Fisheries Journal, 15 (5), 2371-2382 (2025)
http://doi.org/10.29303/jp.v15i5.1866

SUSTAINABILITY ANALYSIS OF MUNDU MANGROVE ECOTOURISM, MUNDU PESISIR VILLAGE, MUNDU DISTRICT, CIREBON REGENCY

Analisis Status Keberlanjutan Ekowisata Mangrove Mundu, Desa Mundu Pesisir, Kecamatan Mundu, Kabupaten Cirebon

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(Received September 12th 2025; Accepted October 12th 2025)

ABSTRACT

Mundu Mangrove Ecotourism is located in Mundu Pesisir Village, Mundu District, Cirebon Regency. Ecotourism is a form of tourism that is managed through a conservation approach. This study aims to analyze the sustainability status of mangrove ecotourism based on five dimensions of ecology, economy, socio-culture, infrastructure, and institutional law using the RAPFISH approach, identify critical attributes that affect sustainability, and formulate mangrove ecotourism development strategies in Mundu Pesisir Village. Data were collected through field surveys, interviews, and questionnaires to various stakeholders, then analyzed using the Multidimensional Scaling (MDS) method through RAPFISH (Rapid Appraisal Technique for Evaluating Fisheries Sustainability). The results of the sustainability analysis based on 5 dimensions, namely the ecological dimension of 48.33 (less sustainable), the economic dimension of 22.05 (unsustainable), the socio-cultural dimension of 53.13 (moderately sustainable), the infrastructure dimension of 32.14 (less sustainable), and the institutional legal dimension of 76.03 (sustainable). The results of the analysis show that there are still many things that need attention to improve the sustainability score, especially in dimensions that still get a small score.

Key words: Mangrove Mundu Ecotourism, RAPFISH, Sustainability Status

ABSTRAK

Ekowisata Mangrove Mundu terletak di Desa Mundu Pesisir, Kecamatan Mundu, Kabupaten Cirebon. Ekowisata merupakan bentuk wisata yang dikelola melalui pendekatan konservasi. Penelitian ini bertujuan untuk menganalisis status keberlanjutan ekowisata mangrove berdasarkan lima dimensi ekologi, ekonomi, sosial budaya, infrastruktur, dan hukum kelembagaan menggunakan pendekatan RAPFISH, mengidentifikasi atribut-atribut kritis yang mempengaruhi keberlanjutan, dan merumuskan strategi pengembangan ekowisata mangrove

di Desa Mundu Pesisir. Data dikumpulkan melalui survei lapangan, wawancara, dan kuesioner terhadap berbagai pemangku kepentingan, kemudian dianalisis menggunakan metode Multidimensional Scaling (MDS) melalui RAPFISH (Rapid Appraisal Technique for Evaluating Fisheries Sustainability). Hasil analisis keberlanjutan berdasarkan 5 dimensi yaitu dimensi ekologi sebesar 48,33 (kurang berkelanjutan, dimensi ekonomi 22,05 (tidak berkelanjutan), dimensi sosial budaya 53,13 (cukup berkelanjutan), dimensi infrastruktur 32,14 (kurang berkelanjutan), dan dimensi hukum kelembagaan 76,03 (berkelanjutan). Hasil analisis menunjukkan masih banyak hal yang perlu diperhatikan untuk memperbaiki nilai keberlanjutan, terutama pada dimensi yang masih mendapatkan skor kecil.

