

EVALUATION OF THE SUSTAINABILITY STATUS OF THE BANGSRING UNDERWATER WITH INDONESIA'S CORAL REEF ECOSYSTEM

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Abstract: Bangsring underwater is a type of ecotourism where the main attractions are coral reef ecosystems and swimming with sharks. Management based on the idea of ecotourism has a positive effect on changes in coral reef areas. On the other hand, tourism activities can hurt coral reef ecosystems if tourists act in a destructive way. The purpose of this research is to evaluate the sustainability status (ecology, economy, social, technology, and law - Institutions aspects) of the Bangsring Underwater coral reef ecosystem, in Indonesia using the rapid appraisal for fisheries (Rapfish). The sampling technique used purposive sampling with MDS Rapecotourism data analysis. Bangsring underwater offers tourist attractions in the form of floating houses, swimming with sharks, snorkeling, diving, planting coral reefs, and feeding fish. The evaluation value of sustainability in the quite sustainable category is the social dimension of 67.08%, with priorities that can be considered for increasing the sustainability of the social dimension being the role of the community in the form of participation in ecotourism management. Meanwhile, the multidimensional evaluation of sustainability yields a value of 76.48% in the sustainable category. This indicates that ecological conditions and law enforcement efforts to protect the sustainability of coral reef ecosystems are going well. Bangsring underwater ecotourism development takes into account ecological sustainability and provides economic opportunities for the community.

Key words: attractions, bangsring underwater, coral reefs, ecotourism, sustainability

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INTRODUCTION

Tourism is a natural resource that has economic value. The tourism sector is an activity that has a strategic role in improving economic development and is proclaimed as one of the economic drivers of an area that has the potential for tourism. Tourism is one of the sectors that can absorb labour, so the government is trying to develop strategies and policies that can support the development of the tourism sector. The amazing natural potential can be used as a tourist attraction for the community. Management of a tourist area can generate a very high economic value (Lailatufa et al., 2019). Tourism development, particularly in Indonesia, is showing a positive trend. This positive trend is towards developing tourism with the concept of ecotourism (Kusumaa and Amirudin, 2019). Ecotourism is a sustainable tourism development concept that aims to conserve the environment (nature and culture) (Intyas et al., 2021). Ecotourism is becoming increasingly popular with increasing attention and awareness of the ecological environment (Xu et al., 2022). Ecotourism can function as education and awareness for tourists, local communities, and other stakeholders about the importance of environmental sustainability, the concept of preserving and conserving natural resources, the environment, and local culture (Butarbutar and Soemarno, 2012).

The potential for marine tourism, especially coral reef ecotourism in coastal areas, is carried out as an effort to strengthen existing marine tourism (Widhiatmoko et al., 2020). The beautiful and well-maintained coral reef ecosystem also has economic value as part of marine ecotourism (Intyas et al., 2023). About 30% of the world's coral reefs are valued in the tourism sector, with an estimated total value of nearly US\$36 billion, or more than 9% of all coastal tourism value in the world's coral reef countries (Spalding et al., 2017). Indonesia has the best relative performance in conducting coral reef-based tourism among other countries in the region, followed sequentially by Papua New Guinea, Malaysia, the Philippines, Timor-Leste, and the Solomon Islands (Huang and Coelho, 2017). Marine ecotourism is not only a way to enjoy the coastal environment, but tourists can also help take care of the coastal environment so that the ecosystem stays healthy (Herison et

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al., 2021). Bangsring Underwater is a marine tourism project with a coral reef ecosystem in Banyuwangi Regency, Indonesia, that is managed by a group of fishermen and started in 2008; it was inaugurated in 2014 with the concept of ecotourism. The condition of the coral reefs was still damaged before 2008 because fishermen still used bombs to catch fish. Coral reef ecosystem management from 2008–2020 resulted in an additional 3.5 ha of living coral reef area.

