Perceived Seagrass Ecosystem Services and Community Support for Conservation: A PLS-SEM Approach in Coastal Communities of Soropia, Indonesia

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Abstract
Seagrass ecosystems provide essential ecological and socio-cultural benefits that contribute to coastal resilience and community well-being. However, conservation success depends not only on ecological restoration but also on how communities perceive ecosystem services and translate these perceptions into conservation support. This study aims to examine coastal communities' perceptions of seagrass ecosystem services and investigate the structural relationships between perceived ecosystem benefits and support for seagrass conservation. A quantitative survey was conducted among 188 coastal residents in Soropia District, Southeast Sulawesi, Indonesia. Data were analyzed using descriptive statistics and Partial Least Squares Structural Equation Modeling (PLS-SEM) to evaluate the influence of coastal protection, nursery ground functions, water quality regulation, and aesthetic values on conservation support. The results showed that all dimensions of seagrass ecosystem services were perceived at a very high level, with perception scores ranging from 80.51% to 88.96%. The nursery ground function received the highest perception score, while water quality regulation was the least recognized service. The structural model revealed that coastal protection ($\beta = 0.178$; $p = 0.041$) and aesthetic value ($\beta = 0.335$; $p = 0.003$) significantly influenced conservation support, whereas nursery ground and water quality regulation showed positive but non-significant effects. These findings demonstrate that community conservation support is more strongly driven by ecosystem benefits that are directly observable and socially relevant. Strengthening community-based seagrass conservation strategies should therefore integrate visible ecosystem benefits with improved awareness of less tangible ecological functions.

Keywords: Seagrass ecosystem, Ecosystem services, Community perception, Conservation support; PLS-SEM

1. Introduction

Seagrass meadows are one of the most important coastal ecosystems that play a crucial role in maintaining the sustainability of marine social-ecological systems. These ecosystems provide a wide range of ecosystem services that support human well-being, including providing habitats for marine organisms, enhancing fisheries productivity, protecting coastal areas from wave energy, and improving water quality. Beyond their ecological functions, seagrass ecosystems also hold significant social and economic values due to their direct connection with the livelihoods of coastal communities that depend on marine resources [1].

However, seagrass ecosystems worldwide continue to experience increasing pressures due to anthropogenic activities, including coastal development, pollution, unsustainable fishing practices, and environmental changes. Previous studies have demonstrated that successful seagrass conservation depends not only on ecological restoration efforts but also on active community involvement as resource users and coastal ecosystem managers. Limited public understanding of the ecological values and functions of seagrass ecosystems remains one of the major challenges in achieving sustainable seagrass conservation [2].

The urgency of seagrass conservation has become increasingly important as these ecosystems face multiple anthropogenic pressures and environmental changes. Numerous studies have reported declines in seagrass coverage and increasing degradation caused by coastal development, fishing activities, pollution, and climate-related impacts. Indonesia represents a significant region in this context because it possesses extensive seagrass meadows while simultaneously facing substantial pressures from coastal resource utilization. [3] reported that seagrass conditions in Eastern Indonesia were categorized as healthy in only 25% of observed areas, while 67%

were classified as less healthy. Therefore, the success of seagrass conservation is determined not only by ecological conditions but also by the extent to which communities understand seagrass benefits, perceive these benefits as relevant to their livelihoods, and provide support for conservation initiatives [2].
Within the framework of social-ecological systems, the relationship between humans and ecosystems is shaped not only by biophysical conditions but also by interactions among ecosystem characteristics, community experiences, and the ways in which people perceive and value ecosystem benefits [4]. From an ecosystem services perspective, community perceptions of ecological benefits serve as an important link between ecosystem functions and social responses toward conservation efforts[5], [6]. Particularly for seagrass ecosystems, stakeholder perceptions of ecosystem services have been identified as an important factor in supporting community-based governance and conservation strategies [7]. Furthermore, [8] demonstrated that community perceptions of fisheries-related functions and coastal protection services were associated with local engagement in seagrass restoration activities.
Previous studies have investigated community perceptions of seagrass ecosystem services through approaches focusing on environmental knowledge, awareness, and assessments of socio-economic benefits. [1] demonstrated that the perceived social values of seagrass ecosystem services vary depending on geographical contexts and community characteristics, indicating that perceptions of seagrass benefits are not uniform across different regions. [7] found that stakeholder perceptions of seagrass ecosystem services play an important role in supporting conservation management, particularly when ecosystem benefits are directly connected to community well-being. However, these studies primarily employed exploratory approaches to understand perceptions and governance processes, without quantitatively examining the relative contribution of individual ecosystem service dimensions to conservation support.
Furthermore, [9], [10] revealed that communities tend to better recognize direct ecosystem benefits, such as fisheries support and nursery ground functions, compared with indirect regulatory services such as coastal protection and water quality improvement. Nevertheless, it remains unclear how variations in perceptions across different ecosystem service dimensions simultaneously influence community support for seagrass conservation. [11] further highlighted that limited public awareness regarding seagrass ecosystem services in Indonesia affects resource utilization patterns and community participation in conservation initiatives aimed at protecting these ecosystems. Therefore, strengthening community involvement is essential for achieving effective and sustainable conservation outcomes.
Previous studies have demonstrated that communities recognize various ecosystem services provided by seagrass meadows, including fisheries support, coastal protection, and environmental regulation. However, most existing studies have focused primarily on identifying perceived benefits or measuring levels of environmental awareness rather than determining which specific ecosystem service dimensions significantly influence conservation support. Consequently, the mechanisms through which perceived ecosystem services are translated into community conservation support remain insufficiently understood.
This study addresses this knowledge gap by developing a structural model using Partial Least Squares Structural Equation Modeling (PLS-SEM) to identify the relative contributions of different seagrass ecosystem service dimensions in predicting community support for conservation. This analytical approach enables a deeper understanding of the structural relationships between community perceptions of ecosystem services and conservation support.
Therefore, this study aims to: (1) identify coastal communities' perceptions of seagrass ecosystem services; and (2) analyze the structural relationships between perceptions of coastal protection functions, nursery ground functions, water quality regulation, and aesthetic values with community support for seagrass conservation.

2. Materials and Methods

2.1 Study Area and Research Period

This study was conducted from June to July 2026 in Soropia District, Konawe Regency, Southeast Sulawesi, Indonesia. The study area consists of 14 coastal villages/sub-districts, namely Toronipa Urban Village, Mekar Village, Bajo Indah, Bajoe, Atowatu, Tapulaga, Waworaha, Bokori, Leppe, Sorue Jaya, Soropia, Sawapudo, Talaga Biru, and Saponda Laut. The study area was selected due to its strong social-ecological relationship with the presence of seagrass ecosystems, particularly through community activities that depend on and utilize coastal resources. The research population consisted of coastal communities with experience, interactions, or livelihoods associated with seagrass ecosystems and surrounding coastal areas.