Kata Kunci: Ekowisata Mangrove Mundu, RAPFSIH, Status Keberlanjutan

INTRODUCTION

The mangrove ecosystem is one of the most unique and important ecosystems in the world. Located in tropical and subtropical coastal areas, this ecosystem consists of various types of vegetation that have special adaptations to survive in dynamic and often extreme environments (Prihadi, 2025). Mangrove ecosystems have numerous benefits for all aspects of life. Mangrove ecosystems are one of the ecosystems with high ecological and economic value. Ecologically, mangroves play a role in preventing abrasion, preventing seawater intrusion, serving as a feeding ground for biota, a nursery ground for biota, and a spawning ground for biota. Complex mangrove roots form a strong network on the underground surface, which can function as a natural barrier to protect the coast from abrasion, tidal waves, and storms (Zega *et al.,* 2024). In addition to ecological benefits, mangroves also have economic benefits. Wood from mangrove trees can be used as raw material for furniture, as a source of food, as a source of income for fishermen, for agriculture, and can be used for education and tourism.

Ecotourism is a type of travel that visits natural or cultural environments, with the aim of providing information and engaging with participants, and aims to ensure the sustainability of nature and socio-cultural life (Dian *et al.,* 2024). Ecotourism focuses on sustainable travel and educating tourists about nature. This encourages responsible activities within natural ecosystems, aimed at protecting the environment and benefiting local communities (Prihadi *et al.,* 2024). Ecotourism can be defined as a form of tourism managed through a conservation approach. Mangrove ecosystems are one ecosystem that can be utilized as ecotourism areas.

To develop and determine the sustainability status of mangrove ecotourism management, it can be assessed by balancing ecological, economic, socio-cultural, infrastructure, legal, and institutional dimensions. Therefore, an approach that can analyze sustainability comprehensively is necessary. According to Pitcher & Kavanagh (2004). RAPFISH is a fast, compact, and multidisciplinary assessment method, using simple, easy-to-assess attributes, thus this method is cost-effective in terms of quantitatively and qualitatively evaluating the sustainability of the fisheries and marine sectors through predetermined criteria and analyzed numerically based on the attribute values obtained (Eunike *et al.,* 2018).

RESEARCH METHODS

Time and Location of Research

This research was conducted at the Mundu Mangrove Ecotourism Area, Mundu Pesisir Village, Mundu District, Cirebon Regency, located at coordinates 6°46′16″S 108°34′58″E. Data collection was conducted between April and June 2025.

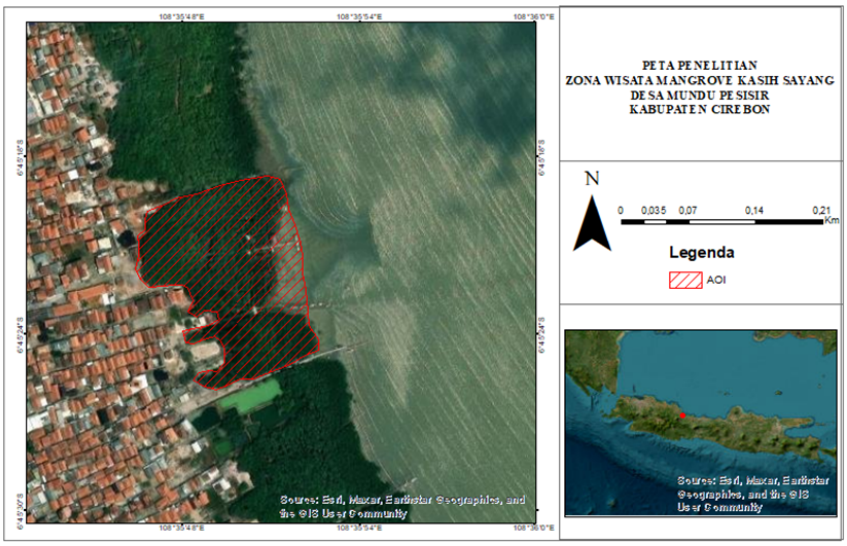

Figure 1. Research Location Map

Research Tools and Materials

The tools and materials used in this study include GPS, camera, roll meter, raffia rope, cloth meter, mangrove identification book used to collect mangrove data, then questionnaire form, and stationery used to fill out the questionnaire and interviews, as well as ArcGIS, Excel, Rapfish software used to process the data.