Table 1. Dimensions, attributes, and assessment scale for the sustainability of Bangsring underwater (Source: modification after Tjahjono et al., 2022)

No	Dimension	Attribute	Scoring scale
1	Ecology	Water brightness (%)	1 = 20-<50; 2 = 50-80; 3 = >80
2		Coral covers (%)	1 = 20-50; 2 = >50-75; 3 = >75
3		Types of reef fish (fish)	1 = 20-<50; 2 = 50-100; 3 = >100
4		Types of coral reefs (Species of corals)	1 = 4-7; 2 = 7-12; 3 = >12
5		Water current (cm/s)	1 = >30-50; 2 = >15-30; 3 = 0-15
6		Coral depth (m)	1 = >20-30; 2 = >15-20; 3 = 6-15
7		Cleanliness of coral reef ecotourism	1 = Dirty due to lack of trash cans (>1000m); 2 = Fairly clean because there are trash bins but they are far apart (500-1000m); 3 = Clean because the distance between trash bins is close (100-500m)
8		Arrangement of Bangsring Underwater ecotourism area Banyuwangi	1 = Unorganized; 2 = Moderately organized; 3 = Well organized
9		Bleaching coral	1 = Severe; 2 = Moderate; 3 = Did Not Occur
10	Economy	Tourists visit	1 = Low; 2 = Seasonally; 3 = High
11		Government budget in managing ecotourism	1 = None; 2 = Low; 3 = As needed
12		Employment	1 = Low; 2 = Seasonally; 3 = High
13		Tourism market potential	1 = Local market; 2 = Local and national market; 3 = Local, national and international market
14		Area accessibility	1 = Difficult; 2 = Moderate; 3 = Easy
15		Community income after ecotourism	1 = Low income and high poverty rate; 2 = Adequate income and low poverty rate; 3 = High income and avoiding poverty line
16	Social	The level of conflict in the use of the area as an ecotourism site	1 = Many conflicts; 2 = Slight conflict; 3 = No conflict
17		Livelihoods before and after tourism	1 = Non-tourist work and does not switch to tourism; 2 = Non-tourist jobs that penetrate the tourism sector; 3 = Tourism workers who continue to develop tourism business
18		Community participation in ecotourism management	1 = Not participating in management; 2 = Participating but not active in management; 3 = Participate and be active in management
19		Coral reef rehabilitation	1 = Never; 2 = Rarely; 3 = Consistently
20		Community knowledge about coral reefs	1 = Don't know about coral reefs; 2 = Knowing but not taking part in preserving sustainability; 3 = Knowing and taking part in maintaining sustainability
21		Tourist and public awareness of sustainability	1 = Low; 2 = Moderate; 3 = High
22	Technology	Use of information technology for ecotourism promotion	1 = Unable; 2 = Able but less consistent in promotions; 3 = Able and consistent in promotions
23		Development of environmentally friendly ecotourism facilities	1 = Construction using concrete as raw material and changing the shape of the environment; 2 = Development using concrete as raw material but still considering the environment; 3 = Development using environmentally friendly raw materials
24		Availability and access to clean water	1 = >2km; 2 = 1-2km; 3 = <1km
25		Public facilities and infrastructure	1 = No public infrastructure is available; 2 = Public infrastructure facilities are available but not optimal; 3 = Availability of public infrastructure with comfortable conditions
26		Modes of transportation	1 = High rates without knowing the pattern of tourist trips and not helping tourism development; 2 = Affordable rates but do not know the pattern of tourist trips and can help develop tourism; 3 = Affordable rates by knowing travel patterns and helping tourism development
27		Telecommunications infrastructure	1 = There is no communication signal transmitter yet; 2 = There are communication signal transmitters with limited providers; 3 = There is a communication signal transmitter to access all providers
28	Law and Institutions	Availability of tourism services	1 = Few or 1-25 tourism services; 2 = Moderate or 26-50 tourism services; 3 = Many or > 50 tourism services
29		Availability of management regulations	1 = There is no coordination ; 2 = There is not optimal coordination between stakeholders; 3 = Established good coordination between stakeholders
30		Coordination between stakeholders	1 = There is no settings in management; 2 = There is not optimal settings in management; 3 = Established good settings in management
31		Occupational Safety and Health (OSH)	1 = There is no implementation of OSH for workers and visitors; 2 = There has been an implementation of OSH for workers and visitors, but it is not optimal; 3 = OSH has been implemented for workers and visitors with optimal conditions
32		Level of community compliance with regulations	1 = low; 2 = moderate; 3 = high
33		Local government commitment to managing ecotourism	1 = low; 2 = moderate; 3 = high

This sustainable condition provides opportunities for tourist attractions. The number of tourist visits in 2020 was 59,182 in April–June 2020, under lockdown due to the COVID-19 pandemic. In 2021, as many as 50,463 tourists visited because of Community Activities Restrictions Enforcement (PPKM) policies in April, Ramadan, and August. Whereas in 2022, until September, the number of tourist visits was 70,422 because government policies have allowed tourism activities.