2.2 Research Design and Sampling Procedure

This study employed a quantitative approach with an explanatory survey design. This approach was used to identify community perceptions of seagrass ecosystem services and to examine the structural relationships between perceptions of seagrass benefits and community support for conservation. Respondents were selected using a purposive sampling technique, meaning that the interpretation of the findings is directed toward empirical evidence from the selected respondent group and is not intended to provide statistical estimates for the entire coastal community population. A total of 188 respondents participated in this study. The inclusion criteria required respondents to be coastal residents who obtained benefits from seagrass ecosystems, particularly through fishing activities conducted within seagrass-associated areas. The sample size was considered adequate based on the minimum requirements for Partial Least Squares Structural Equation Modeling (PLS-SEM) analysis, which recommends determining sample size based on statistical power and model complexity [12].

2.3 Research Instrument and Instrument Validation

The research instrument was developed to measure community perceptions of seagrass ecosystem benefits based on the ecosystem services approach. The research model consisted of four exogenous constructs, namely coastal protection, nursery ground functions, water quality regulation, and aesthetic and beauty values, with seagrass conservation support as the endogenous construct. The development of these constructs was based on previous studies related to coastal ecosystem services and community conservation behavior (Ruiz-Frau et al., 2019; Amone-Mabuto et al., 2023b). All constructs were specified as reflective constructs, as the observed indicators represent manifestations of the underlying latent perceptions.

Table 1: Variables/Constructs and Research Instrument Indicators

Variables/Constructs	Research Indicators	Measurement Scale
Coastal Protection [13]	Seagrass helps reduce coastal erosion (PP1)	Likert 1-5
	Seagrass helps reduce the strength of ocean waves (PP2)	
	Seagrass helps maintain coastal stability (PP3)	
	Seagrass degradation can increase coastal erosion (PP4)	
Nursery Ground [13], [10]	Seagrass provides habitat and nursery areas for juvenile fish (NG1)	Likert 1-5
	Seagrass helps increase fishermen's catch yields (NG2)	
	Seagrass degradation can reduce marine biodiversity (NG3)	
	Communities benefit from fishery resources associated with seagrass ecosystems (NG4)	
Water Quality Regulation [2]	Seagrass helps maintain marine water clarity (KA1)	Likert 1-5
	Seagrass helps absorb pollutants in coastal waters (KA2)	
	Seagrass helps maintain the balance of coastal ecosystems (KA3)	
	Seagrass condition reflects the quality of the marine environment (KA4)	
Aesthetic Value and Beauty [13]	Seagrass enhances the beauty of coastal areas (EK1)	Likert 1-5
	Seagrass has potential to support marine tourism (EK2)	
	Seagrass conservation increases coastal attractiveness (EK3)	
	Healthy seagrass ecosystems are attractive for visitors (EK4)	
Conservation Awareness and Support [7]	Seagrass conservation is a shared responsibility (DK1)	Likert 1-5
	Communities are willing to participate in seagrass conservation efforts (DK2)	
	Seagrass education is important for communities (DK3)	
	Seagrass degradation can affect coastal community livelihoods (DK4)	
	Seagrass conservation is important for future generations (DK5)	

Each indicator was measured using a five-point Likert scale, ranging from 1 = strongly disagree to 5 = strongly agree. Prior to the main data collection, the research instrument was evaluated to ensure the validity and reliability of the measurements. Indicator validity was assessed using the Corrected Item-Total Correlation value, where a value of ≥ 0.30 indicates that the item provides an adequate contribution to the measured construct [14], [15]. The reliability of the instrument was evaluated using Cronbach's Alpha, with a value of ≥ 0.70 indicating acceptable internal consistency. The interpretation of Cronbach's Alpha values followed the criteria proposed by [16] and [17], where values ranging from 0.70-0.80 are categorized as acceptable, 0.80-0.90 as good, and ≥ 0.90 as excellent.

The validation results demonstrated that all constructs met the required validity and reliability criteria. The Corrected Item-Total Correlation values for all indicators exceeded 0.30, while the Cronbach's Alpha values for all constructs were above 0.70 (Table 2). These findings indicate that the instrument had adequate measurement quality and was suitable for further analysis using Partial Least Squares Structural Equation Modeling (PLS-SEM).

Table 2: Results of Research Instrument Testing

Construct	Rentang Corrected Item-Total Correlation	Cronbach's Alpha	Interpretation
Coastal Protection	0.677-0.769	0.875	Valid and reliable (good)
Nursery Ground	0.332-0.621	0.719	Valid and reliable (acceptable)
Water Quality	0.378-0.623	0.704	Valid and reliable (acceptable)
Aesthetic Value and Beauty	0.507-0.684	0.777	Valid and reliable (acceptable)
Conservation Support	0.306-0.585	0.704	Valid and reliable (acceptable)

2.4 Data Analysis

2.4.1 Analysis of Community Perceptions toward Seagrass Ecosystem Benefits

Community perceptions of seagrass ecosystem benefits were analyzed using a quantitative descriptive approach. Descriptive analysis was employed to describe the level of understanding, evaluation, and attitudinal tendencies of coastal communities toward seagrass ecosystem services, including coastal protection functions, nursery ground functions, water quality regulation, aesthetic values, and seagrass conservation support. A Likert-scale-based perception analysis approach has been widely applied in coastal social-ecological studies because it enables the systematic quantification of community assessments regarding ecosystem benefits [18].

The perception measurement instrument consisted of a questionnaire using a five-point Likert scale. Each respondent was asked to evaluate statements representing the benefits of seagrass ecosystems, with a score of 5 for strongly agree, 4 for agree, 3 for moderately agree, 2 for disagree, and 1 for strongly disagree. The scores of each indicator were subsequently calculated to obtain the perception value for each dimension of seagrass ecosystem services. The community perception index was calculated using the percentage approach of the observed score relative to the maximum possible score, using the following equation: $IP = (\Sigma X/Xmaks) \times 100\%$, where IP represents the community perception index (%), ΣX represents the total actual score obtained from all respondents, and Xmax represents the maximum possible score. This maximum-score-based index approach is commonly used in Likert-scale perception studies to transform ordinal response scores into percentage values, thereby facilitating the interpretation of respondent acceptance levels [19], [20].

The perception index values were categorized into five levels based on the following intervals: 80-100% (very high), 60-79.99% (high), 40-59.99% (moderate), 20-39.99% (low), and 0-19.99% (very low). This classification follows the Likert index interpretation approach commonly applied in community perception survey research [20]

The results of the perception analysis were presented as the mean percentage values for each indicator and ecosystem service dimension. This analysis was used to identify which seagrass benefits were most recognized by local communities and which ecological aspects require further strengthening through environmental education and community-based conservation strategies. This approach is consistent with previous studies on coastal ecosystem perceptions, which demonstrate that community understanding of ecosystem services can serve as an important foundation for developing more participatory ecosystem management and conservation strategies [18].

