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Determinants of Marine Ecotourism Sustainability in Gili Matra: The Mediating Role of Tourist Satisfaction

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ABSTRACT

This study aims to develop and empirically test a comprehensive model integrating coral reef ecosystem quality, tourism carrying capacity, stakeholder participation, and tourist environmental awareness as determinants of marine ecotourism sustainability in Gili Matra Marine Protected Area (MPA), with tourist satisfaction as a mediating variable. A quantitative approach was employed using Partial Least Squares Structural Equation Modeling (PLS-SEM) with purposive sampling of 110 tourists who engaged in snorkeling and/or diving activities at Gili Matra MPA during March–April 2026. The results indicate that coral reef ecosystem quality does not directly and positively influence sustainability; however, it exerts a significant positive indirect effect through tourist satisfaction as a full mediator. Tourism carrying capacity shows no significant effect on sustainability either directly or through mediation, attributed to the severely deteriorated overtourism condition prevailing in the area. Stakeholder participation positively and significantly influences sustainability directly, but not through tourist satisfaction as a mediator, as its impact operates at the structural governance level rather than at the level of individual tourist experience. Tourist environmental awareness emerges as the strongest determinant in the model ($\beta = 0.368$; $F^2 = 0.490$), positively and significantly influencing sustainability both directly and indirectly through tourist satisfaction as a partial mediator. Tourist satisfaction itself positively and significantly influences marine ecotourism sustainability ($\beta = 0.266$; $p = 0.020$), confirming its role as the central psychological mechanism linking destination conditions to tourists' loyalty behavior and conservation support. The model demonstrates strong explanatory power, with an R^2 value of 0.728 for tourist satisfaction and 0.692 for marine ecotourism sustainability.

Keywords: Marine Ecotourism Sustainability, Tourist Satisfaction, Coral Reef Ecosystem, Carrying Capacity,

Stakeholder participation, environmental awareness.

INTRODUCTION

Indonesia is widely recognized as a maritime nation endowed with exceptionally rich marine resources, holding substantial potential to drive sustainable natural resource-based economic growth (Rianawati et al., 2024; Rizal et al., 2018; Wulandari et al., 2025). This potential is reflected in Indonesia's position as part of the Coral Triangle, which encompasses approximately 75% of the world's known coral reef species, positioning its marine ecosystems as fundamental assets for the development of sustainable marine ecotourism (Gili Shark Conservation, 2026). At the global level, the coastal and marine tourism sector contributed approximately USD 4.6 trillion or 5.2% of world gross domestic product in 2019 (Balestracci et al., 2025), while in Indonesia the marine economy contributes approximately 28% of national gross domestic product (OECD, 2021). Nevertheless, the rapid expansion of marine tourism has simultaneously imposed serious pressures on coral reef ecosystems that serve as the primary attraction base of such activities (Lamb et al., 2014; Uyarra et al., 2009).

Gili Matra Marine Protected Area, comprising Gili Air, Gili Meno, and Gili Trawangan in North Lombok Regency, West Nusa Tenggara Province, and designated as a Marine Tourism Park through Ministerial Decree No. 57/2014 of the Ministry of Marine Affairs and Fisheries, most acutely represents this tension. Receiving approximately 500,000 tourist visits annually and contributing around 70% of North Lombok's total economic activity (Rahmadyani et al., 2023), Gili Matra has grown into one of Indonesia's most prominent marine ecotourism destinations. Firmansyah et al. (2024) documented that the economic structure of West Nusa Tenggara Province has undergone significant transformation with tourism and services as the primary drivers, affirming the strategic position of tourism areas such as Gili Matra within the regional economy of NTB. At the local governance level, the efficiency of district and municipal government budget management plays a determining role in the quality of development and the capacity of local communities to support the sustainable management of tourism destinations. Sriningsih et al. (2024) found that the efficiency of regional government expenditure in West Nusa Tenggara varies significantly across districts and municipalities, with implications for local human resource capacity including in tourism areas such as Gili Matra to actively participate in sustainable tourism management. Adequate institutional and fiscal capacity at the local level constitutes an essential prerequisite for the effective implementation of conservation area management policies, given that MPA management requires sustained investment in ecosystem monitoring, regulatory enforcement, and community empowerment (Sriningsih et al., 2024). However, its ecosystem vulnerability index has reached 0.68, classifying it within a vulnerable category susceptible to environmental degradation as a consequence of overtourism (Kurniawan et al., 2016). This condition manifests across four interconnected problems. Coral reef ecosystem quality has continued to deteriorate, as physical contact from snorkelers and divers has been proven to reduce coral growth rates by as much as 50% (Lamb et al., 2014). No comprehensive assessment of tourism carrying capacity integrating ecological, social, and managerial dimensions in an integrated manner has yet been conducted for the area (Davis & Tisdell, 1995; O'Reilly, 1986). Stakeholder participation remains severely limited, with local communities tending to function merely as passive beneficiaries without meaningful involvement in management decision-making, thereby weakening collaborative governance mechanisms (Rahmadyani et al., 2023; Tosun, 2000). Tourist environmental awareness is alarmingly low, with 68% of tourists unaware of the harmful effects of touching coral reefs and 82% having never received any briefing on sustainable marine tourism code of conduct prior to engaging in their activities (Gili Eco Trust, 2024).