Bangsring underwater provides tourist attractions in the form of floating houses, swimming with sharks, snorkeling, diving, planting coral reefs, and feeding fish (Sumarmi et al., 2022). Coral reef ecosystems are ecosystems that are vulnerable to changes in environmental conditions and have low resilience when environmental stress occurs (Wahyudi et al., 2021). Apart from providing economic benefits, tourism activities also have a negative impact on coral reef ecosystems. The most destructive behavior carried out by licensed tourists is stepping on corals, while those who are not licensed are holding corals. The impact is divided into three, namely the emergence of coral fractures, scratches on the surface of coral colonies, and the destruction of coral colonies (Muhidin et al., 2017). Sustainable marine ecotourism management must consider ecological aspects, which are objects of an activity, by involving social elements as tourism actors in management so that they can provide economic benefits (Koroy et al., 2017). Tourism is basically a mass industry.

Its products and services are aimed at enabling the regeneration of body and spirit, getting to know, and experiencing something new, interesting to as many people as possible. However, the present shows that, as in other sectors (for example the economy), it is necessary to apply elements of sustainability in tourism as well (Šambrónská et al., 2023). The status of coral reef ecosystems in the Pangkajene and Kepulauan (PANGKEP) Regency using the rapfish analysis identified 41 types of threat to the status of coral reef ecosystems, based on five indices: economic (51.92), social (47.33), technological (47.26), legal and institutional (45.60), and ecological (37.65). The averaged cumulative index of coral reef ecosystem sustainability was 45.95, within a threshold denoting a “less sustainable” status (Haya and Fujii, 2020). The sustainability status of coral reef ecosystem management following the establishment of the KKPD Pulo Pasi Gusung is based on the ecological dimension included in the good category, the economic dimension included in the less sustainable category, the sociocultural dimension included in the quite sustainable category, the technological and infrastructure dimensions included in the less sustainable category, and then the legal and institutional dimensions included in the moderately sustainable category (Cahyani et al., 2018). The following are the main characteristics or crucial elements that affect the sustainability of coral reef ecosystem management in the East Bintan KKLD: coral reef condition, protected areas, community income, employment of the tourism workforce, accessibility of human resources, government policies, cooperation between stakeholders, community compliance, legal advice on environmental matters, and infrastructure for oversight (Adriman et al., 2012). Management sustainability status is a consideration in resource utilization so as to minimize damage. Sustainable management of the ecological dimension will have a positive impact on other dimensions, and conversely, unsustainable management of the ecological dimension will have a negative impact on other dimensions (Fattah et al., 2021). The purpose of this research is to evaluate the sustainability status (ecology, economy, social, technology, and law - Institutions aspects) of the Bangsring Underwater coral reef ecosystem, in Indonesia using the rapid appraisal for fisheries (Rapfish).

Table 2. Categories of sustainability status (Source: Pitcher and Preikshot, 2001)

Index Value	Category
0 – 25	unsustainable
>25 – 50	insufficient
>50 – 75	sufficient
>75 – 100	sustainable

MATERIALS AND METHODS

The research on evaluating the sustainability status of Bangsring Underwater in the Indonesian coral reef ecosystem used a sampling technique in the form of purposive sampling from managers, agencies, and community leaders. *Multi-Dimensional Scaling* (MDS) Rapecotourism Data Analysis refers to the Rapfish technique (rapid appraisal for fisheries), which aims to evaluate the sustainability of fishery resources by considering ecological, economic, social, technological, and legal and institutional dimensions. Dimensions, attributes, and a rating scale as an evaluation are presented in Table 1. The sustainability of Bangsring Underwater is assessed based on 5 dimensions using a questionnaire by experts, where each indicator from the 5 dimensions is given a score of 1 (poor) to 3 (good). Higher scores indicate Bangsring Underwater ecotourism is in good condition. The stages of analysis consist of (Kavanagh and Pitcher, 2004):

1. *Multi-Dimensional Scaling* (MDS): The ordination technique is analyzed by MDS to determine the position of the good and bad points.

2. *Monte Carlo* (MC): The Monte Carlo method evaluates how random error affects the estimate of the ordinate value.

3. *Leverage*: Leverage analysis to determine the sensitive attributes of each dimension of sustainability in increasing the measured index value, namely ecology, economics, social, and technological aspects, as well as legal and institutional aspects.