2.4.2 Structural Relationship Analysis between Seagrass Benefit Perceptions and Conservation Support

The structural relationships between perceptions of seagrass ecosystem benefits and conservation support were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) with the assistance of SmartPLS 4 software. The PLS-SEM approach was selected because it enables the simultaneous analysis of relationships among latent constructs and is suitable for exploratory research involving complex models with multiple predictor variables [12], [21]. The model evaluation was conducted in two stages. The first stage involved the evaluation of the measurement model (outer model), which included convergent validity, discriminant validity, and construct reliability assessments. Convergent validity was evaluated based on outer loading values and the Average Variance Extracted (AVE), while construct reliability was assessed using Cronbach's alpha and composite reliability values.

The second stage involved the evaluation of the structural model (inner model) through the assessment of the coefficient of determination (R^2), path coefficients, and the significance of hypothesized relationships using the bootstrapping procedure. This study formulated four hypotheses to examine the effects of different seagrass ecosystem service dimensions on conservation support:

H1: Coastal protection has a positive effect on conservation support.
H2: Nursery ground functions have a positive effect on conservation support.
H3: Water quality regulation has a positive effect on conservation support.
H4: Aesthetic values have a positive effect on conservation support.

3. Results

3.1 Community Perceptions of Seagrass Ecosystem Services and Conservation Support

The assessment results indicated that community perceptions of seagrass ecosystem benefits were categorized as very high across all analyzed dimensions. The average perception scores ranged from 80.51% to 88.96%. The dimension with the highest perception score was the nursery ground function (88.96%), followed by conservation support (87.28%), coastal protection function (84.97%), aesthetic value and beauty (80.98%), and water quality regulation (80.51%).

Table 3 : Mean Community Perception Scores for Each Dimension of Seagrass Ecosystem Services

No.	Seagrass Ecosystem Service Dimension	Mean Perception Score (%)	Category
1	Nursery ground	88.96	Very high
2	Conservation support	87.28	Very high
3	Coastal protection	84.97	Very high
4	Aesthetic Value and Beauty	80.98	Very high
5	Water Quality	80.51	Very high

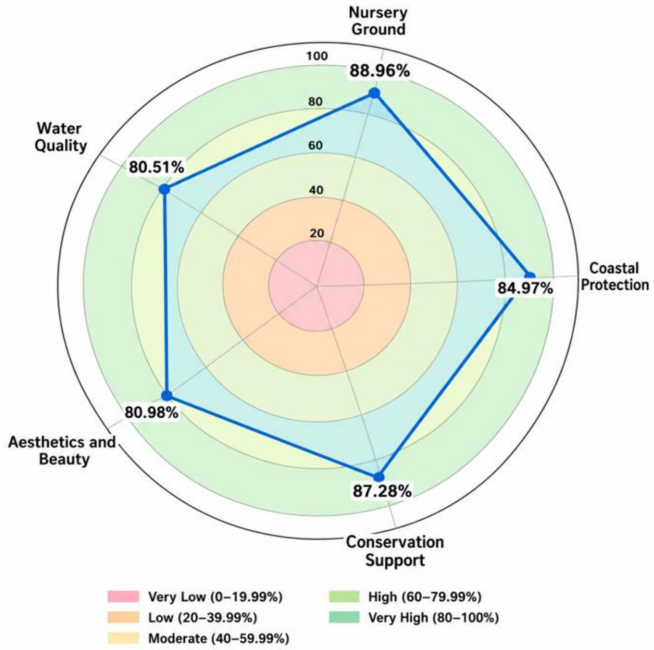

Figure 1: Community Perceptions of Seagrass Ecosystem Services and Conservation Support

3.1.1 Variations in Community Perceptions of Seagrass Benefits

Indicator-level analysis revealed clearer variations compared with the average values across ecosystem service dimensions. The calculated indicator scores ranged from 72.45% to 91.81%. The highest score was found for the indicator representing seagrass as a habitat for juvenile fish and marine organisms within the nursery ground dimension, whereas the lowest score was recorded for the indicator related to the ability of seagrass to absorb pollutants or excess nutrients in coastal waters within the water quality regulation dimension.

Within the nursery ground dimension, all indicators showed relatively high scores, ranging from 87.23% to 91.81%. The highest score in this dimension was associated with the perception that seagrass ecosystems serve as nursery habitats for juvenile fish and other young marine organisms. Meanwhile, within the conservation support dimension, indicator scores ranged from 84.36% to 90.21%, with the highest value observed for the perception that seagrass conservation represents a shared responsibility between governments and local communities.

Greater variation was observed in the water quality regulation dimension. Indicator scores within this dimension ranged from 72.45% to 87.77%. The indicator related to the absorption of pollutants or excess nutrients received the lowest score, while the other indicators showed relatively higher values. In the aesthetic value and beauty dimension, scores ranged from 75.53% to 84.57%, with perceptions regarding the potential role of seagrass ecosystems in supporting marine tourism representing one of the lowest scores among all assessed indicators.

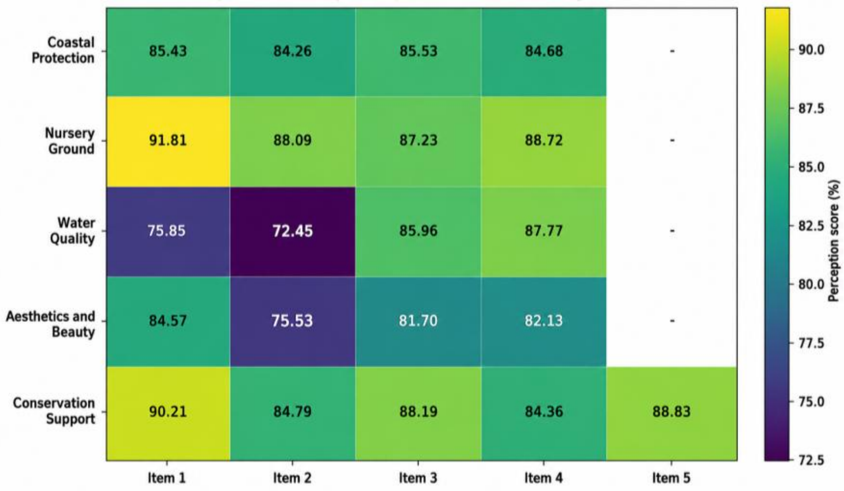

Figure 2 : Heatmap Visualization of Community Perceptions across Different Seagrass Ecosystem Service Indicators

3.1.2 Highest and Lowest Perception Indicators

The results showed that community perceptions of seagrass ecosystem benefits were categorized as high, with indicator scores ranging from 72.45% to 91.81%. The indicator with the highest perception score was the function of seagrass ecosystems as nursery habitats for juvenile fish and marine organisms (nursery ground), with a score of 91.81%. This finding indicates that communities have recognized the important role of seagrass ecosystems in supporting the sustainability of fisheries resources. Furthermore, conservation support indicators also showed high perception values, particularly regarding the perception that seagrass conservation represents a shared responsibility between governments and local communities (90.21%) and that seagrass conservation is important for the well-being of future generations (88.83%). Conversely, the lowest perception scores were found in the water quality regulation dimension, particularly regarding the ability of seagrass ecosystems to absorb pollutants or excess nutrients in coastal waters (72.45%) and maintain seawater clarity (75.85%).

