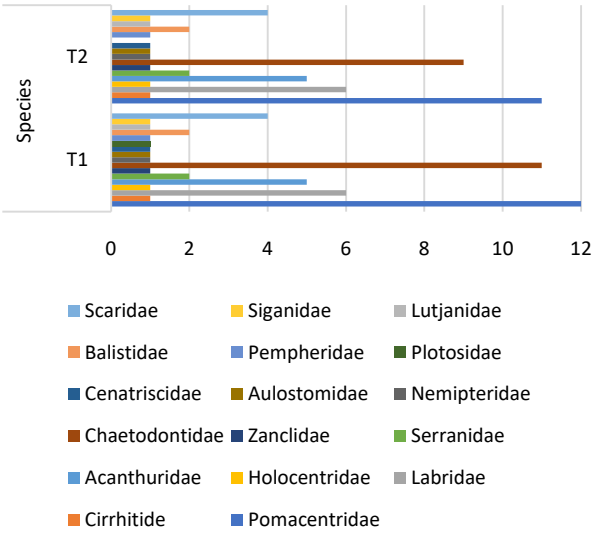

Figure 4 – Reef Fish Family Composition

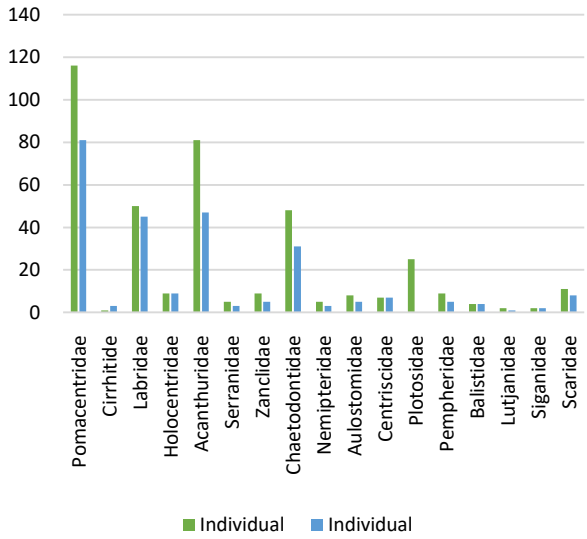

Figure 5 – Individual coral fish

At a depth of 3 m, 392 coral fish were found, belonging to 52 species and 17 families. The most significant number of individual fish found at a depth of 3 m came from the Pomacentridae family, with 116 individuals; the Acanthuridae family, with 81 individuals; and the Labridae family, with 50 individuals. The abundance of individuals from other families is less than 50 individuals each.

At a depth of 5 m, 259 coral fish were found, belonging to 48 species and 16 families. The most significant number of individual fish found at a depth of 5 m came from the Pomacentridae family, 81, the Acanthuridae family, 47, and the Labridae family, 45. The abundance of individuals from the other families is less than 45 individuals each.

Coral reef fish are classified into target, indicator, and major. Dartnall and Jones [14], classified reef fish into three main groups based on management objectives, namely: target fish are economically important fish, which are the main targets of fishermen's catches as a source of consumption and economy; indicator fish show the condition of the coral; major fish are the most significant number and type of fish in the coral reef ecosystem, so their existence is closely related to the presence of coral reefs.

Fish belonging to the target category are Scaridae, Balistidae, Nemipteridae, Acanthuridae, Siganidae, Lutjanidae, and Serranidae. Fish belonging to the indicator category are Chaetodontidae. Fish belonging to the major category are Pempheridae, Zanclidae, Serranidae, Holocentridae, Labridae, Cirrhitide, Aulostomidae, Cenatriscidae, Plotosidae and Pomacentridae. Chaetodontidae family are actual coral reef fish. Its distribution is limited to coral reef ecosystems because of its dependence on coral reefs as a food source [15].

The research results show that both have a water visibility value of 100% and can be categorized as very suitable (Table 2). The visibility category ideal for a diving area is good if the value is between 80-100% [16]. Snorkeling tourism satisfaction is positively and directly related to water transparency [10]. Stagnant water and increased nutrient levels in the water column drive high water turbidity and low visibility.

The depth of the coral reef at site 1, namely 3 m, is categorized as very suitable, and the depth at site 2, namely 5 m, is in the relevant category (Table 2). The depth of coral reefs strongly influences visibility and is negatively related to snorkeling satisfaction [10]. The deeper the depth, the more limited visibility will be. Meanwhile, snorkeling is tourism that is only surface-based.

Snorkeling satisfaction is negatively related to flow velocity (due to high energy expenditure for swimming and maintaining buoyancy in areas with high flow velocity) [10]. Based on the results of observations, the current speed at Penimbangan of 0 cm/second is included in the very suitable category (Table 2). Currents classified as the right conditions for diving activities range from 0-15 cm/s [9].

Coral community overlay is only intended for snorkeling activities. Remember that snorkeling can only enjoy a flat stretch of coral from the surface. The width of the period at site 1 is 86 m, and 78 m at site 2, which is categorized as unsuitable (Table 2). The flat expanse of coral ideal for snorkeling is more than 100 m [9].

Tourist activities at Penimbangan Beach have been developed since 2016. The development of reef tourism on Penimbangan Beach considers not only environmental issues but also economic and social issues, including the beauty of the landscape and the presence of charismatic species such as rock corals, echinoderms, and reef fish. As well as safety, infrastructure, and accessibility conditions for high-quality recreational snorkeling guarantees regarding cleanliness and comfort have been well structured. The location manager Pokmaswas Penimbangan's service will give the impression of a deep travel experience. Almost 100% of street vendors and managers are residents of Baktiseraga or Penimbangan villages. People whose livelihoods come from there will feel a sense of ownership and will be more aware of the importance of protecting and being responsible for preserving nature and the Penimbangan tourism environment. Entrepreneurial abilities generally decline from generation to generation [17].

The tendency to travel is to enjoy natural beauty and provide meaning as educational tourism. The activities are in special forms, such as tours with learning tour package

programs and general conditions, such as observing wildlife, introducing culture, and learning about nature. The potential of Penimbangan Beach is the complexity of its underwater ecosystem. Penimbangan Beach, as a conservation area, can affect the ecological integrity of a wider range of natural ecosystems. This is also feedback from conservation area management for the community to provide optimal benefits from nature tourism. Other developments are being carried out to increase tourist interest, with the construction of the Indonesia Coral Reef Garden, a turtle hatchery, and seagrass tourism, which a blue carbon education centre will later develop.

CONCLUSION

Based on the analysis and discussion, the following conclusions can be drawn: measurement of the tourism suitability index at the research location shows that the TSI category is not suitable. The scores at each site are 1.725 (T1) and 1.495 (T2). Coral community cover at both sites was less than 25% and 19 types of lifeforms were found, with a flat expanse of only around 80m^2. The types of coral fish found were 52 species (T1) and 48 species (T2), with a total of 651 individuals divided into 17 families. The visibility value is 100%, and the current speed is 0 cm/sec. The depth of the reef is between 3 m and 5 m. Apart from its topographic potential, the completeness of tourist infrastructure, ease of access, guaranteed hygiene issues, and well-structured comfort make Penimbangan Beach suitable for development as a snorkeling tourist attraction. Apart from that, other tourist attractions that can be enjoyed are turtle breeding educational tours, dolphin view tours, and diving tours.

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