Prior studies have examined these problems in isolation. Kurniawan et al. (2016) focused on ecological vulnerability assessment without examining tourist behavior. Rahmadyani et al. (2023) explored stakeholder perceptions of ecosystem service values without testing causal relationships with sustainability outcomes. Kurniawan et al. (2023) investigated the impact of tourism on seawater quality without integrating governance and behavioral dimensions. Diswandi et al. (2025) proposed a Payment for Ecosystem Services mechanism without empirically testing the psychological factors influencing tourist willingness to contribute. At the global level, research on coral reef ecosystem quality and tourist satisfaction (Coghlan, 2012; Uyarra et al., 2009), tourism carrying capacity (Davis & Tisdell, 1995), stakeholder participation (Byrd, 2007), and environmental awareness (Kollmuss & Agyeman, 2002; Ramkissoon et al., 2013) remains partial and fragmented. No prior study has integrated all four determinants within a single comprehensive causal model that incorporates mediation mechanisms, as emphasized by Baron & Kenny (1986) regarding the importance of testing mediating variables to understand the psychological mechanisms linking independent and dependent variables.

This study addresses these gaps by developing and empirically testing an integrative model grounded in three complementary theories. Sustainable Tourism Theory (Butler, 1999) explains carrying capacity management and sustainability outcomes measured through triple bottom line dimensions (Elkington, 1998) and tourist behavioral intentions. Stakeholder Theory (Freeman, 1984) provides the conceptual basis for understanding how collaborative governance among government agencies, MPA management authorities, tourism operators, local communities, and non-governmental organizations shapes ecosystem conditions and management effectiveness (Christie, 2004). Expectancy-Disconfirmation Theory (Oliver, 1980) explains how tourist environmental awareness shapes pre-visit expectations and how the comparison between those expectations and actual destination performance generates tourist satisfaction that subsequently drives loyalty behavior and conservation support (Chi & Qu, 2008). The novelty of this study lies in its simultaneous integration of ecological, governance, and behavioral perspectives within a single PLS-SEM framework the first of its kind in the context of Gili Matra Marine Protected Area while explicitly testing tourist satisfaction as a mediating variable linking all four determinants to marine ecotourism sustainability. The methodological approach is further justified by Firmansyah et al. (2025), who validated the use of PLS-SEM in sustainable tourism research at the Mandalika area of West Nusa Tenggara, demonstrating that this approach effectively captures the complex relationships among tourism sustainability variables within the Indonesian context. This urgency is further reinforced by projections that tourist arrivals to West Nusa Tenggara Province will reach approximately 2.55 million by 2026 (Antara News, 2026), a trajectory that risks causing irreversible ecosystem degradation. This study therefore aims to develop and empirically test a comprehensive model examining the direct and indirect effects of coral reef ecosystem quality, tourism carrying capacity, stakeholder participation, and tourist environmental awareness on marine ecotourism sustainability at Gili Matra, with tourist satisfaction as the mediating variable, contributing theoretically to the sustainable marine ecotourism literature and practically to evidence-based policy recommendations for marine protected area management in Indonesia.

RESEARCH METHODOLOGY

This study employed a quantitative approach with an explanatory research design aimed at examining causal relationships among variables through empirical hypothesis testing. The research was conducted at Gili Matra Marine Protected Area comprising Gili Air, Gili Meno, and Gili Trawangan in North Lombok Regency, West Nusa Tenggara Province, Indonesia, during March to April 2026. The population consisted of tourists who engaged in snorkeling and/or diving activities at Gili Matra MPA, and a total of 110 respondents were obtained through purposive sampling with the criteria that respondents must have directly participated in snorkeling and/or diving activities and must be at least 17 years of age. This criterion ensured that all respondents possessed a direct experiential basis for evaluating all measurement indicators, particularly those related to coral reef ecosystem quality and tourism carrying capacity that require firsthand underwater experience. This study examined six variables: coral reef ecosystem quality (X1), tourism carrying capacity (X2), stakeholder participation (X3), and tourist environmental awareness (X4) as independent variables; tourist satisfaction (M) as the mediating variable; and marine ecotourism sustainability (Y) as the dependent variable. All variables were measured using a five-point Likert scale and operationalized through 17 indicators in total, following the elimination of one indicator from the tourism carrying capacity construct that did not meet the minimum outer loading threshold of 0.70 (Hulland, 1999). Data were collected through a structured questionnaire distributed directly to respondents at snorkeling and diving sites across the three islands of Gili Matra.

The collected data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS 3.0 software. PLS-SEM was selected over Covariance-Based SEM for three primary reasons: its predictive orientation in explaining and predicting the variance of endogenous variables (Hair et al., 2019); its flexibility in not imposing strict data normality assumptions, which is appropriate for Likert-scale perceptual data; and its efficiency in producing stable parameter estimates with relatively smaller sample sizes compared to CB-SEM, which typically requires a minimum of 100 respondents for models of comparable complexity (Hair et al., 2017). The analysis was conducted in two sequential stages covering outer model evaluation and inner model evaluation. Outer model evaluation assessed convergent validity through outer loading values with a minimum threshold of 0.70 and Average Variance Extracted (AVE) with a minimum threshold of 0.50 (Fornell & Larcker, 1981), discriminant validity through the Fornell-Larcker criterion and cross-loading analysis, and reliability through Composite Reliability and Cronbach's Alpha both requiring minimum values of 0.70 (Hair et al., 2017).

Inner model evaluation assessed the explanatory and predictive power of the structural model through the coefficient of determination (R^2), classified as strong at 0.67, moderate at 0.33, and weak at 0.19 (Chin, 1998); effect size (F^2), classified as large at 0.35, medium at 0.15, and small at 0.02 (Cohen, 1988); and predictive relevance (Q^2), with values above 0.35 indicating large predictive relevance (Hair et al., 2017). Hypothesis testing was conducted through bootstrapping with 5,000 resamples, with hypotheses accepted when the T-statistic exceeded 1.96 and the p-value was below 0.05 at a 95% confidence level. Mediation analysis was further conducted to identify the type of mediation, whether full or partial, for each indirect effect pathway in the model, following the criteria established by Baron & Kenny (1986).