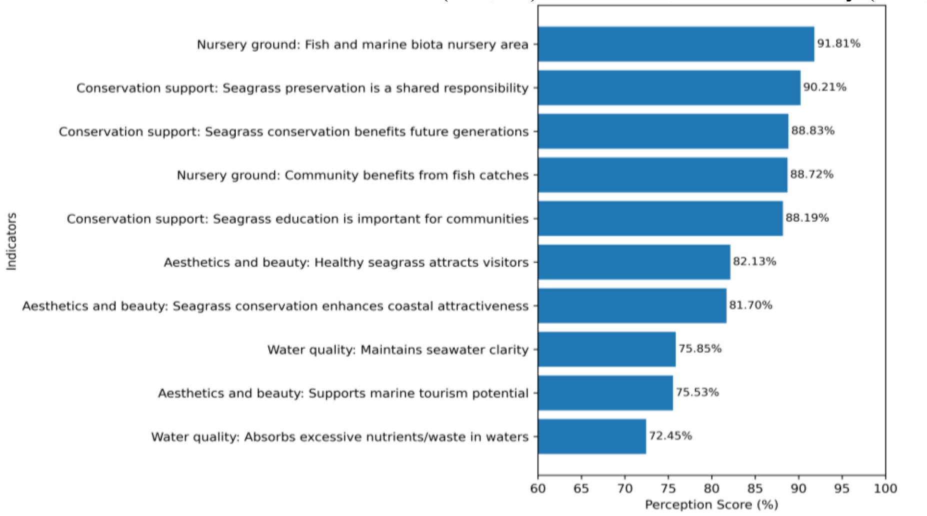

Figure 3 : Ranking of Community Perception Indicators for Seagrass Ecosystem Benefits from Highest to Lowest Scores

3.2 Structural Relationship between Perceived Benefits of Seagrass Ecosystems and Conservation Support

The research model consisted of four exogenous constructs, namely coastal protection, nursery ground, water quality, and aesthetic value and beauty, which were tested for their effects on the endogenous construct, namely conservation support. The latent variable model of the study is presented in Figure 4.

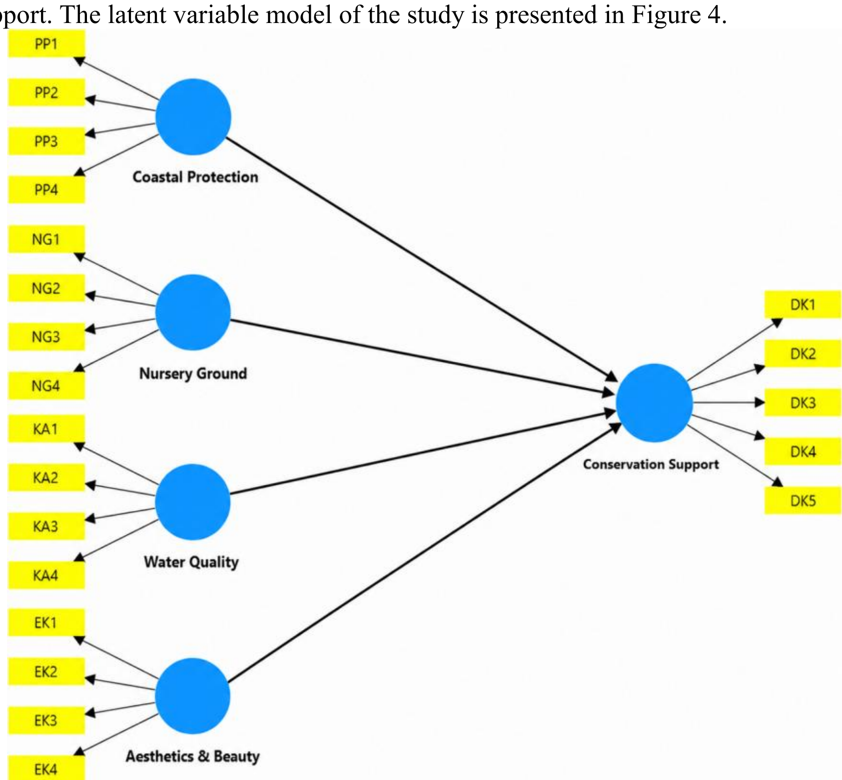

Figure 4 : Latent Variable Model of Community Perceptions of Seagrass Ecosystem Services

3.2.1 Evaluasi Model Pengukuran (Outer Model)

3.2.1.1 Convergent Validity

The evaluation of the outer model was conducted to ensure that the indicators used were valid and reliable in measuring the latent constructs. The assessment included convergent validity, discriminant validity, and construct reliability. Convergent validity was evaluated based on the loading factor values and the Average Variance Extracted (AVE). Indicators with loading factor values below 0.70 were removed, and the model was re-evaluated [12], [21]. The initial assessment showed that several indicators did not meet the validity criteria; therefore, model adjustments were performed. The final evaluation results showed that all retained indicators had loading factor values above 0.70, indicating that the indicators adequately represented the respective latent constructs.

Table 4 : Outer Loading Uji Convergent Validity Tahap Akhir

Construct	Indicator	Loading Factor	Interpretation
Conservation support	DK2	0.818	Valid
	DK3	0.829	Valid
	DK5	0.767	Valid
Aesthetic Value and Beauty	EK2	0.799	Valid
	EK3	0.798	Valid
	EK4	0.855	Valid
Water Quality	KA3	0.936	Valid
	KA4	0.846	Valid
Nursery Ground	NG1	0.753	Valid
	NG2	0.754	Valid
	NG4	0.896	Valid
Coastal protection	PP1	0.793	Valid
	PP2	0.875	Valid
	PP3	0.840	Valid

SmartPLS 4, Partial Least Squares Structural Equation Modeling (PLS-SEM)

The Average Variance Extracted (AVE) values for all constructs also met the criteria for convergent validity. The AVE values ranged from 0.646 to 0.796, with the highest value observed in the water quality regulation construct (0.796) and the lowest value found in the nursery ground construct (0.646). All constructs had AVE values greater than the minimum threshold of 0.50, indicating that each construct was able to explain an adequate proportion of variance in its associated indicators.