The *goodness of fit* in the MDS analysis is evaluated through the S-stress value and the coefficient of determination (R^2). A low S-stress value indicates good fit (Fauzi and Anna, 2005). The model is said to be good or almost good if the results of the analysis produce an S-stress value of less than 0.25 ($S < 0.25$), and an R^2 close to 1 (100%) (Pitcher, 1999).

Further analysis was carried out with the *Rapfish software* tool to determine the results of the evaluation of the sustainability status of Bangsring Underwater with the Indonesian coral reef ecosystem, as shown in Table 2, which are grouped into four categories of sustainability status, namely: unsustainable, insufficient, sufficient, and sustainable.

RESULTS AND DISCUSSION

Bangsring Underwater (*Bunder*) is a tourism spot in Bangsring Village, Wongsorejo District, Banyuwangi Regency that helps protect coral reefs. The beauty of *Bunder* lies not on the beach but in a completely preserved underwater garden. Tourists can see many ornamental fish, such as Nemo; to see them, they can go snorkeling or diving. *Bunder* is also known as the Floating House; this house functions as a fish clinic and a shark breeding place (Ridla et al., 2021). The uniqueness of the Bangsring Underwater Ecotourism Area is located at the edge of Java Island near Bali Island and other small islands such as Tabuhan Island and Menjangan Island. This makes the Bangsring Underwater Ecotourism Area a strategic area with small island attractions that are still untouched. In addition, Bangsring Underwater Ecotourism has implemented ecotourism principles such as the conservation of sharks and coral reefs, as well as presenting underwater tourist attractions such as snorkeling and diving. This is unique for Bangsring Underwater Ecotourism when compared to other ecotourism.

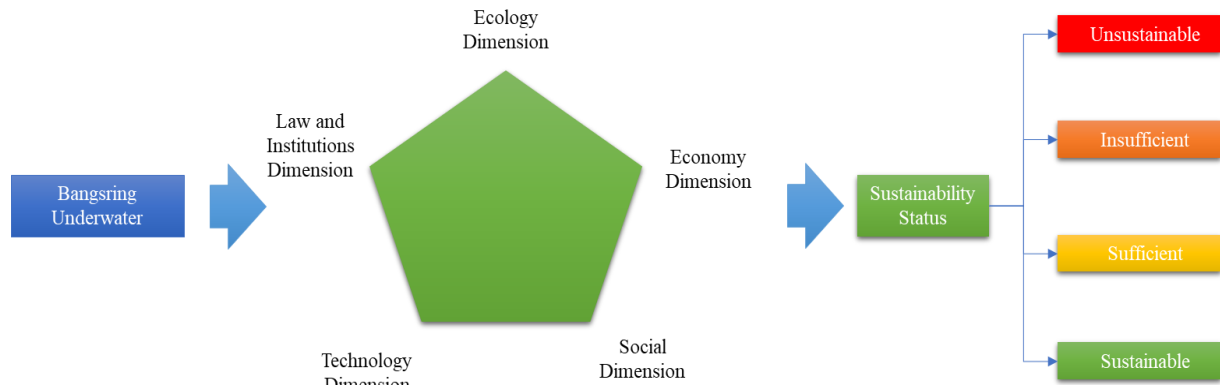


Figure 1. Research methodology (Source: Authors)

An alternative way to manage that is good for the environment is to use the ecotourism model in the form of ecotourism products or attractions that work together. Bangsring Underwater Ecotourism is a type of marine ecotourism that focuses on education and gives the ecotourism community more power. Education in *Bunder* ecotourism includes education on transplantation on coral reefs, introduction to fish apartment, planting fir using coconut waste, reading gardens, introduction to shark clinics, planting corals, and various kinds of ornamental fish. Empowerment of fishermen and the surrounding community, namely many fishermen who work as ecotourism officers and tour guides, work together to use the services of fishing boats to cross the islands of Tabuhan and Menjangan Island, open food stalls, and engage in other economic activities. Ecotourism products at *Bunder* Ecotourism include floating houses, snorkeling, diving, shark clinics, fish apartments, marine education and ecotourism supporting vehicles, namely banana boats, speed boats, canoes and paddles, and jet skis (Aini et al., 2018). The amount of waste that is found on the surface of Bangsring beach and its surroundings is the result of the mistakes of tourists who still do not have the awareness to dispose of waste responsibly and still often use single-use plastics. This is a concern because if the waste problem is left unchecked, it will damage the Bangsring underwater environment and the ecosystems that exist in the Bangsring Sea. The amount of waste that has accumulated in the coastal area of Bangsring is generated by the remnants of tourist activities that leave trash in the form of food and drink wrappers, plastic bottles, cigarette butts, paper, and food scraps (Ningrum and Rohman, 2020).

