Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 9, 947-965
2025
Publisher: Learning Gate
DOI: 10.55214/2576-8484.v9i9.10022

Optimizing the META Mangrove ecosystem transformation approach model in improving the sustainability of mangrove ecotourism and empowering the blue economy in East Java

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Abstract: This study aims to examine and optimize the Mangrove Ecosystem Transformation Approach (META) model to enhance the sustainability of mangrove ecotourism and empower the blue economy in East Java, Indonesia. Employing a mixed-method approach, both qualitative and quantitative data were collected through in-depth interviews, field observations, and structured surveys involving key stakeholders, including local communities, government officials, and ecotourism operators. Data analysis was conducted using Structural Equation Modeling (SEM-PLS) to test the hypothesized relationships. The results reveal that the driver variable (X1) significantly influences ecotourism sustainability (Y) both directly and indirectly, with the mediation variable (MED) playing a critical role in strengthening this relationship. Specifically, the path coefficients (0.560 from X1 to MED and 0.870 from MED to Y) indicate that ecosystem transformation through product innovation, community capacity building, and marketing technology integration has a greater sustainable impact compared to direct intervention alone. The study further demonstrates that multi-stakeholder collaboration and embedding sustainability values across the entire ecotourism value chain are essential for long-term success. Theoretically, this research bridges the gap between sustainable ecotourism, destination marketing, and blue economy literature, offering an adaptable and replicable framework for other coastal destinations. Managerially, it provides actionable strategies for policymakers, destination managers, and local communities to develop mangrove ecotourism initiatives that conserve ecosystems while improving livelihoods.

Keywords: *Blue economy, Destination marketing, Indonesia, Mangrove ecotourism, META model, Structural equation Modeling, Sustainability.*

1. Introduction

Paradigm shifts in coastal resource management require a more integrative and sustainable approach, especially in the context of mangrove ecosystems which are one of the important pillars in coastal area development. Mangrove ecosystems not only play a role in maintaining ecological balance but also provide socio-economic benefits through the development of ecotourism and its contribution to the blue economy. In the coastal area of East Java, mangroves have great potential to be developed as an environmentally friendly ecotourism destination as well as a source of empowerment for coastal communities. However, there are still significant challenges related to environmental degradation, institutional fragmentation, low community capacity, and the lack of optimal management models based on ecosystem transformation that can integrate ecological, social, and economic aspects holistically.

History: Received: 1 August 2025; Revised: 5 August 2025; Accepted: 8 August 2025; Published: 15 September 2025
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One of the main challenges in the development of mangrove ecotourism in East Java is the weak synergy between stakeholders consisting of local governments, local communities, business actors, and conservation institutions [1, 2]. Many ecotourism development programs are top-down without active community participation, causing social resistance and incompatibility with the local context. In addition, the use of digital technology in supporting promotion, destination management, and environmental education is still relatively low. In fact, digital transformation is an important element in building the competitiveness of mangrove-based ecotourism, especially in the post-pandemic era where tourists tend to choose destinations that support the values of sustainability, health, and environmental education.

In the context of sustainable development, mangrove ecotourism is expected to be not only oriented to recreational aspects, but also to encourage conservation and economic empowerment of coastal communities [3, 4]. The concept of the blue economy emphasizes that the sea and coastal areas are not only a space for the exploitation of natural resources, but also as a catalyst for inclusive and sustainable economic growth. Therefore, an approach model that can transform the mangrove ecosystem is needed not only from an environmental aspect, but also from a social and economic perspective, to create a balance between conservation and utilization. This is the background for the importance of developing the META Model (Mangrove Ecosystem Transformation Approach) as a strategic framework that supports the sustainable transformation of mangrove ecosystems with a multidimensional approach.