Table 5 : Average Variance Extracted (AVE) Values

Construct	Average Variance Extracted (AVE)	Interpretation
Conservation support	0.648	Valid
Aesthetic Value and Beauty	0.669	Valid
Water Quality	0.796	Valid
Nursery Ground	0.646	Valid
Coastal protection	0.723	Valid

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3.2.1.2 Discriminant Validity

Discriminant validity was assessed to ensure that each construct in the research model had distinct empirical characteristics and that no substantial overlap existed among constructs. The assessment was conducted using three approaches: cross-loading analysis, latent variable correlation analysis, and the Fornell-Larcker criterion.

The evaluation results showed that all indicators had higher loading values on their respective constructs compared with other constructs. Furthermore, the Average Variance Extracted (AVE) value of each construct was greater than the squared correlations among constructs, and all constructs fulfilled the Fornell-Larcker criterion [12]. Therefore, the measurement model was confirmed to achieve adequate discriminant validity.

Table 6 : Summary of Discriminant Validity Assessment Results

Method	Evaluation Results	Conclusion
Cross Loading	Indicator loadings on their respective constructs were higher than those on other constructs	Valid
Latent Variable Correlation	The square root of AVE values was greater than the correlations among constructs	Valid
Fornell-Larcker	All constructs met the √AVE criterion	Valid

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3.2.1.3 Construct Reliability

Construct reliability was assessed using Cronbach's Alpha and Composite Reliability values. The analysis results showed that all constructs had reliability values above the recommended minimum threshold. This indicates that the research instrument demonstrated good internal consistency. The Cronbach's Alpha values ranged from 0.737 to 0.825, while the Composite Reliability values ranged from 0.729 to 0.908 [12], [21]. The coastal protection construct showed the highest reliability level, with a Composite Reliability value of 0.908, whereas the conservation support construct had the lowest Composite Reliability value of 0.729.

Tabel 7 : Construct Reliability Assessment

Construct	Cronbach Alpha	Composite Reliability	Interpretation
Conservation support	0.737	0.729	Reliable
Aesthetic Value and Beauty	0.764	0.802	Reliable
Water Quality	0.771	0.846	Reliable
Nursery Ground	0.755	0.843	Reliable
Coastal protection	0.825	0.908	Reliable

SmartPLS 4, Partial Least Squares Structural Equation Modeling (PLS-SEM)

3.2.1.4 Model Fit Assessment

Model fit evaluation was conducted to assess the degree of agreement between the proposed research model and the empirical data. The assessment results showed that all model fit parameters met the recommended acceptance criteria. The Standardized Root Mean Square Residual (SRMR) value was 0.083, the d_ULS value was 0.823, the d_G value was 0.352, and the Normed Fit Index (NFI) value was 0.701, indicating that the model achieved an acceptable level of fit. Furthermore, the Chi-square value showed a statistical value of 218.831, which was lower than the reference value of 391.781. Therefore, the proposed model was considered to have an acceptable level of goodness-of-fit and was suitable for further structural model analysis [12].

Tabel 8 : Model Fit Assessment Results

Parameter	**Rule of Thumb**	**Saturated model**	**Interpretation**
SRMR	< 0.10	0.083	Fit
d_ULS	> 0.05	0.823	Fit
d_G	> 0.05	0.352	Fit
Chi-square	χ^2 statistik $\geq \chi^2$ tabel	391.781 > 218.831	Fit
NFI	Mendekati nilai 1	0.701	Fit

SmartPLS 4, Partial Least Squares Structural Equation Modeling (PLS-SEM)

3.2.2 Structural Model Evaluation (Inner Model)

3.2.2.1 Coefficient of Determination (R^2)

The explanatory power of the model in predicting the endogenous construct was evaluated using the coefficient of determination (R^2). The analysis results showed that the conservation support construct had an R^2 value of 0.407 and an Adjusted R^2 value of 0.394. These results indicate that the perceived seagrass ecosystem benefits included in the model explained 40.7% of the variance in community conservation support, while the remaining 59.3% was explained by other factors outside the proposed research model.

Tabel 9 : Hasil Uji R Square

Endogenous Construct	R^2	Adjusted R^2
Conservation support	0.407	0.394

SmartPLS 4, Partial Least Squares Structural Equation Modeling (PLS-SEM)