The multidimensional results of Rapecotourism sustainability based on ecology, economy, social issues, technology, and law and institutions produce a value of 76.48% (Figure 2). This shows that underwater ecotourism is in the sustainable category. The results of the study (Ekawati et al., 2020) explained that the decrease in the area of coral reefs from 2005 to 2008 was 1.22 ha. This decline also occurs in dead coral reef ecosystems. The area of living coral reef ecosystems has increased by 2.4 hectares from 2011 to 2020. This can be caused by an increase in efforts to preserve coral reefs in Bangsring Village. In 2014, the people of Bangsring Village jointly built a 'Floating House' and designated Bangsring Beach as an ecotourism area. After six years of determining the area, the total area of living coral reef ecosystems in this area until the end of September 2020 reached 6.1 ha. The ecological dimension that is taken into consideration in sustainability when developing

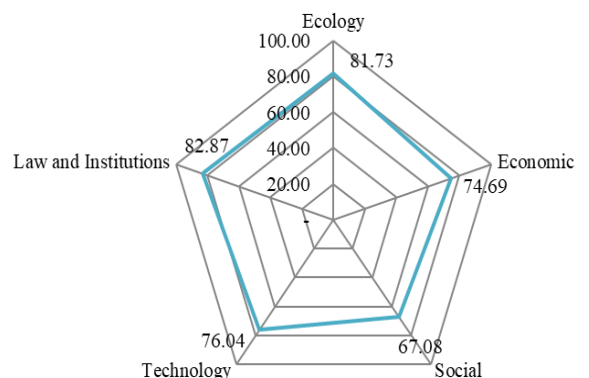


Figure 2. Sustainability based on Multidimensional

Bangsring underwater ecotourism is ocean water current (Figure 4). Tourists carrying out snorkeling or diving activities need sea water current that are not too strong so as to be comfortable while traveling. The beauty of coral reefs is no less interesting and is presented through snorkeling and diving activity to see the coral reefs on the seabed. Snorkeling and diving activities will be provided by a guide who will guide and direct visitors in viewing and documenting coral reefs.

The coral reefs presented are found in several spots around the Floating House, Tabuhan Island, and Menjangan Island. Coral reefs in Bangsring Underwater Ecotourism are still very well maintained and growing well. This is a good impact from conservation activities, which are the principles of the Bangsring Underwater Ecotourism Manager. According to the

results of the study (Aprillita and Luthfi, 2019), the water current speed in Bangsring Underwater is not fast (between 0.01 and 0.19 m/s) and tends to head south but greatly affects the growth of coral reefs.

Tabuhan Island (Figure 3A) presents a view of white sand with a row of mountains beside it, plus the water depth is not that deep and is clear, which is very suitable as a snorkeling spot. On this island, there are shallow waters and deep waters, so it can be an option for visitors to choose snorkeling and diving activities. Tabuhan Island is an uninhabited island, so it is perfect for visitors who want a private beach. To get to Tabuhan Island, use an island-crossing boat, and it takes about 15 to 25 minutes, depending on the speed of the boat, wave conditions, and wind. Menjangan Island is one of the exotic islands that offers the beauty of a small island decorated with rocks and the presence of deer (*menjangan*).

This is a very interesting spot to visit. To get to Menjangan Island, it takes an average of about 40 to 45 minutes. Visitors to this island can enjoy its beauty by snorkeling, diving, and viewing deer (*menjangan*). Bangsring Beach (Figure 3B) presents views of the sunrise and the splendor of Bali Island. Along the Bangsring Beach line, sea pine trees are arranged, which make Bangsring Beach cool and shady. Even though Bangsring Beach has black sand, this beach is very clean and has water with a level of clarity and brightness that is ideal for snorkeling and diving activities. The following is a picture of the attractiveness of natural beauty from several spots in the Bangsring Underwater Ecotourism.