RESULTS AND DISCUSSION

Tabel 1: Respondent Demographics

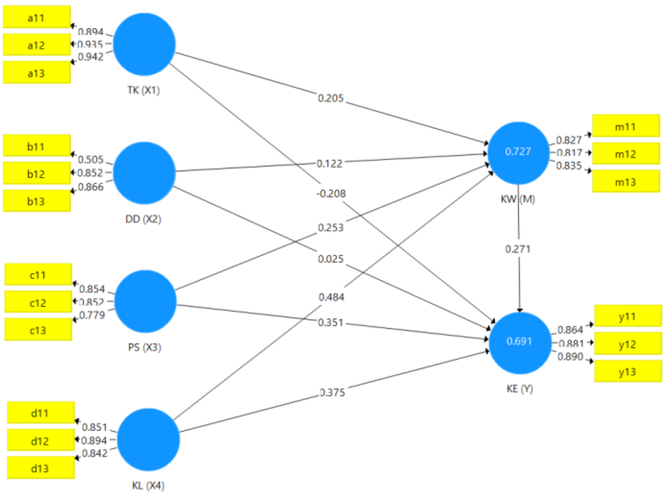
Characteristics	Category	Number of people	Percentage (%)
Gender	Male	68	61,8
	Female	42	38,2
Age	17-25 years old	50	45,5
	26–35 years old	35	31,8
	36–45 years old	17	15,5
	≥ 45 years old	8	7,3
Last Education	Senior High School	37	33,6
	Diploma	10	9,1

Characteristics	Category	Number of people	Percentage (%)
	Bachelor's Degree	49	44,5
	Master's/Doctoral	14	12,7
Nationality	Domestic	87	79,1
	International	23	20,9
Frequency of Visits	First time	49	44,5
	2–3 times	43	39,1
	> 3 times	18	16,4
Occupation	Student	35	31,8
	Employee	30	27,3
	Entrepreneur/Business	14	12,7
	Freelancer	12	10,9
	Professional	12	10,9
	Homemaker	7	6,4
Primary Activity	Snorkeling	68	61,8
	Scuba Diving	22	20
	Both	20	18,2

Source: Primary Data

This study involved 110 respondents selected through purposive sampling based on the criterion of having directly engaged in snorkeling and/or diving activities at Gili Matra Marine Protected Area during the data collection period of March to April 2026. The respondent profile is presented in Table 1 below to provide a descriptive overview of the sample characteristics used in this study.

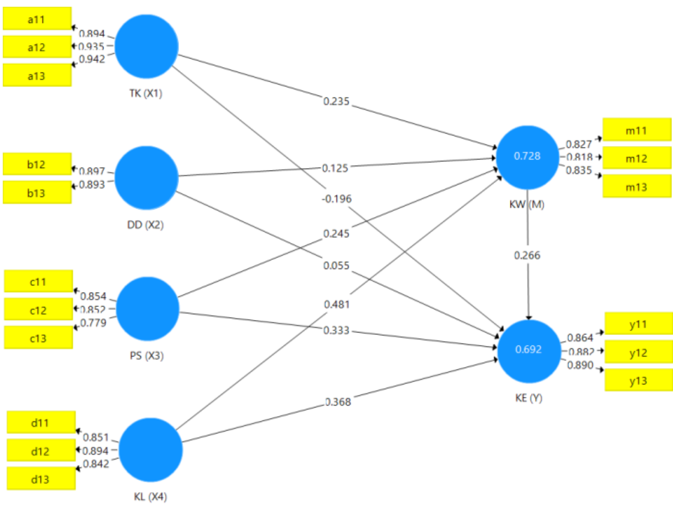
Figure 1. Estimated Model Before Elimination



Source: Developed by author (2026)

Outer loading evaluation was conducted through two iterative stages using SmartPLS. In the first iteration, all indicators of coral reef ecosystem quality (X1), stakeholder participation (X3), tourist environmental awareness (X4), tourist satisfaction (M), and marine ecotourism sustainability (Y) met the minimum outer loading threshold of 0.70. However, one indicator of the tourism carrying capacity construct (X2), namely b11, obtained an outer loading value of 0.505, falling below the required minimum threshold. Following the recommendations of Hulland (1999) and Hair et al. (2017), indicators with low outer loading values should be eliminated when their removal can improve the AVE and composite reliability values of the construct.

Figure 2. Estimated Model After Elimination



Source: Developed by author (2026)

Following the elimination of indicator b11, a second iteration was performed and the results confirmed that all remaining indicators met the minimum outer loading threshold of 0.70. Coral reef ecosystem quality (X1) was reflected by three indicators (a11 = 0.894, a12 = 0.935, a13 = 0.942), tourism carrying capacity (X2) by two indicators (b12 = 0.897, b13 = 0.893), stakeholder participation (X3) by three indicators (c11 = 0.854, c12 = 0.852, c13 = 0.779), tourist environmental awareness (X4) by three indicators (d11 = 0.851, d12 = 0.894, d13 = 0.842), tourist satisfaction (M) by three indicators (m11 = 0.827, m12 = 0.818, m13 = 0.835), and marine ecotourism sustainability (Y) by three indicators (y11 = 0.864, y12 = 0.882, y13 = 0.890). All remaining indicators therefore satisfy the outer loading criterion of ≥ 0.70 (Hair et al., 2017; Hulland, 1999), confirming that each indicator validly reflects its respective construct and that the measurement model is suitable for proceeding to the Validity and Reliability Testing stage.