Data Collection

Ecological dimension data collection used primary and secondary data. Primary data collected included mangrove thickness, mangrove density, mangrove species, and biota. Secondary data included tidal data obtained from the Geospatial Information Agency. Mangrove thickness measurements were conducted manually using a roll meter. The thickness was measured from the outermost starting point from the seaward direction, then measured perpendicularly towards the land (Susi *et al.,* 2018). Biota data was collected directly at each station, simultaneously with data collection on mangrove species, and then identified.

The Line Transect and Sample Plot methods were used to measure and determine mangrove condition. This method involves sampling ecosystem populations using a sample plot approach along a line drawn along the ecosystem (Ministry of Environment, 2004). The line transect was drawn 50 m from the coastal area or beach inland. If the mangrove area was less than 50 m, the transect was drawn to the boundary of the last mangrove vegetation.

Data collection on the economic, socio-cultural, infrastructure, and institutional legal dimensions was carried out through questionnaires and interviews. A questionnaire is a data collection technique that includes systematically formulated questions. Respondents who are asked to complete the questionnaire will be asked to provide measurable responses through predetermined answer options (Ardiansyah *et al.,* 2023). The determination of respondents was carried out by purposive sampling with the criteria that respondents understand the problem and can make decisions directly related to mangrove ecotourism management. Interviews are a data collection technique that allows researchers and research participants to interact directly. Interviews aim to gain a deeper understanding of individual experiences, views, and perspectives related to the phenomenon being studied (Ardiansyah *et al.,* 2023). The number of respondents for the non-metric multidimensional scaling method has no fixed limit, but is adjusted again according to the population size. Therefore, the number of respondents was determined to be 30 people.

Table 1. Dimensions and Attributes of Sustainability

No	Dimensions of Sustainability	Sustainability Attributes
1	Ecology	1. Mangrove density 2. Mangrove thickness 3. Mangrove species 4. Biota objects 5. ups and down 6. Type of use land around the mangroves
2	Economy	1. Average income of local people 2. tourist visits 3. The contribution of mangroves to local communities 4. Productivity fishery 5. Utilization of mangrove ecosystem products 6. CSR funding support
3	Social culture	1. Knowledge community about mangroves 2. Awareness society about the importance of mangrove forests 3. Damage mangrove ecosystem by the community 4. Wisdom local / policy 5. Participation community in management mangrove forests 6. Conflict utilization mangrove forests
4	Infrastructure	1. Public facilities and infrastructure 2. Infrastructure telecommunications and information 3. Infrastructure conditions tourist 4. Mangrove trek 5. Access to the Location 6. Availability lodging
5	Law and institutions	1. Policy and planning management mangrove forests 2. Compliance to management rules 3. Monitoring and supervision 4. Giving sanctions for violators 5. Cooperation between institutions /stakeholders 6. The role of government

(Source: Yulianda, 2007 in Nugroho *et al.,* 2019; Hidayah *et al.,* 2024; Muhsimin *et al.,* 2018; Kuvaini *et al.,* 2019; Theresa *et al.,* 2015; Paembonan *et al.,* 2024; Ismane *et al.,* 2018)

Data Analysis

The analysis method used in this study is the Multidimensional Scaling (MDS) method with the Rapid Appraisal for Mangroves (RAPMangroves) approach, which is a modification of the Rapid Appraisal for Fisheries (RAPfish) program (Kavanagh & Pitcher, 2004). The basis of the RAPFISH method is the grouping of attribute score ordinations into several evaluation areas or dimensions using MDS (Hidayah *et al.,* 2024).

RESULT

Ecological Dimension

The results of the RAPFISH ordination of the ecological dimension obtained a sustainability index value of 48.33, indicating that the sustainability status for the ecological dimension is in the "less sustainable" category. This value indicates that there are several attributes in the ecological dimension that must be further improved to improve the sustainability status of the Mundu Mangrove ecotourism.