Figure 3. (A) Tabuhan Island dan (B) Bangsring Beach (Source: Authors, 2022)

The sustainability of Bangsring ecotourism in the economic dimension needs to consider employment absorption (Figure 5). A regional economy when there are tourism activities has a significant impact on the diversity of jobs, so there are increased job opportunities. The existence of Bangsring Underwater Ecotourism can be felt by the community, especially by the people who are in the area. Communities around ecotourism used to make a living as ornamental fish fishermen before ecotourism existed. They survive only by relying on the catch of ornamental fish. They catch ornamental fish by diving and using bombs. Apart from that, some of them also work odd jobs, such as being construction workers, to supplement their income. However, after this ecotourism, they can work as guides, ecotourism managers, counter keepers, boat renters, land transportation drivers, stall traders, and so on. Indirectly, the existence of ecotourism increases the diversity of employment opportunities. In addition, research (Sumarmi et al., 2022) explains that coral reef ecotourism activities generate business opportunities that are also open to the people of Bangsring. Managers set up stalls managed by residents around the Bangsring Underwater area. The stalls provide food, drinks, toys, and swimwear.

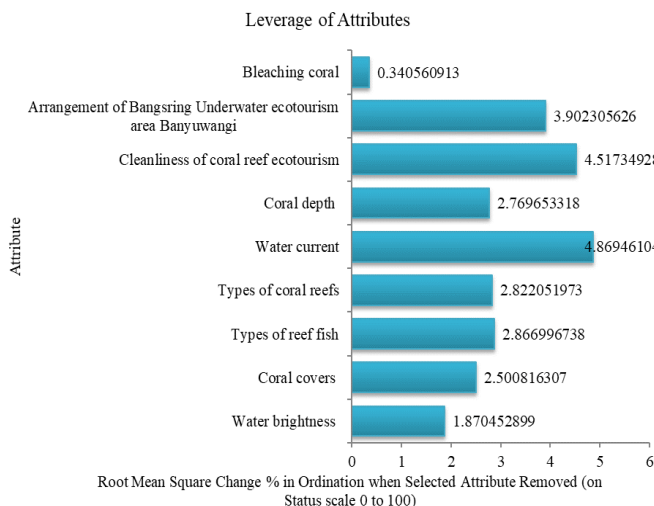


Figure 4. Ecology Leverage

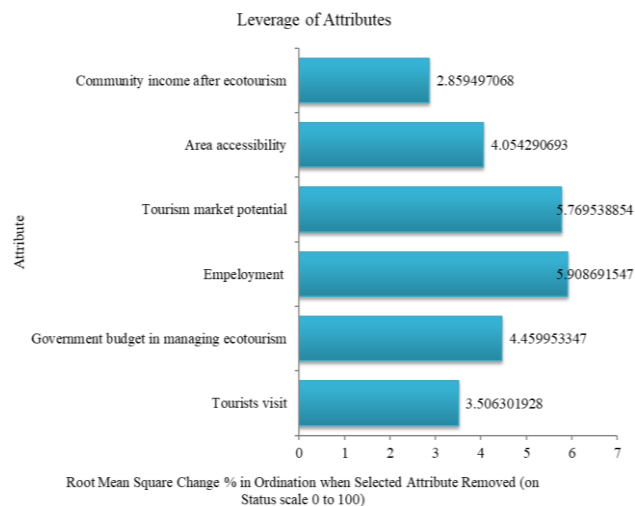


Figure 5. Economic Leverage

The role of the community in managing ecotourism (Figure 6) is an important way to help underwater ecotourism in Bangsring stay around for a long time. This community involvement supports a sense of belonging to ecotourism so that it makes efforts to preserve coral reef ecosystems. The impact of ecotourism is not only felt economically but also socially. This can be seen in the change in mindset and habits from fishermen who prioritize their own income regardless of environmental sustainability to people who are very concerned about the sustainability of marine biota. This ecotourism education is also felt by ecotourism managers, especially in foreign languages. This is done by apprentice students and *KKN* in the field of ecotourism. The Bangsring Underwater Ecotourism Manager is also aware that the presence of ecotourism visitors will have a negative impact, namely the waste problem. The waste in question is inorganic waste, namely plastic. Therefore, ecotourism managers turn waste processing equipment into gasoline to use as boat fuel. Every five kilograms of plastic waste will produce one liter of gasoline. The results of the study (Purwanti et al., 2020), explain that an intensive negotiation approach in each institution that intersects with the existence of coastal ecosystems and FGD activities for all management institutions can change behavior and views in sustainable management of coastal ecosystems and can reduce management conflicts. The key to maintaining the remaining ecosystem area for conservation activities is to involve community groups or communities in managing coastal ecosystems. (Brewer and Moon, 2015) add that co-management has gained significant traction in small-scale fisheries as part of solutions to address economic inefficiencies, unsustainable harvesting, and unequal distribution of profits derived from fisheries, yielding some promising results.