Table 2. Results of Validity and Reliability Testing

Indicator	Item	Factor Loadings	Cronbach's Alpha	Composite Reliability	AVE
Coral Reef Ecosystem (X1)	a1	0.894	0.914	0.946	0.854
	a2	0.935			
	a3	0.942			
Tourism Carrying Capacity (X2)	b2	0.897	0.752	0.890	0.801
	b3	0.893			
Stakeholder Participation (X3)	c1	0.854	0.779	0.868	0.688
	c2	0.852			
	c3	0.779			
Environmental Awareness (X4)	d1	0.851	0.829	0.897	0.744
	d2	0.894			
	d3	0.842			
Tourist Satisfaction (M)	m1	0.827	0.769	0.866	0.683
	m2	0.818			
	m3	0.835			
Ecotourism Sustainability (Y)	y1	0.864	0.853	0.910	0.772

y2	0.882
y3	0.890

Source: Author's SmartPLS 3 Data Analysis (2026)

Table 2 presents the results of the validity and reliability testing for all constructs in this study. Convergent validity was assessed through outer loading values and Average Variance Extracted (AVE). All remaining indicators obtained outer loading values above the minimum threshold of 0.70 (Hulland, 1999), with coral reef ecosystem quality (X1) reflected by three indicators (a1 = 0.894, a2 = 0.935, a3 = 0.942), tourism carrying capacity (X2) by two indicators following the elimination of one indicator that did not meet the required threshold (b2 = 0.897, b3 = 0.893), stakeholder participation (X3) by three indicators (c1 = 0.854, c2 = 0.852, c3 = 0.779), environmental awareness (X4) by three indicators (d1 = 0.851, d2 = 0.894, d3 = 0.842), tourist satisfaction (M) by three indicators (m1 = 0.827, m2 = 0.818, m3 = 0.835), and ecotourism sustainability (Y) by three indicators (y1 = 0.864, y2 = 0.882, y3 = 0.890). All constructs also obtained AVE values above the minimum threshold of 0.50 (Fornell & Larcker, 1981), ranging from 0.683 for tourist satisfaction to 0.854 for coral reef ecosystem quality, confirming that convergent validity is fully satisfied. Reliability was assessed through Composite Reliability and Cronbach's Alpha, both of which exceeded the minimum threshold of 0.70 for all constructs (Cronbach, 1951; Hair et al., 2019). Composite Reliability values ranged from 0.866 for tourist satisfaction to 0.946 for coral reef ecosystem quality, while Cronbach's Alpha values ranged from 0.752 for tourism carrying capacity to 0.914 for coral reef ecosystem quality. These results confirm that all constructs demonstrate adequate internal consistency and that the measurement model is valid and reliable, warranting progression to the structural model evaluation stage.

Table 3. Results of Discriminant Validity

Indicator	X2	Y	X4	M	X3	X1
X2	**0.895**	-				
Y	0.676	**0.879**	-			
X4	0.624	0.729	**0.863**	-		
M	0.653	0.714	0.760	**0.826**	-	
X3	0.759	0.688	0.545	0.684	**0.829**	-
X1	0.177	0.162	0.287	0.481	0.348	**0.924**

Source: Author's SmartPLS 3 Data Analysis (2026)

Discriminant validity testing was first conducted using the Fornell-Larcker criterion. Fornell & Larcker (1981) established that discriminant validity is satisfied when the square root of a construct's AVE exceeds its correlations with all other constructs in the model, ensuring that each construct shares more variance with its own indicators than with any other construct. The results of the Fornell-Larcker criterion testing are presented in Table 3. The diagonal values represent the square root of each construct's AVE, namely tourism carrying capacity (X2) at 0.895, ecotourism sustainability (Y) at 0.879, environmental awareness (X4) at 0.863, tourist satisfaction (M) at 0.826, stakeholder participation (X3) at 0.829, and coral reef ecosystem quality (X1) at 0.924. All diagonal values exceed the inter-construct correlation values in their corresponding rows and columns. The highest inter-construct correlation was observed between stakeholder participation (X3) and tourism carrying capacity (X2) at 0.759, which remains below the square root of AVE for both constructs at 0.829 and 0.895 respectively. These results confirm that all constructs in this study satisfy the discriminant validity criteria based on the Fornell-Larcker approach (Fornell & Larcker, 1981).

Table 4. Cross Loading

Item	TK (X1)	DD (X2)	PS (X3)	KL (X4)	KW (M)	KE (Y)
a1	**0.894**	0.183	0.339	0.299	0.413	0.178
a2	**0.935**	0.119	0.291	0.224	0.430	0.095
a3	**0.942**	0.184	0.332	0.271	0.483	0.173
b2	0.168	**0.897**	0.571	0.589	0.610	0.588
b3	0.148	**0.893**	0.790	0.528	0.558	0.622
c1	0.306	0.690	**0.854**	0.532	0.741	0.654
c2	0.247	0.613	**0.852**	0.414	0.469	0.544
c3	0.312	0.566	**0.779**	0.377	0.417	0.481
d1	0.265	0.576	0.483	**0.851**	0.696	0.616
d2	0.270	0.573	0.519	**0.894**	0.708	0.685
d3	0.201	0.455	0.397	**0.842**	0.549	0.579
m1	0.481	0.532	0.634	0.672	**0.827**	0.569
m2	0.378	0.517	0.517	0.549	**0.818**	0.478
m3	0.332	0.566	0.538	0.651	**0.835**	0.703
y1	0.150	0.511	0.500	0.689	0.647	**0.864**
y2	0.119	0.612	0.615	0.558	0.585	**0.882**
y3	0.157	0.653	0.691	0.670	0.648	**0.890**