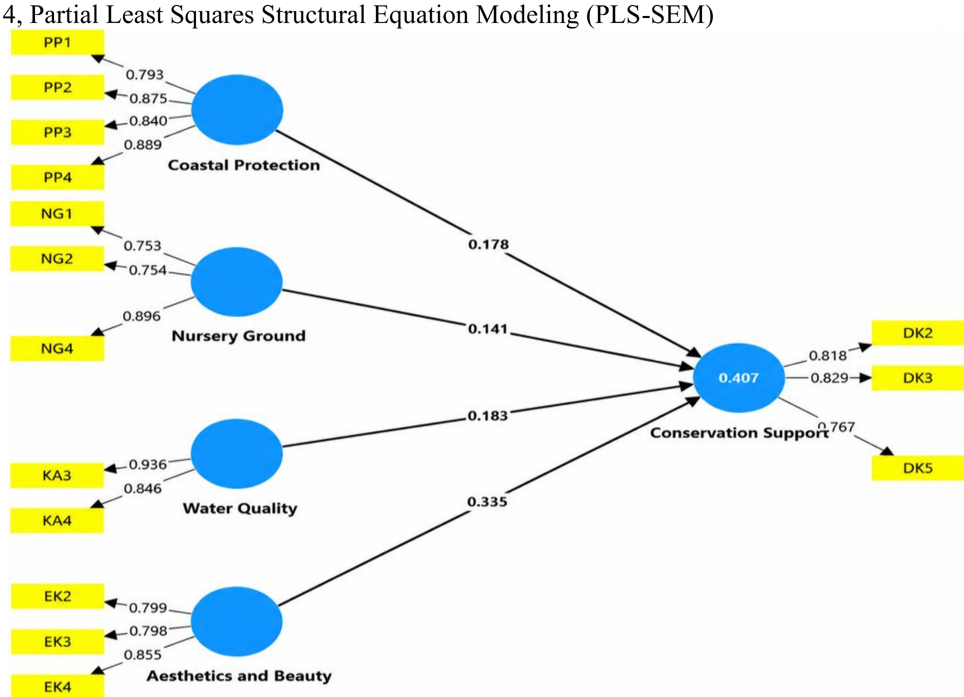

Figure 5. Structural Model Output Generated by the PLS-SEM Algorithm

3.2.2.2 Hypothesis Testing

The results of the structural model assessment showed that, among the four hypotheses tested, two hypotheses were statistically supported, namely the effects of coastal protection and aesthetic value on conservation support. Coastal protection had a positive and significant effect on conservation support, with a path coefficient of 0.178 (t-statistic = 2.040; p-value = 0.041), indicating that H1 was supported. In contrast, the nursery ground function showed a positive but non-significant relationship with conservation support (path coefficient = 0.141; t-statistic = 1.692; p-value = 0.091), indicating that H2 was not supported. Similarly, water quality regulation exhibited a positive but non-significant relationship with conservation support (path coefficient = 0.183; t-statistic = 1.600; p-value = 0.110), indicating that H3 was not supported. Meanwhile, aesthetic value and beauty showed a positive and significant effect on conservation support, with a path coefficient of 0.335 (t-statistic = 2.950; p-value = 0.003), indicating that H4 was supported. Overall, these findings indicate that coastal protection functions and aesthetic values are significant factors contributing to community support for seagrass conservation.

Tabel 10 : Path Coefficient Bootstrapping Results for Direct Effects

Construct Relationship	Original Sample	Standard deviation (STDEV)	T-statistic (>1.96)	P-value (<0.05)	Decision
Aesthetic Value and Beauty → Conservation Support	0.335	0.114	2.950	0.003	Supported
Water Quality Regulation → Conservation Support	0.183	0.114	1.600	0.110	Not Supported
Nursery Ground → Conservation Support	0.141	0.083	1.692	0.091	Not Supported
Coastal Protection → Conservation Support	0.178	0.087	2.040	0.041	Supported

SmartPLS 4, Partial Least Squares Structural Equation Modeling (PLS-SEM)

4. DISCUSSION

4.1 High Perceptions of Seagrass Ecosystem Services Do Not Always Predict Conservation Support

This study demonstrates that communities have very high perceptions of various seagrass ecosystem services, with all assessed dimensions obtaining scores above 80%. The high level of community perception indicates that seagrass ecosystems are recognized as providing important ecological and social benefits. This finding is consistent with [22], who reported that local communities possess positive perceptions regarding the ecological functions and economic potential of seagrass ecosystems, as well as a high level of awareness regarding the importance of seagrass conservation.

However, the findings of this study provide further insight that positive perceptions of ecosystem services do not necessarily translate into significant support for conservation. Based on the PLS-SEM analysis, only coastal protection functions and aesthetic values were identified as significant predictors of conservation support, whereas nursery ground functions and water quality regulation did not show significant effects. This finding indicates that although communities recognize the presence and benefits of seagrass ecosystems, there is a distinction between ecosystem service awareness and the factors that drive conservation-oriented behavioral tendencies.

These results highlight a difference between ecosystem service recognition and behavioral intention toward conservation. Communities may understand or acknowledge the existence of ecological benefits provided by seagrass ecosystems; however, such understanding may not be sufficient to encourage active participation in conservation activities. This phenomenon is consistent with [10], who demonstrated that community perceptions of seagrass ecosystem services may vary among different indicators, indicating the need to strengthen awareness of seagrass functions through targeted conservation education approaches.

[10] further showed that community recognition of seagrass ecosystem services does not always correspond directly with conservation actions. Communities may understand the ecological benefits of seagrass ecosystems, but other factors, such as social attachment, direct livelihood benefits, and personal experiences with ecosystems, play important roles in shaping conservation support. Similarly, [9] found that variations in community perceptions of seagrass ecosystem services are influenced by local experiences, community involvement, and patterns of resource utilization.

The findings of this study also support the results of [11], who emphasized that limited public understanding of seagrass ecosystem services can influence resource utilization patterns and community engagement in community-based conservation initiatives. Therefore, the success of seagrass conservation depends not only on the level of community knowledge regarding the existence and functions of seagrass ecosystems but also on the extent to which these benefits are perceived as relevant to their social and economic conditions.

4.2 Aesthetic Value as the Strongest Predictor of Seagrass Conservation Support

The results of this study indicate that aesthetic value and beauty represent the strongest factor influencing seagrass conservation support, with a path coefficient of 0.335 (t-statistic = 2.950; p-value = 0.003). This finding suggests that higher community perceptions of the aesthetic value of seagrass ecosystems are associated with stronger support for conservation efforts. These results highlight the important role of the social-perceptual dimension of ecosystem services in shaping conservation behavior.

Unlike ecological functions, which are often complex and require scientific understanding, aesthetic values represent benefits that can be directly observed through community visual experiences of coastal environmental conditions. From the perspective of cultural ecosystem services, aesthetic values are not only related to visual attractiveness but also contribute to the formation of value-based relationships between humans and the environment. [23] explained that aesthetic experiences of ecosystems can enhance human connections with nature and strengthen environmental stewardship toward sustainability. Furthermore, environmental benefits that can be directly observed and experienced are more likely to develop emotional attachment between communities and ecosystems [24].

When an ecosystem is perceived as attractive, healthy, and possessing recreational value, communities tend to consider its existence as part of their environmental identity that should be protected. This finding is supported by [25], who demonstrated that aesthetic and recreational values represent important cultural ecosystem services that contribute to human well-being and can enhance public support for ecosystem management and conservation.

These findings provide additional insights into previous research by [26], which demonstrated that public perceptions of seagrass ecosystem services remain relatively lower compared with other marine ecosystems, such as coral reefs. Their study showed that only a limited proportion of the public recognized seagrass ecosystems as important providers of ecosystem services. However, increasing ecosystem visibility and providing direct experiences with ecosystems can enhance public attention toward conservation. The aesthetic value of seagrass ecosystems enables communities to develop stronger emotional connections with coastal environments, which can subsequently be translated into greater support for conservation initiatives.

4.3 Coastal Protection as a Relevant Seagrass Ecosystem Service for Local Communities

In addition to aesthetic values, coastal protection also showed a positive and significant effect on conservation support, with a path coefficient of 0.178 (t-statistic = 2.040; p-value = 0.041). This finding indicates that communities are more likely to support conservation efforts when the benefits of seagrass ecosystems are directly associated with the security and sustainability of their living environment. The coastal protection function is highly relevant for coastal communities because it is directly related to environmental risks that can be experienced in daily life, such as coastal erosion and changes in shoreline conditions. Therefore, the perception of seagrass ecosystems as a natural coastal protection component can establish a connection between ecological interests and the social needs of local communities.

This finding is consistent with the perspective of [27], who highlighted that coastal communities have complex social-ecological relationships with seagrass ecosystems through the utilization of ecosystem services, particularly in supporting local economic activities and habitat sustainability. Furthermore, [28] emphasized that seagrass ecosystems play an important role in supporting fisheries productivity, biodiversity conservation, and food security in coastal regions of the Indo-Pacific.