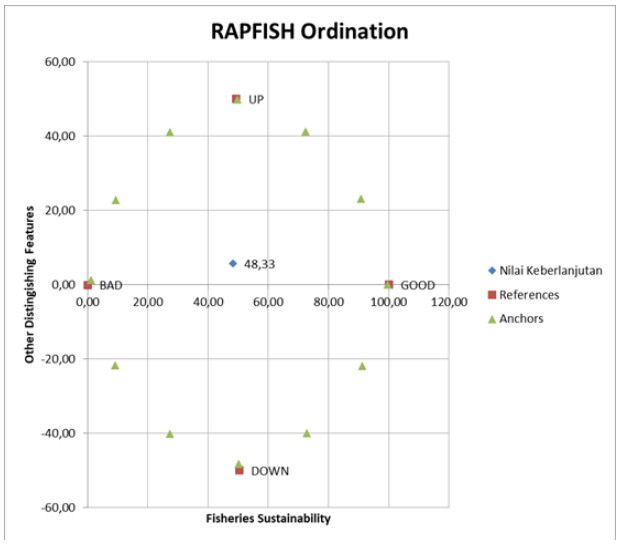

Figure 2. Results of Ecological Dimension Ordination

Based on the results of the ecological dimension leverage analysis, it was found that the most sensitive attribute to the sustainability score was the biota object, with the highest leverage value of 2.99. This proves that the presence and diversity of biota greatly determine the sustainability value of mangrove ecotourism areas. Biota diversity can reflect the level of ecosystem health, so a decrease in the value of this attribute can have a significant impact on the overall ecological status. According to research by Nurcholisudin *et al.* (2024), the potential of associated biota found in mangrove forest areas can be an additional attraction for tourists.

Economic Dimension

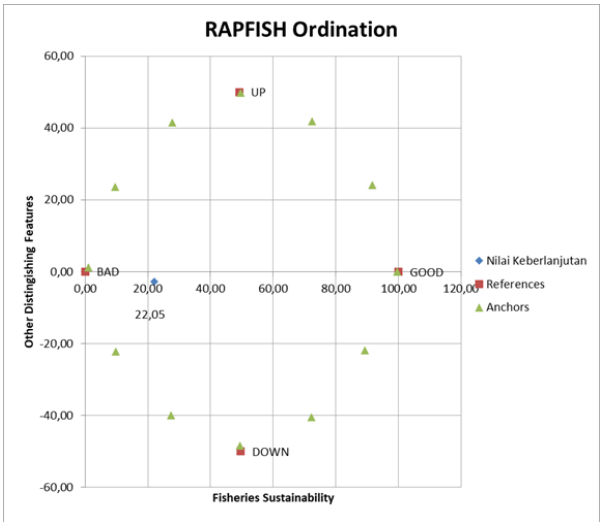

Figure 3. Results of the Economic Dimension Ordination

The RAPFISH ordination results for the economic dimension yielded a score of 22.05, indicating that the sustainability status for the economic dimension falls into the "unsustainable" category. This score indicates that the attributes in the economic dimension are very unsupportive of maintaining the sustainability of the Mundu Mangrove ecotourism area. Evaluation and improvement are needed to improve the sustainability status of the Mundu Mangrove ecotourism area.

Based on the leverage analysis of the economic dimension, the attribute with the highest influence on the sustainability score is "number of tourist visits," with an RMS value of 9.08. This indicates that the level of tourist visits is a major factor in supporting the local economy in the mangrove ecotourism area.