Figure 7 shows that the public facilities and infrastructure in Bangsring underwater ecotourism make it easy for tourists to feel at home. Facilities that meet the standards will provide satisfaction for tourist visits so that they will have the possibility to visit again. The available facilities and infrastructure include prayer rooms, toilets, gazebos, reading houses, storage of goods, food stalls and souvenirs, counters, docks, ferry boats, boats to islands, water sources, electricity sources, and ride facilities. Bangsring Underwater Ecotourism has provided adequate accommodation facilities as a place for visitors to stay in the form of homestays. The homestays provided by Bangsring Underwater Ecotourism consist of three types: family rooms, nemo homestays, and bunker homestays. The results of the study (Hanafi et al., 2021), state that tourists' perceptions of underwater sports facilities in Bangsring Village, Banyuwangi Regency, include: (1) sources of information and visiting purposes have a good percentage of 85%. (2) Underwater sports tourism facilities and infrastructure have a good percentage of 89%. (3) The uniqueness of the underwater sports vehicle in Bangsring village has a very good percentage of 91.4%. (4) Types of tourist services have a fairly good percentage of 84%. (5) Management of tourist attractions has a pretty good percentage too, with 87.5%. Based on the results of the data analysis in this study, it can be concluded that the perception of tourists about underwater sports, especially snorkeling and diving in Bangsring Village, Banyuwangi Regency, as a whole, can be said to be positive.

Figure 8 shows how easy it is for tourists to choose tourism services, which is a chance to make Bangsring underwater ecotourism more sustainable. More and more available tourism services provide an alternative for tourists to choose quality tourism services at competitive prices. Accessibility is an indication of the level of affordability of a tourist attraction and is a driving factor for market potential. The accessibility of Bangsring Underwater Ecotourism is assessed based on the