Source: Author's SmartPLS 3 Data Analysis (2026)

Discriminant validity was further assessed through cross-loading evaluation. Chin (1998) established that discriminant validity through cross-loading is satisfied when each indicator obtains its highest loading value on its intended construct compared to its loading values on all other latent constructs in the model. The results of the cross-loading analysis are presented in Table 4. Indicators a1, a2, and a3 obtained their highest loading values on the coral reef ecosystem quality construct (X1) at 0.894, 0.935, and 0.942 respectively, considerably exceeding their loading values on all other constructs. Indicators b2 and b3 obtained their highest loading values on the tourism carrying capacity construct (X2) at 0.897 and 0.893 respectively. Indicators c1, c2, and c3 obtained their highest loading values on the stakeholder participation construct (X3) at 0.854, 0.852, and 0.779 respectively. Indicators d1, d2, and d3 obtained their highest loading values on the environmental awareness construct (X4) at 0.851, 0.894, and 0.842 respectively. Indicators m1, m2, and m3 obtained their highest loading values on the tourist satisfaction construct (M) at 0.827, 0.818, and 0.835 respectively. Indicators y1, y2, and y3 obtained their highest loading values on the ecotourism sustainability construct (Y) at 0.864, 0.882, and 0.890 respectively. These results confirm that all indicators in the model obtain their highest loading values on their respective constructs, satisfying the discriminant validity criteria through the cross-loading approach (Chin, 1998), and further reinforcing the conclusion that each construct measures a distinct and non-overlapping concept within the model.

Table 5. Results of R-Square and F-Square

R-Square	**R Square**	**R Square Adjusted**	
Y	0.692	0.677	
M	0.728	0.717	
F-Square		**M**	**Y**
X2		0.020	0.003
Y			
X4		0.490	0.170
M			0.062
X3		0.083	0.124
X1		0.168	0.089

Source: Author's SmartPLS 3 Data Analysis (2026)

Structural model evaluation commenced with the assessment of the coefficient of determination (R^2), which measures the extent to which the variation in endogenous variables can be explained by the exogenous variables in the model. Chin (1998) classifies R^2 values of 0.67 as strong, 0.33 as moderate, and 0.19 as weak. The results indicate that tourist satisfaction (M) obtained an R^2 value of 0.728 with an adjusted R^2 of 0.717, while marine ecotourism sustainability (Y) obtained an R^2 value of 0.692 with an adjusted R^2 of 0.677. Based on Chin's (1998) classification, both values fall within the strong category, indicating that 72.8% of the variation in tourist satisfaction can be explained by coral reef ecosystem quality (X1), tourism carrying capacity (X2), stakeholder participation (X3), and tourist environmental awareness (X4), while 69.2% of the variation in marine ecotourism sustainability can be explained by the four exogenous variables along with tourist satisfaction as the mediating variable.

Effect size (F^2) was subsequently assessed to evaluate the specific contribution of each exogenous variable to the endogenous variables in the structural model. Cohen (1988) classifies F^2 values of 0.35 as large, 0.15 as medium, and 0.02 as small. With respect to tourist satisfaction (M), environmental awareness (X4) demonstrated the largest effect size at 0.490, classified as large, followed by coral reef ecosystem quality (X1) at 0.168, classified as medium, stakeholder participation (X3) at 0.083, classified as small, and tourism carrying capacity (X2) at 0.020, classified as small. With respect to marine ecotourism sustainability (Y), environmental awareness (X4) again demonstrated the largest effect size at 0.170, classified as medium, followed by stakeholder participation (X3) at 0.124, coral reef ecosystem quality (X1) at 0.089, tourist satisfaction (M) at 0.062, and tourism carrying capacity (X2) at 0.003, all classified as small. These results indicate that tourist environmental awareness (X4) constitutes the most dominant contributor to both tourist satisfaction and marine ecotourism sustainability within the model (Cohen, 1988).

Table 6. Results of Q-Square

Q-Square	Q^2 (=1-SSE/SSO)
M	0.472
Y	0.523

Source: Author's SmartPLS 3 Data Analysis (2026)

Predictive relevance (Q^2) was assessed through the blindfolding procedure to evaluate the predictive capability of the structural model against the observed data. Hair et al. (2017) state that Q^2 values above 0.35 indicate large predictive relevance, above 0.15 indicate medium predictive relevance, and above 0 indicate small predictive relevance. Tourist satisfaction (M) obtained a Q^2 value of 0.472 and marine ecotourism sustainability (Y) obtained a Q^2 value of 0.523, both exceeding the 0.35 threshold and therefore classified within the large predictive relevance category. These results confirm that the structural model possesses strong predictive capability against the observed data, warranting progression to hypothesis testing.

Table 7. Direct Effect

Hypothesis	Path	Original Sample (O)	T Statistics	P Values	Results
H1	X1 -> Y	-0.196	2.674	**0.008**	**Rejected**
H2	X2 -> Y	0.055	0.47	**0.639**	**Rejected**
H3	X3 -> Y	0.333	2.874	**0.004**	**Accepted**

H4	X4 -> Y	0.368	3.67	**0.000**	**Accepted**
H5	M -> Y	0.266	2.334	**0.020**	**Accepted**

Source: Author's SmartPLS 3 Data Analysis (2026)

Hypothesis testing was conducted through bootstrapping procedures to obtain path coefficients, T-statistics, and p-values. A hypothesis is accepted when the T-statistic exceeds 1.96 and the p-value is below 0.05 at a significance level of α = 0.05 (Purwanto & Sudargini, 2021). The testing results encompass direct effects (H1–H5) and indirect effects through tourist satisfaction as the mediating variable (H6–H9) as presented in Table 7 and Table 8.