Therefore, the findings of this study suggest that seagrass conservation strategies can be more effective when they are linked to coastal protection benefits that are directly relevant to community needs. Conservation approaches that emphasize the role of seagrass in reducing coastal vulnerability and maintaining the sustainability of coastal environments may strengthen community support and participation in conservation initiatives.

4.4 Nursery Ground and Water Quality Regulation Functions as Non-Significant Predictors of Conservation Support

Unlike coastal protection and aesthetic value, the nursery ground function did not show a significant effect on conservation support, although it exhibited a positive relationship (path coefficient = 0.141; t-statistic = 1.692; p-value = 0.091). This result indicates that community perceptions of seagrass as a habitat for juvenile fish and marine organisms were not sufficiently strong to significantly encourage conservation support. However, based on the descriptive analysis, the nursery ground dimension obtained the highest perception score among all ecosystem service dimensions (88.96%), with the indicator related to the role of seagrass as a habitat for juvenile fish and marine organisms receiving the highest score (91.81%). This finding suggests that communities have recognized the importance of seagrass ecosystems in supporting fisheries resources; however, this understanding has not yet fully developed into awareness of the need for long-term habitat protection.

This condition may occur because the nursery ground function is often perceived primarily as a direct benefit associated with fish availability rather than as an ecological function requiring long-term conservation. [10] demonstrated that community recognition of seagrass ecosystem services does not always correspond with conservation actions, as local experiences, direct benefits, and patterns of resource utilization also influence conservation support. Furthermore, [29] explained that community understanding of seagrass ecosystem services is strongly influenced by interactions and dependence on coastal resources. [27] further emphasized that coastal communities have strong social–ecological relationships with seagrass ecosystems through fisheries activities; however, the connection between economic benefits and habitat protection still requires further strengthening.

A similar pattern was observed for the water quality regulation construct, which showed a positive but non-significant relationship with conservation support (path coefficient = 0.183; t-statistic = 1.600; p-value = 0.110). This result indicates that ecological functions of seagrass ecosystems related to maintaining environmental quality, such as nutrient absorption and water condition improvement, have not yet become major factors influencing community conservation support. This finding is supported by the perception results, where the indicator related to the ability of seagrass to absorb pollutants or excess nutrients received the lowest score (72.45%). The relatively low recognition of regulatory ecosystem functions suggests that ecological benefits that are not directly visible require more contextualized conservation communication strategies.

Overall, this study demonstrates that seagrass conservation support is not only developed through increasing ecological knowledge but also through the ability to connect ecosystem benefits with community social and economic needs. Community-based conservation approaches should integrate directly perceived benefits, such as fisheries sustainability and coastal protection, with broader understanding of seagrass ecological functions. This approach is consistent with [30], who emphasized that effective seagrass management requires adaptive, science-based, and participatory approaches involving local communities and institutional coordination. Furthermore, [2] highlighted that successful seagrass conservation within social-ecological systems depends on the ability to link ecosystem services with the social and economic values of coastal communities.

5. CONCLUSION

This study demonstrates that coastal communities have very high perceptions of various seagrass ecosystem services, with all assessed dimensions falling within the very high category. The nursery ground function was the most recognized ecosystem service, indicating that communities have acknowledged the important role of seagrass ecosystems in supporting fisheries resources.

However, the PLS-SEM analysis revealed that high perceptions of ecosystem services do not necessarily translate into stronger conservation support. Among the assessed ecosystem service dimensions, aesthetic value and coastal protection showed significant positive effects on conservation support, with aesthetic value representing the strongest predictor. In contrast, the nursery ground and water quality regulation functions showed positive but non-significant relationships with conservation support.

These findings indicate that community support for seagrass conservation is more strongly influenced by ecosystem benefits that are directly observable and experienced, such as coastal protection and aesthetic values, rather than ecological functions that are less visible and indirect. Therefore, effective community-based seagrass conservation strategies should integrate social, cultural, and protective ecosystem benefits while strengthening public understanding of the ecological functions of seagrass ecosystems to promote long-term community engagement and sustainable coastal management.

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REFERENCES

[1] L. M. Nordlund, E. W. Koch, E. B. Barbier, and J. C. Creed, “Seagrass Ecosystem Services and Their Variability across Genera and Geographical Regions,” vol. 11, no. 10, pp. 1–23, 2016, doi: 10.1016/j.marpolbul.2017.09.014.

[2] R. K. F. Unsworth *et al.*, “Global challenges for seagrass conservation,” vol. 48, no. 8, pp. 801–815, 2019.

[3] I. H. Supriyadi, M. Y. Iswari, S. Rahmawati, I. Riniatsih, Suyarso, and M. Hafizt, “Seagrass Ecosystems in Eastern Indonesia: Status, Diversity, and Management Challenges.,” *Ilmu Kelautan: Indonesian Journal of Marine Sciences*, vol. 29, no. 4, p. 503, Dec. 2024, doi: 10.14710/ik.ijms.29.4.503-518.

[4] E. Ostrom, “A General Framework for Analyzing Sustainability of Social-Ecological Systems,” *Science*, vol. 325, no. 5939, pp. 419–422, Jul. 2009, doi: 10.1126/science.1172133.

[5] N. J. Bennett *et al.*, “Conservation social science: Understanding and integrating human dimensions to improve conservation,” *Biological Conservation*, vol. 205, pp. 93–108, Jan. 2017, doi: 10.1016/j.biocon.2016.10.006.

[6] S. Díaz *et al.*, “Assessing nature’s contributions to people,” *Science*, vol. 359, no. 6373, pp. 270–272, Jan. 2018, doi: 10.1126/science.aap8826.

[7] A. Ruiz-Frau, T. Krause, and N. Marbà, “In the blind-spot of governance – Stakeholder perceptions on seagrasses to guide the management of an important ecosystem services provider,” *Science of The Total Environment*, vol. 688, pp. 1081–1091, Oct. 2019, doi: 10.1016/j.scitotenv.2019.06.324.

[8] M. Amone-Mabuto *et al.*, “Coastal community’s perceptions on the role of seagrass ecosystems for coastal protection and implications for management,” *Ocean & Coastal Management*, vol. 244, p. 106811, Sep. 2023, doi: 10.1016/j.ocecoaman.2023.106811.

[9] J. M. D. Quevedo, Y. Uchiyama, and R. Kohsaka, “Understanding rural and urban perceptions of seagrass ecosystem services for their blue carbon conservation strategies in the Philippines,” *Ecological Research*, vol. 38, no. 4, pp. 521–540, 2023, doi: 10.1111/1440-1703.12325.