Socio-Cultural Dimension

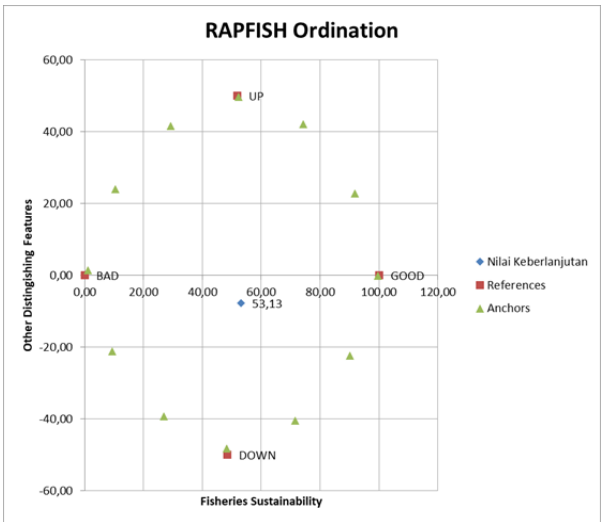

Figure 4. Results of Socio-Cultural Dimension Ordination

The RAPFISH ordination results for the Social dimension yielded a score of 53.13, placing the sustainability condition in this dimension in the "moderately sustainable" category. Several attributes supporting sustainability are present, but improvements and evaluation are still needed to achieve a more ideal level.

The leverage analysis of the Mundu Mangrove Ecotourism socio-cultural dimension revealed that the most sensitive and influential attribute on the sustainability score is community participation in mangrove forest management. This attribute also has the lowest score among the other attributes, with a Root Mean Square (RMS) value of 9.62.

Infrastructure Dimension

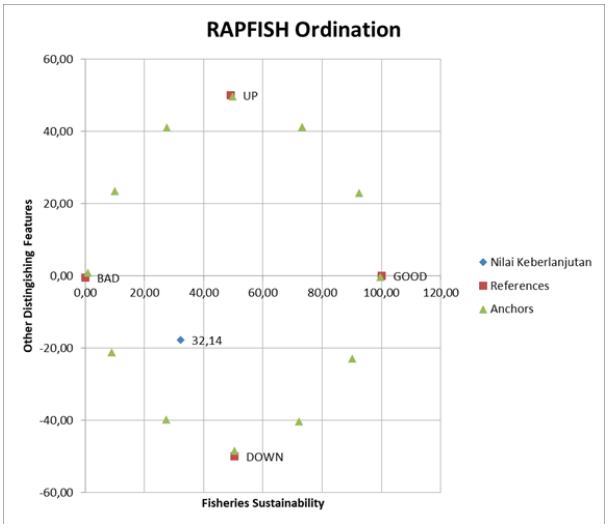

Figure 5. Results of Infrastructure Dimension Coordination

The RAPFISH ordination results for the Infrastructure dimension showed a sustainability index score of 32.14, which falls into the "less sustainable" category. This score indicates that the ecotourism area is not yet supported by adequate infrastructure, facilities, and infrastructure. Further evaluation and attention are needed to improve the sustainability score for this dimension.

The leverage analysis of the Mundu Mangrove Ecotourism infrastructure dimension revealed that the most sensitive and influential attribute on the sustainability score was the condition of tourism infrastructure, with a Root Mean Square (RMS) value of 6.96, followed by the telecommunications and information infrastructure attribute, which had a similar value of 6.75. These two attributes also had the lowest scores among the other attributes.

Legal and Institutional Dimensions

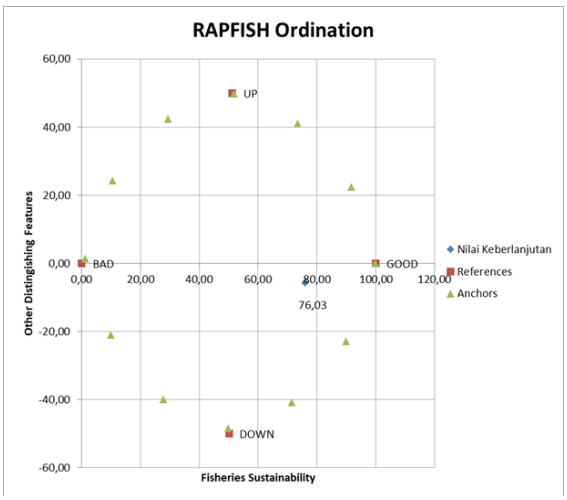

Figure 6. Results of the Ordinance of Legal and Institutional Dimensions

Based on the RAPFISH ordination results for the legal dimension shown in the figure above, a sustainability score of 76.03 was obtained, which is considered "sustainable." This

score is certainly excellent, but monitoring and development are still needed to maintain this positive score, or even improve it.