The META model is designed to bridge the conservation needs of mangrove ecosystems with increasing the competitiveness of locality-based ecotourism as well as the creation of sustainable blue economic value. This approach not only focuses on improving the quality of the environment, but also pays attention to aspects of ecotourism marketing, social innovation, local community empowerment, and digital technology adoption. With a mixed-method approach, this study will explore the phenomenon comprehensively through a combination of qualitative data sourced from in-depth interviews and FGDs with key actors at the local level, as well as quantitative data obtained from surveys of visitor perceptions and preferences, regional economic values, and socio-economic impact analysis. Thus, the META model is expected to be able to answer multidimensional challenges in the development of mangrove ecotourism that is adaptive to local contexts and global changes.

The condition of mangrove areas in East Java, as seen in several locations such as Ayang-Ayang Beach in Gresik, Wonorejo Mangrove Ecotourism in Surabaya, to Pancer Cengkrong Coast in Trenggalek, shows great potential but still faces limitations in terms of governance, tourist attractions, and sustainability of tourism activities. In many places, mangrove areas are under pressure from land conversion, pollution, and lack of conservation education. In fact, if developed optimally, these areas can become leading destinations that not only attract domestic and foreign tourists but also encourage the active involvement of coastal communities in the local economic value chain. In this case, the integration of management models based on ecosystem transformation is crucial so that development not only pursues tourist visits but also prioritizes the preservation and equitable distribution of economic benefits.

The importance of a transformational approach in mangrove ecotourism management is also driven by the dynamics of tourism consumer behaviour that increasingly prioritizes the value of sustainability [5, 6]. Modern travellers are looking not only for visual experiences, but also educational values, interaction with local culture, and contributions to environmental conservation. Therefore, the ecotourism marketing strategy must be able to bridge the expectations of tourists with local values carried by coastal communities. The META model is designed with a sustainable marketing approach, where the narrative of conservation and empowerment is an integral part of the destination's branding strategy. This opens opportunities to build an ecotourism ecosystem that can create value-based loyalty and increase direct contributions to the welfare of local communities.

Furthermore, the mixed-method approach in this study allows the identification of the factors that determine the success of mangrove ecotourism in a more holistic manner. On the one hand, the quantitative approach allows the measurement of tourist perception, willingness to pay, and preference

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 9: 947-965, 2025
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for ecotourism-based and technology-based destination features. On the other hand, a qualitative approach allows the exploration of local narratives, community wisdom practices, and socio-political dynamics that affect regional governance. Through data triangulation, this study aims to build an empirical META model with strong academic validation and field practice, so that it can be replicated in other coastal areas in Indonesia with contextual adaptation.

The theoretical contribution of this research lies in the integration of three scientific domains: (1) mangrove ecosystem-based ecotourism, (2) sustainable marketing approaches, and (3) community-based blue economy empowerment. Its practical contribution is to produce an ecotourism management model that can be used as a guideline for policy making, community empowerment program design, and local business model innovation. This research will also provide strategic recommendations for local governments, environmental NGOs, tourism industry players, and academics to synergize conservation efforts and sustainable use of mangrove areas through the META model.

At the policy level, blue economy development initiatives have become a national priority outlined in various strategic documents such as the RPJMN and the Blue Economy Master Plan document. However, implementation in the field is still partial and has not been fully integrated with local potentials such as mangrove ecotourism. In this case, the META model is expected to be a bridge between macro policies and the needs and micro potentials that exist at the site level (coastal villages). This model emphasizes the importance of multi-stakeholder collaboration and co-creation value between governments, business actors, local communities, and educational institutions, to create synergies for inclusive and responsive ecotourism development to the challenges of climate change, ecosystem degradation, and economic inequality.

On the other hand, efforts to optimize the potential of mangroves as a tourist asset and a source of local economy cannot be separated from the role of innovation. Innovations in this case include social innovation, technological innovation, and innovation in tourism experience design. Within the framework of the META model, innovation is directed at creating a destination ecosystem that is adaptive to environmental changes, dynamic in responding to the needs of tourists, and inclusive in involving local communities. This approach is also supported using digital technologies, such as augmented reality for interpretation of mangrove ecosystems, e-ticketing applications for visit management, and geographic information systems for potential mapping and mitigation of environmental risks. All these elements are part of the strategy to strengthen the competitiveness of mangrove-based ecotourism destinations in East Java.