[10] H. Rifai *et al.*, “Understanding community awareness of seagrass ecosystem services for their blue carbon conservation in marine protected areas: A case study of Karimunjawa National Park,” *Ecological Research*, vol. 38, no. 4, pp. 541–556, 2023, doi: 10.1111/1440-1703.12391.

[11] U. Salma and I. Angrelina, “Bibliometric Analysis and Ecological Challenges in the Era of Climate Change for Seagrass Conservation Research in Indonesia,” *Asian Journal of Fisheries and Aquatic Research*, vol. 26, no. 10, pp. 44–56, Oct. 2024, doi: 10.9734/ajfar/2024/v26i10817.
[12] J. F. Hair, G. T. M. Hult, C. M. Ringle, M. Sarstedt, N. P. Danks, and S. Ray, *Partial Least Squares Structural Equation Modeling (PLS-SEM) Using R: A Workbook*. Springer Nature, 2021. doi: 10.1007/978-3-030-80519-7.
[13] A. Ruiz-Frau, S. Gelcich, I. E. Hendriks, C. M. Duarte, and N. Marbà, “Current state of seagrass ecosystem services: Research and policy integration,” *Ocean & Coastal Management*, vol. 149, pp. 107–115, Nov. 2017, doi: 10.1016/j.ocecoaman.2017.10.004.
[14] G. O. Boateng, T. B. Neilands, E. A. Frongillo, H. R. Melgar-Quiñonez, and S. L. Young, “Best Practices for Developing and Validating Scales for Health, Social, and Behavioral Research: A Primer,” *Front. Public Health*, vol. 6, Jun. 2018, doi: 10.3389/fpubh.2018.00149.
[15] J. Rattray and M. C. Jones, “Essential elements of questionnaire design and development,” *Journal of Clinical Nursing*, vol. 16, no. 2, pp. 234–243, Feb. 2007, doi: 10.1111/j.1365-2702.2006.01573.x.
[16] R. Mahkotawati, T. Rijanto, and P. W. Rusimamto, “Uji Validitas dan Reliabilitas Instrumen Penelitian: Angket Pengalaman Praktik Kerja Lapangan (PKL) pada Siswa SMK | JIIP - Jurnal Ilmiah Ilmu Pendidikan,” *JIIP (Jurnal Ilmiah Ilmu Pendidikan)*, vol. 8, no. 2, pp. 1830–1835, 2025.
[17] R. Mutiah, “Uji Validitas dan Reliabilitas Kuisioner Penilaian Manajemen Sarana dan Prasarana,” *LENTERA : Jurnal kajian dan Riset Pendidikan Islam*, vol. 3, no. 2, pp. 81–91, 2025.
[18] M. F. Idrus, A. S. Baruadi, C. Panigoro, and O. Umar, “Analisis Kerapatan jenis dan Tutupan Lamun di Perairan Teluk Tomini Desa Torosiaje Laut Kecamatan Popayato Kabupaten Pohuwato,” *The NIKé Journal*, vol. 13, no. 3, pp. 104–108, 2025, doi: 10.37905/nj.v13i3.35631.
[19] H. Boone and D. Boone, “Analyzing Likert Data,” *Journal of Extension*, vol. 50, no. 2, Apr. 2012, doi: 10.34068/joe.50.02.48.
[20] V. H. Pranatawijaya, W. Widiatry, R. Priskila, and P. B. A. A. Putra, “Penerapan Skala Likert dan Skala Dikotomi Pada Kuesioner Online,” *Jurnal Sains dan Informatika*, vol. 5, no. 2, pp. 128–137, Dec. 2019, doi: 10.34128/jsi.v5i2.185.
[21] J. F. Hair, M. Sarstedt, and C. M. Ringle, “Rethinking some of the rethinking of partial least squares,” *European Journal of Marketing*, vol. 53, no. 4, pp. 566–584, Mar. 2019, doi: 10.1108/EJM-10-2018-0665.
[22] E. R. Cahyani and S. Sihsubekti, “Analisis Manajerial terhadap Persepsi Masyarakat Terhadap Manfaat Ekologis dan Ekonomis Ekosistem Lamun,” *Idarotuna : Journal of Administrative Science*, vol. 5, no. 2, pp. 329–344, Nov. 2024, doi: 10.54471/idarotuna.v5i2.127.
[23] N. Cooper, E. Brady, H. Steen, and R. Bryce, “Aesthetic and spiritual values of ecosystems: Recognising the ontological and axiological plurality of cultural ecosystem ‘services,’” *Ecosystem Services*, vol. 21, no. PB, pp. 218–229, 2016.
[24] G. Cundill, J. C. Bezerra, A. De Vos, and N. Ntingana, “Beyond benefit sharing: Place attachment and the importance of access to protected areas for surrounding communities,” *Ecosystem Services*, vol. 28, pp. 140–148, Dec. 2017, doi: 10.1016/j.ecoser.2017.03.011.
[25] T. L. Elwell, D. López-Carr, S. Gelcich, and S. D. Gaines, “The importance of cultural ecosystem services in natural resource-dependent communities: Implications for management,” *Ecosystem Services*, vol. 44, p. 101123, Aug. 2020, doi: 10.1016/j.ecoser.2020.101123.
[26] R. Losciale, R. Hay, M. Rasheed, and S. Heron, “‘The public perception of the role, importance, and vulnerability of seagrass. A case study from the Great Barrier Reef,’” *Environmental Development*, vol. 44, p. 100757, Dec. 2022, doi: 10.1016/j.envdev.2022.100757.
[27] A. A. Digdo, E. Astari, B. R. Arinda, and J. Arendege, “Humans and seagrass: a complex and intertwining links - an illustration from North Sulawesi, Indonesia,” *IOP Conf. Ser.: Earth Environ. Sci.*, vol. 1220, no. 1, p. 012027, Jul. 2023, doi: 10.1088/1755-1315/1220/1/012027.
[28] R. K. F. Unsworth and L. C. Cullen, “Recognising the necessity for Indo-Pacific seagrass conservation,” *Conservation Letters*, vol. 3, no. 2, pp. 63–73, 2010, doi: 10.1111/j.1755-263X.2010.00101.x.
[29] K. M. Lukman, Y. Uchiyama, J. M. D. Quevedo, and R. Kohsaka, “Local awareness as an instrument for management and conservation of seagrass ecosystem: Case of Berau Regency, Indonesia,” *Ocean & Coastal Management*, vol. 203, p. 105451, Apr. 2021, doi: 10.1016/j.ocecoaman.2020.105451.
[30] W. Kurniawan and D. A. Hasan, “A bibliometric and systematic literature review of seagrass conservation for sustainable management.,” *Journal of Biology, Environment, and Edu-Tourism*, vol. 1, no. 3, pp. 165–173, Dec. 2025, doi: 10.65622/jbee.v1i3.183.