The leverage analysis of the legal and institutional dimensions of the Mundu Mangrove Ecotourism revealed three attributes with high and close RMS values: the attribute of imposing sanctions on violators (5.44), the attribute of compliance with management regulations (5.42), and the attribute of monitoring and supervision (5.29).

DISCUSSION

Ecological Dimension

Two attributes scored fairly well: mangrove density, with a value of 4, at 28.88 individuals/100 m2. This good density indicates relatively good mangrove vegetation and supports ecological functions, such as providing habitat for biota. Furthermore, the biota attribute, with a value of 3, featured several biota, including *Periopthalmus* sp. (glodok fish), *Scylla* sp. (mangrove crab), *Littoraria carinifera* (sea snail), and Ardeidae (egrets).

The attributes for thickness, mangrove species, tides, and land use, scored 2, which is quite low. Two mangrove species were found, *Rhizopora mucronata* and *Avicienna marina*, indicating low diversity, which could impact ecosystem stability. Thickness was measured from the outermost starting point from the seaward direction, then perpendicularly measured towards the mangrove land. The measurements showed a mangrove thickness of approximately 116 m, a score of 2, which is relatively low. This is due to the land use surrounding the mangroves being occupied by residential areas.

The tidal height at the Mundu Mangrove ecotourism site is 2.02 m, which is quite high. The tidal pattern in Cirebon waters is mixed semi-diurnal, meaning there are two high tides and two low tides per day, but with varying heights and periods (Arnol *et al.,* 2016). These high tides often cause tidal flooding, reaching residential areas.

Economic Dimension

RAPFISH analysis of the economic dimension shows that only the number of tourist visits and CSR funding support are quite good, while other attributes such as community income, mangrove contribution, fisheries productivity over the past five years, and utilization of mangrove ecosystem products remain low. The income of the people of Mundu Pesisir Village is below the minimum regional minimum wage, indicating that ecotourism's economic potential for improving welfare is not yet optimal. Tourist visits have begun to increase, but have not yet had a significant impact on the community, while the utilization of mangrove products is not sustainable.

Fishery productivity has declined since the operation of the coal-fired power plant, which is suspected of causing pollution and reducing fishermen's incomes. CSR funds are available, but utilization remains minimal due to a lack of planning and coordination, despite their potential to support infrastructure development, area rehabilitation, promotion, and business training.

To improve the situation, it is necessary to develop mangrove ecotourism-based MSMEs, utilize resources sustainably, and promote digitally through educational tour packages and innovative mangrove-based products. These efforts are expected to increase the number of tourists while positively impacting the local economy. Economic activities carried out by the local community can certainly help improve the welfare of the surrounding community (Lestari *et al.,* 2016).

Socio-Cultural Dimensions

The RAPFISH analysis results indicate that socio-cultural conditions are quite good. Community knowledge and awareness of mangroves scored high (3), indicating a good understanding of the importance of the mangrove ecosystem. Community damage to the ecosystem and conflicts over resource use were also low (score 4). However, problems remain, including weak policy implementation and local wisdom (score 2), as well as the presence of household waste in mangrove areas.

To improve sustainability, revitalization of local wisdom with government support is necessary, for example, through village regulations, such as the sasi tradition in West Seram. Community participation also needs to be strengthened through the establishment of local institutions such as the Community-Based Community Development Group (POKMASWAS) or Community-Based Community Development Group (POKDARWIS), as is the best practice in Bunaken. Furthermore, ongoing education is crucial for maintaining socio-cultural awareness while also opening up new economic opportunities for the community.