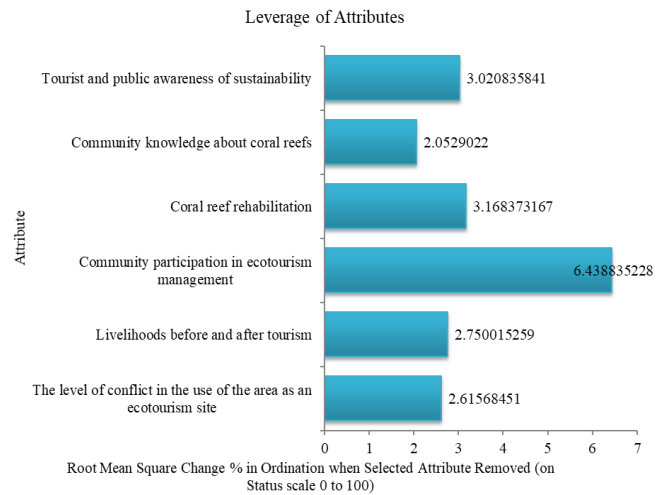


Figure 6. Social Leverage

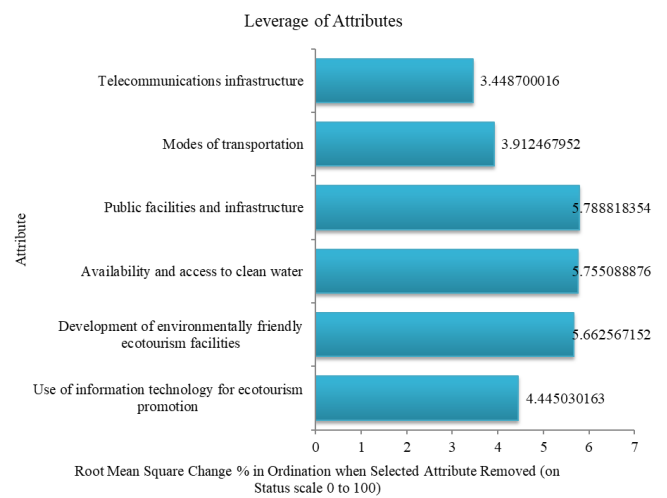


Figure 7. Technology Leverage

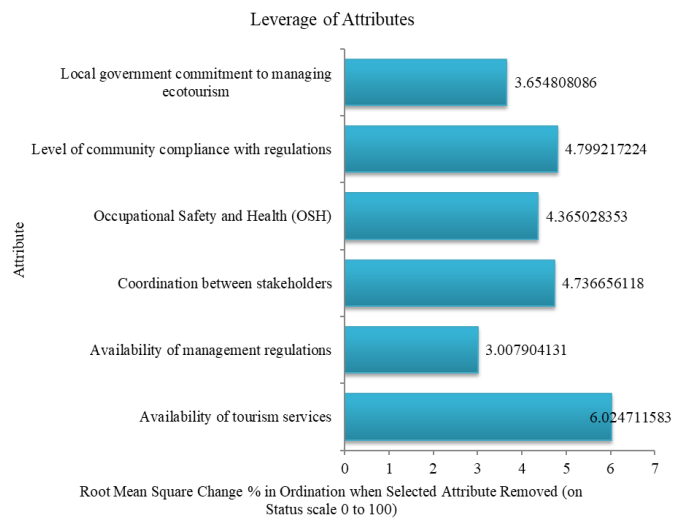


Figure 8. Law and Institutions Leverage

availability, distance, and conditions of transportation access. Bangsring Underwater Ecotourism can be reached by train from the nearest station, namely Ketapang Banyuwangi Station, with a distance of 12 km; by bus from the nearest terminal, Kapuran Bus Terminal, with a distance of 9.9 km; or by boat from the nearest port, namely Ketapang Harbor, with a distance of 12 km. The condition of the road to Bangsring Underwater Ecotourism is easy to access because it is close to the highway, namely Jalan Raya Banyuwangi Situbondo, so that it has good road conditions and is easily accessible by two-wheeled and four-wheeled vehicles. To go to Bangsring Underwater Ecotourism (*BUNDER*) you have to pass Jalan Pantai Mutiara Pulau Tabuhan for 1.5 km on a small paved road. It's just that buses and other large four-wheeled vehicles can only get to the outside parking lot with a distance of about 30 m and can be reached on foot. According to (Sumarmi et al., 2022), tourists coming from outside Banyuwangi Regency can reach the location through the following transportation options: planes, trains, ferries (ships), and intercity buses. (Utami et al., 2022) stakeholders are expected to synergize with each other in managing activities in ecotourism. Apart from exploiting their economic potential, the community and the private sector are also expected to participate in maintaining compliance with regulations to preserve the coastal ecosystem. The government should monitor and enforce regulations related to ecotourism and support the development of ecotourism so that its benefits are sustainable.

Table 3. Comparison of Multidimensional Scaling with *MonteCarlo* and *Goodness of Fit* for Underwater Bansring Sustainability

Dimension	MDS	MC	MDS-MC Difference	R ²	Stress
Ecology	81.73	81.01	0.719	0.949	0.136
Economy	74.69	74.62	0.069	0.948	0.144
Social	67.08	66.54	0.545	0.947	0.152
Technology	76.04	75.47	0.573	0.949	0.145
Law and Institutions	82.87	82.47	0.396	0.950	0.141

Monte Carlo analysis to evaluate the effect of errors on the MDS ordination process (Kavanagh and Pitcher, 2004). The low difference between the MDS and MC values results in an indication that the MDS score has a high level of confidence due to a minimum of errors in understanding or procedures for indicators, and variations in scoring (Fattah et al., 2021). Ecological, economic, social, technological as well as legal and institutional dimensions produce a difference between MDS and Monte Carlo that is not too large so that this value indicates that the calculation results are good (Table 3).

The S-Stress value, which is calculated from the S value, shows how well the *Multidimensional Scaling Rapfish* analysis works. Low S-Stress values indicate high accuracy (*goodness of fit*). A good model is indicated by an S-Stress value that is less than 0.25 (<25%) with a coefficient of determination (R²) close to 1.0 or 100% (Purwanti et al., 2021). Based on the calculation of determination (R²) in Table 3, it shows that the 5 dimensions produce an average of 0.95 or 95%, which is close to 100%, and the average stress value is 0.14 or below 0.25, so the model is declared good or has a high accuracy.

CONCLUSION

Bangsring underwater provides tourist attractions that are environmentally friendly so as to minimize damage to coral reef ecosystems, in the form of floating houses, swimming with sharks, snorkeling, diving, planting coral reefs, and feeding fish. The multidimensional sustainability status of Bangsring underwater is in the sustainable category because it produces a value of 76.48%. The social dimension is the main concern in increasing sustainability, with the priority of community participation in managing Bansring underwater ecotourism.

Managers should evaluate physical parameters for snorkeling and diving and maintain facilities and infrastructure on a regular basis, managers should develop tour packages with the concept of ecotourism with tour service providers, and managers should develop tourist attractions that involve the participation of the surrounding community.

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