H1: Effect of Coral Reef Ecosystem Quality (X1) on Marine Ecotourism Sustainability (Y)

The results indicate that coral reef ecosystem quality (X1) negatively influences marine ecotourism sustainability (Y) with a path coefficient of -0.196, T-statistic of 2.674, and p-value of 0.008. Although the T-statistic and p-value satisfy the statistical significance criteria, the negative direction of the coefficient contradicts the hypothesized positive effect, and H1 is therefore rejected. This finding diverges from Uyarra et al. (2009) who found that coral reef quality positively influenced tourist satisfaction and loyalty in Caribbean MPA destinations, and Laffoley et al. (2018) who emphasized that maintaining ecosystem quality is a prerequisite for MPA sustainability. However, two explanations can be proposed. First, this phenomenon can be explained through the mediation mechanism, as demonstrated by the positive and significant indirect effect result (coefficient = 0.063, T-statistic = 2.034, p-value = 0.042), indicating that the effect of ecosystem quality on sustainability occurs through tourist satisfaction rather than directly. This is consistent with Diswandi et al. (2025) who identified that tourist satisfaction with ecosystem quality drives willingness to pay for conservation as a form of sustainability support. Second, the negative coefficient may reflect actual field conditions at Gili Matra, where Rahmadyani et al. (2023) identified that communities and local stakeholders have experienced the real impacts of tourism pressure on coral reef ecosystems, and the ongoing degradation has paradoxically stimulated collective awareness of conservation urgency. Tourists who are environmentally sensitive and witness ecosystem deterioration tend to be more motivated to support conservation programs as a form of responsibility toward destination preservation, consistent with Kurniawan et al. (2016) who documented a vulnerability index of 0.68 for Gili Matra, classifying the area as vulnerable and reinforcing tourists' perception of the need for active sustainability support.

H2: Effect of Tourism Carrying Capacity (X2) on Marine Ecotourism Sustainability (Y)

The results indicate that tourism carrying capacity (X2) does not significantly influence marine ecotourism sustainability (Y) with a path coefficient of 0.055, T-statistic of 0.470, and p-value of 0.639. Since the T-statistic is below 1.96 and the p-value exceeds 0.05, H2 is rejected. This finding diverges from Sobhani et al. (2022) who demonstrated that effective carrying capacity management directly contributes to destination sustainability, and Papageorgiou (2016) who emphasized the importance of carrying capacity management in sustainable marine tourism. Nevertheless, the non-significant effect can be understood within the specific overtourism context prevailing at Gili Matra. Mihalic (2020) explains that when tourist arrivals have already exceeded a destination's carrying capacity, overtourism conditions actually reverse the expected dynamic between carrying capacity and sustainability. Rather than fostering tourist support for sustainability, excessive crowding creates discomfort that weakens tourists' positive behavioral intentions toward the destination. Papadopoulou et al. (2023) empirically demonstrated using SEM that perceived overcrowding produces negative disconfirmation evaluations that trigger tourist dissatisfaction and reduce destination loyalty, thereby weakening tourists' supportive behavior toward sustainability. This explains why tourists experiencing overcrowding during snorkeling and diving activities at Gili Matra's coral reef areas feel uncomfortable, and their negative perceptions of crowding do not motivate but rather weaken their motivation to support destination sustainability. This finding signals to Gili Matra MPA managers that controlling visitor density must be prioritized as an urgent measure, not only to restore ecosystem quality but also to restore tourist experience quality as a prerequisite for forming active sustainability support.

H3: Effect of Stakeholder Participation (X3) on Marine Ecotourism Sustainability (Y)

The results indicate that stakeholder participation (X3) positively and significantly influences marine ecotourism sustainability (Y) with a path coefficient of 0.333, T-statistic of 2.874, and p-value of 0.004. Since the T-statistic exceeds 1.96 and the p-value is below 0.05 with a positive coefficient direction, H3 is accepted. This finding is consistent with Byrd (2007) who found that stakeholder participation levels positively correlate with support for sustainable development, and Christie (2004) who demonstrated that MPAs engaging stakeholders inclusively tend to achieve better conservation outcomes and long-term sustainability. Furthermore, Rahmadyani et al. (2023) identified that effective stakeholder participation at Gili Matra contributes to the sustainable management of ecosystem services. These findings confirm that the active involvement of government agencies, tourism operators, local communities, and NGOs such as Gili Eco Trust and Gili Shark Conservation in the management of Gili Matra MPA makes a meaningful contribution to marine ecotourism sustainability in the area.

H4: Effect of Tourist Environmental Awareness (X4) on Marine Ecotourism Sustainability (Y)

The results indicate that tourist environmental awareness (X4) positively and significantly influences marine ecotourism sustainability (Y) with a path coefficient of 0.368, T-statistic of 3.670, and p-value of 0.000. Since the T-statistic exceeds 1.96 and the p-value is below 0.05 with a positive coefficient direction, H4 is accepted. This variable demonstrates the largest direct path coefficient toward Y among all independent variables in the model.