Infrastructure Dimension

The RAPFISH analysis of the infrastructure dimension shows that most attributes remain weak. Telecommunications infrastructure was deemed unavailable (score 1), and poorly maintained infrastructure also received a low score. Roads to the location are still poor, supporting facilities such as food stalls and clean water are limited, and access to digital information and promotions is minimal, making it difficult for tourists to obtain information.

Public facilities and infrastructure such as toilets, information boards, trash cans, and parking areas are present, but their quantity and quality are inadequate (score 2). Mangrove trails are available, but many points are damaged, posing a danger to visitors. Access to the location is still hampered by dense settlements, resulting in a low score. However, one attribute was rated good, namely the availability of accommodation with a score of 4, indicating that accommodation is sufficiently varied and readily available.

This situation confirms that infrastructure, particularly basic tourism facilities and information and telecommunications, is a key factor in ecotourism sustainability. Improvements require the construction and maintenance of basic facilities, revitalization of the mangrove trails, improved access to the location, and development of digital promotions through websites and social media. This effort requires collaboration between village governments, ecotourism managers, tourism agencies, and private sector CSR support. Digital channels can facilitate access for the public and tourists to information and data about ecotourism and can serve as a promotional tool for the destination itself (Jatiningrum *et al.,* 2023). According to research by Sembiring *et al.* (2020), the development of mangrove ecotourism facilities and infrastructure can be a factor in attracting more visitors.

Legal and Institutional Dimensions

The RAPFISH analysis results indicate that the legal and institutional dimensions are quite good, although there are still areas for improvement. Management policies and planning received a score of 3, indicating a legal basis or local strategy is in place, but implementation is not yet consistent. Compliance with regulations also received a score of 3, indicating adequate public and tourist awareness. Meanwhile, monitoring and supervision, as well as sanctions for violators, received a high score of 4, thanks to the presence of the Community Empowerment Group (POKMASWAS) and the active role of management.

The collaboration attribute between institutions/stakeholders was rated quite good with a score of 3, and the government's role was rated strong with a score of 4, indicating effective collaboration between relevant parties. The leverage analysis confirmed that sanctions for

violators are the most influential factor in sustainability, as firm law enforcement can increase compliance and build positive perceptions of tourists.

Therefore, strengthening the legal and institutional systems, particularly the aspects of rule enforcement and sanctions, is a key strategy in supporting the sustainability of the Mundu Mangrove Ecotourism.

CONCLUSION

The sustainability status score is based on five dimensions: the ecological dimension (48.33) (less sustainable), the economic dimension (22.05) (unsustainable), the socio-cultural dimension (53.13) (moderately sustainable), the infrastructure dimension (32.14) (less sustainable), and the legal and institutional dimension (76.03) (sustainable). Leverage analysis shows that the attributes most influential in each dimension of sustainability include biota objects in the ecological dimension, the number of tourist visits in the economic dimension, community participation in mangrove management in the socio-cultural dimension, the condition of tourism infrastructure in the infrastructure dimension, and sanctions for violators in the legal and institutional dimensions. These attributes require special attention because changes in their values significantly impact sustainability status. Development strategies will naturally prioritize dimensions with low sustainability scores. Proposed development strategies include improving tourism facilities and infrastructure, strengthening the role of the community through institutional collaboration, and utilizing CSR funds as an alternative financing source. Furthermore, ongoing education and training are needed to increase public awareness and knowledge about the benefits of mangrove ecotourism and the importance of ecosystem preservation.

ACKNOWLEDGEMENTS

The author would like to express his gratitude to the lecturers and students of the Faculty of Fisheries and Marine Sciences, Padjadjaran University, who assisted in the research and writing of this scientific paper.

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