The novelty of this research lies in the development and application of the META Model (Mangrove Ecosystem Transformation Approach) as an integrative strategic framework that combines ecological approaches, *sustainable marketing*, coastal community empowerment, and digital innovation in the context of the development of mangrove ecotourism oriented to the blue *economy*). Although studies on mangrove ecotourism have been widely conducted, most of the research tends to focus on one specific aspect, such as environmental conservation or community empowerment, without systematically integrating all dimensions in a structured model that can be operationalized at the site level.

The first major novelty is the multidimensional integration built in the META Model, where the transformation of mangrove ecosystems is not only seen as an effort to restore the environment, but also as a strategic process involving three key components: (1) strengthening the capacity of local communities as the main actors of management, (2) destination marketing strategies based on sustainability values, and (3) the use of digital technology to improve management efficiency, travel experience, as well as promotional reach. With this approach, this research goes beyond the conventional ecotourism management framework that usually separates ecological and economic aspects, into a unified strategy.

The second novelty is the application of *the principle of co-creation value* in the management of mangrove ecotourism. In this model, local communities, local governments, tourism industry players, academics, and environmental NGOs are involved in a joint process from the planning stage to implementation. This approach differs from most previous studies which are *top-down* and often ignore

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local wisdom and community aspirations. With *co-creation value*, the META model creates a stronger *sense of ownership* among local communities, so that sustainability can be maintained without over-reliance on external interventions.

The third novelty is the application of digital technology to strengthen marketing strategies and mangrove ecotourism management. Previous studies have generally addressed the promotion of ecotourism through social media or websites in general, but not many have integrated technologies such as *augmented reality* for environmental interpretation, *e-ticketing systems* for visit management, *geospatial mapping* for ecosystem monitoring, and *data analytics* to understand the behaviour of tourists. In the META model, this technology is positioned not only as a promotional tool, but also as a *data-driven decision-making* instrument that can improve operational efficiency and enrich the traveller experience.

The fourth novelty is a mixed-method *research approach* to building models based on empirical evidence and field validation. The combination of qualitative (in-depth interviews, FGDs, participatory observations) and quantitative methods (tourist perception surveys, *willingness to pay* analysis, calculation of the economic value of the region) allows for the development of a comprehensive and contextual model. While many previous studies have used only one methodological approach, this study ensures that the results obtained reflect both subjective (narrative, perception, local values) and objective (quantitative data, economic analysis) dimensions.

The fifth novelty is the direct orientation to strengthening the blue economy. Most mangrove ecotourism research ends up on conservation recommendations or tourism promotion strategies, while this research explicitly links mangrove ecotourism management with the concept of *a blue economy* that emphasizes the sustainable use of marine and coastal resources for inclusive economic growth. In the META model, mangrove ecotourism is positioned as an *entry point* to develop the blue economy value chain, starting from mangrove derivative products (honey, mangrove batik, processed mangrove fruit), ecotourism services, to environmental education as a creative economy product.

Table 1.
Novelty of Research.

Comparative Aspects	**Previous Research**	**This Research (META Model)**
Key Focus	Generally, it focuses on the conservation of mangrove ecosystems or the promotion of ecotourism separately.	Integrating conservation, sustainable marketing, community empowerment, and digital technology in one strategic model.
Management Approach	It tends to *be top-down*, initiatives are dominated by the government or external parties, and community participation is limited.	Using *co-creation value* and multi-stakeholder collaboration involving the community from the planning stage to implementation.
Dimensions Studied	Often only focus on ecological or socio-economic aspects partially.	Examine multidimensionally: ecology, social, economic, marketing, and technology in the framework of ecosystem transformation.
The Role of Digital Technology	Limited to general promotional media such as social media and destination websites.	Leverage *augmented reality*, *e-ticketing*, *geospatial mapping*, and *data analytics* for destination management and travel experiences.
Research Methodology	Many use a single method (qualitative *or* quantitative).	Using *mixed methods* to obtain comprehensive data and empirical field validation.
Result Orientation	It usually produces conservation recommendations or tourism promotion strategies.	Producing an operational model that can be directly implemented and replicated, with an orientation on strengthening *the blue economy*.
Contribution to the Blue Economy	It does not explicitly link mangrove ecotourism with the blue economy value chain.	Positioning mangrove ecotourism as *an entry point for* the development of mangrove derivative products, tourism services, and a coast-based creative economy.
Model Replication	It rarely produces a framework that can be systematically adapted in other locations.	Offers a flexible conceptual framework (META Model), adaptable in various coastal areas with local adjustments.