This finding is consistent with Ramkissoon et al. (2013) who found that tourist environmental awareness enhances pro-environmental behavior and willingness to pay for conservation as sustainability indicators, and Rana et al. (2025) who using PLS-SEM in Indian ecotourism destinations demonstrated that tourist awareness positively influences revisit intentions and ecotourism sustainability. Wang et al. (2023) further confirmed that tourists with higher environmental awareness exhibit more responsible behavior in national park areas and directly contribute to ecosystem sustainability. The largest path coefficient of X4 (0.368) among all variables indicates that investment in environmental education and tourist environmental awareness enhancement programs represents the most effective strategy for promoting marine ecotourism sustainability at Gili Matra.

H5: Effect of Tourist Satisfaction (M) on Marine Ecotourism Sustainability (Y)

The results indicate that tourist satisfaction (M) positively and significantly influences marine ecotourism sustainability (Y) with a path coefficient of 0.266, T-statistic of 2.334, and p-value of 0.020. Since the T-statistic exceeds 1.96 and the p-value is below 0.05 with a positive coefficient direction, H5 is accepted. This finding is consistent with Huruta et al. (2024) who using PLS-SEM at Breksi Cliff Park Yogyakarta directly demonstrated that tourist satisfaction positively and significantly influences tourism sustainability. Chi & Qu (2008) also found that tourist satisfaction functions as a full mediator influencing destination loyalty including revisit intention and word-of-mouth recommendations, which serve as sustainability indicators in this study. Yoon & Uysal (2005) further confirmed that tourist satisfaction influences revisit intention and willingness to recommend the destination, which are important for long-term sustainability. These findings reinforce the position of tourist satisfaction as a valid mediating variable in the model, where satisfaction functions as the psychological mechanism linking destination conditions to tourist behavior that supports marine ecotourism sustainability.

Table 8. Indirect Effect

Hypothesis	Path	Original Sample (O)	T Statistics	P Values	Results
H6	X1 -> M -> Y	0.063	2.034	**0.042**	**Accepted**
H7	X2 -> M -> Y	0.033	1.079	**0.281**	**Rejected**
H8	X3 -> M -> Y	0.065	1.492	**0.136**	**Rejected**
H9	X4 -> M -> Y	0.128	2.167	**0.031**	**Accepted**

Source: Author's SmartPLS 3 Data Analysis (2026)

Mediation effect testing was conducted to examine the role of tourist satisfaction (M) as a mediating variable in the relationship between exogenous variables and marine ecotourism sustainability (Y). The type of mediation was determined based on the significance of both direct and indirect effects: full mediation occurs when the indirect effect is significant while the direct effect is not significant; partial mediation occurs when both effects are significant; and no mediation occurs when the indirect effect is not significant (Baron & Kenny, 1986).

H6: Effect of Coral Reef Ecosystem Quality (X1) on Marine Ecotourism Sustainability (Y) through Tourist Satisfaction (M)

The results indicate that coral reef ecosystem quality (X1) positively and significantly influences marine ecotourism sustainability (Y) through tourist satisfaction (M) with a path coefficient of 0.063, T-statistic of 2.034, and p-value of 0.042. Since the T-statistic exceeds 1.96 and the p-value is below 0.05, H6 is accepted. Referring to the direct effect result (H1) which was significant but negative and the indirect effect result which was positive and significant, it can be concluded that tourist satisfaction serves as a full mediator between coral reef ecosystem quality and marine ecotourism sustainability. This means that ecosystem quality does not directly and positively influence sustainability, but rather operates through the tourist satisfaction mechanism. This finding is consistent with Rasoolimanesh et al. (2022) who found that tourist satisfaction serves as a significant mediator linking destination experience quality with behavioral intentions, and Thang (2025) who demonstrated that ecotourism natural resource quality influences sustainability through tourist satisfaction mediation. These results confirm that tourists who perceive high coral reef ecosystem quality will be more satisfied, and it is this satisfaction that subsequently motivates them to support destination sustainability.

H7: Effect of Tourism Carrying Capacity (X2) on Marine Ecotourism Sustainability (Y) through Tourist Satisfaction (M)

The results indicate that tourism carrying capacity (X2) does not significantly influence marine ecotourism sustainability (Y) through tourist satisfaction (M) with a path coefficient of 0.033, T-statistic of 1.079, and p-value of 0.281. Since the T-statistic is below 1.96 and the p-value exceeds 0.05, H7 is rejected. This finding diverges from Sobhani et al. (2022) and Papageorgiou (2016) who emphasized the importance of carrying capacity management in sustainable marine tourism. However, this non-significant effect can be understood within the specific context of overtourism conditions prevailing at Gili Matra MPA. In marine conservation areas that have experienced overtourism, the dynamic relationship between carrying capacity, satisfaction, and sustainability does not operate as ideally described in theory. Skiniti et al. (2024) explained that in ecologically sensitive coastal conservation areas including coral reef areas, overtourism pressure exceeding carrying capacity limits creates crowding that significantly reduces tourist experience quality, thereby weakening the relationship between area management and visitor satisfaction. Papadopoulou et al. (2023) empirically demonstrated using SEM that perceived overcrowding resulting from overtourism generates tourist dissatisfaction and reduces destination loyalty, where exceeding carrying capacity triggers negative disconfirmation evaluations that weaken tourist support for the destination. Consequently, when area carrying capacity has already been exceeded due to overtourism, the carrying capacity variable no longer functions as a factor driving satisfaction and sustainability but instead becomes a source of dissatisfaction that severs this relationship. This finding signals to managers that controlling visitor density in marine conservation areas must be prioritized as an urgent measure to restore tourist experience quality and rebuild the connection between area carrying capacity and tourist support for marine ecotourism sustainability at Gili Matra.

H8: Effect of Stakeholder Participation (X3) on Marine Ecotourism Sustainability (Y) through Tourist Satisfaction (M)

The results indicate that stakeholder participation (X3) does not significantly influence marine ecotourism sustainability (Y) through tourist satisfaction (M) with a path coefficient of 0.065, T-statistic of 1.492, and p-value of 0.136. Since the T-statistic is below 1.96 and the p-value exceeds 0.05, H8 is rejected. Although stakeholder participation was proven to directly influence sustainability (H3 accepted), its effect through tourist satisfaction mediation is not significant. This finding can be explained through two strong contextual arguments specific to Gili Matra's conditions. First, stakeholder participation at Gili Matra has not yet materialized in the form of infrastructure and tourism facilities that can be directly experienced by tourists. Sidqi et al. (2026) identified that Gili Matra's management faces a duality of authority between central and regional governments that creates gaps in regulatory enforcement, causing inter-stakeholder coordination to operate more at the institutional and structural level far from tourists' direct perception. This means that although stakeholder participation has a real impact on area governance and ecological sustainability, this impact is not directly felt by tourists in the form of satisfying tourism experiences. Second, the limited infrastructure and supporting tourism facilities at Gili Matra further contribute to the severing of this mediation pathway. Rahmadyani et al. (2023) identified that Gili Matra has experienced the loss of public facilities due to coastal abrasion including roads and waste treatment centers, indicating that existing stakeholder involvement has not yet been able to produce infrastructure improvements that can be directly experienced by tourists as components of tourism experience satisfaction. Huruta et al. (2024) found different results at Breksi Cliff Park Yogyakarta, where tourist satisfaction served as a mediator between community involvement and tourism sustainability. This difference can be attributed to differences in destination infrastructure maturity, where land-based destinations with more complete infrastructure allow stakeholder participation to materialize in services directly experienced by tourists, while marine conservation areas such as Gili Matra with existing infrastructure limitations experience a gap between stakeholder collaboration efforts and tourists' satisfaction perceptions.

H9: Effect of Tourist Environmental Awareness (X4) on Marine Ecotourism Sustainability (Y) through Tourist Satisfaction (M)

The results indicate that tourist environmental awareness (X4) positively and significantly influences marine ecotourism sustainability (Y) through tourist satisfaction (M) with a path coefficient of 0.128, T-statistic of 2.167, and p-value of 0.031. Since the T-statistic exceeds 1.96 and the p-value is below 0.05, H9 is accepted. Referring to the significant direct effect result (H4: coefficient = 0.368, p-value = 0.000) and the significant indirect effect result (coefficient = 0.128, p-value = 0.031), it can be concluded that tourist satisfaction serves as a partial mediator between tourist environmental awareness and marine ecotourism sustainability. This means that environmental awareness influences sustainability both directly and through tourist satisfaction. This finding is consistent with Rana et al. (2025) who demonstrated that tourist awareness influences ecotourism sustainability through perceived benefit mediation, and Jiang et al. (2022) who confirmed that tourist environmental awareness influences satisfaction and environmentally responsible behavior as sustainability indicators. Huzaini et al. (2025) further reinforced this finding by demonstrating that tourists with stronger personal values and higher awareness showed significantly greater willingness to pay for conservation programs, indicating that environmental awareness translates not only into behavioral intentions but also into concrete financial contributions that directly support destination sustainability. This partial mediation indicates that tourists with high environmental awareness not only directly support sustainability through pro-environmental behavior, but also through a psychological pathway whereby environmental awareness shapes higher expectations toward ecotourism destinations, generates more meaningful satisfaction, which subsequently drives support for sustainability including willingness to contribute to conservation efforts as a tangible expression of destination loyalty.

CONCLUSIONAND RECOMMENDATIONS

Based on PLS-SEM testing involving 110 respondents at Gili Matra MPA, this study concludes that coral reef ecosystem quality does not directly and positively influence marine ecotourism sustainability but operates through full mediation of tourist satisfaction. Tourism carrying capacity shows no significant effect on sustainability either directly or through mediation, attributed to the severe overtourism conditions prevailing in the area. Stakeholder participation positively and significantly influences sustainability directly, confirming that active multi-stakeholder collaboration constitutes a genuine determinant of sustainability. Tourist environmental awareness emerges as the strongest determinant in the model, positively and significantly influencing sustainability both directly and through tourist satisfaction as a partial mediator. Tourist satisfaction itself positively and significantly influences sustainability, affirming its role as the central psychological mechanism linking destination conditions to tourist loyalty and conservation support behavior. The model demonstrates strong explanatory power with R^2 values of 0.728 for tourist satisfaction and 0.692 for marine ecotourism sustainability.

Theoretically, this study enriches the sustainable marine ecotourism literature by integrating Sustainable Tourism Theory, Stakeholder Theory, and Expectancy-

Disconfirmation Theory within a single comprehensive empirical model in the context of an Indonesian MPA. Practically, MPA managers and regional governments are recommended to mandate environmental briefings prior to coral reef activities, establish structured multi-stakeholder forums, implement science-based visitor quota systems, and develop meaningful tourism products involving tourists in active conservation programs such as coral restoration and marine citizen science. This study acknowledges limitations including non-high season data collection resulting in domestic tourist dominance (79.1%), a limited sample size, a cross-sectional approach, and perception-based carrying capacity measurement without objective ecosystem data validation. Future research is recommended to replicate the study during the high season, expand the sample size, and integrate the Norm Activation Model to deepen understanding of the psychological mechanisms underlying pro-environmental behavioral intentions among marine ecotourists.

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