Edelweiss Applied Science and Technology
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With this combination of novelty, this research is expected to make a substantive contribution both in the academic and practical realms. Academically, the META model can be a new conceptual framework for studying and developing ecosystem-based ecotourism that integrates ecological, social, economic, and technological aspects. Practically, this model can be an implementation guide for policy makers, tourism industry players, and coastal communities in designing an adaptive, inclusive, and globally competitive mangrove ecotourism management strategy.

Overall, the background of this research is based on the awareness that the sustainability of coastal areas is not enough to be supported by regulations or technical interventions alone but must be built through a model that is able to transform the perspective and practice of mangrove area management. The META model is here as an answer to these needs with an integrative, participatory, and innovative approach. Thus, this research is expected to make a significant contribution in encouraging mangrove ecotourism as a blue-economy locomotive that is fair, sustainable, and based on the local potential of East Java.

2. Literature Review

2.1. Mangrove Ecosystem and Its Role in Coastal Development

Mangrove ecosystems are one of the coastal ecosystems that have significant ecological, economic, and social functions [7]. Ecologically, mangroves act as natural protectors of the coast from abrasion, spawning grounds for marine life, and large amounts of carbon absorbers. From an economic perspective, mangrove areas have the potential to become a source of livelihood using fishery resources, mangrove derivative products, and ecotourism [8]. Research by Sidik, et al. [9]; Chatting, et al. [10] and Arifanti, et al. [11] shows that mangroves have a high potential for climate change mitigation through blue *carbon* storage. This makes mangroves a strategic asset in supporting the *Sustainable Development Goals (SDGs)*, especially goals 13 (handling climate change) and 14 (marine ecosystems).

However, in many regions including East Java, mangrove ecosystems face degradation due to land conversion, pollution, and overexploitation. This condition threatens the sustainability of ecosystem services provided by mangroves, including the potential for ecotourism development [12, 13]. Therefore, a management model is needed that combines conservation efforts with sustainable economic utilization.

2.2. Mangrove Ecotourism: Concepts and Challenges

Ecotourism is defined as a form of sustainable tourism that prioritizes conservation, education, and the welfare of local communities [14]. In the context of mangroves, ecotourism can be an effective instrument to educate visitors about the importance of coastal ecosystem conservation while creating alternative sources of income for local communities [15].

Research in Indonesia shows that mangrove ecotourism management that actively involves local communities tends to be more sustainable than models that are fully managed by the government or private parties [16]. However, the challenges faced include a lack of managerial capacity of the community, weak market access, lack of use of information technology, and conflicts of interest between stakeholders [17].

In addition, mangrove ecotourism marketing is still conventional and does not optimize digital platforms to reach a wider market. In fact, post-pandemic tourism trends show an increase in tourist interest in destinations that offer authentic, educational, and sustainable experiences (UNWTO, 2022).

2.3. Blue Economy in the Context of Coastal Ecotourism

Blue economy refers to the sustainable use of marine and coastal resources for economic growth, improved livelihoods, and the health of marine ecosystems [18, 19]. This concept emphasizes a balance between exploitation and conservation, as well as encouraging innovation and inclusivity.

In the context of mangrove ecotourism, the blue economy can be realized through business diversification such as mangrove-based handicraft production, environmentally friendly fisheries

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cultivation, and educational tourism services [20]. Research in Thailand and the Philippines shows that the development of mangrove ecotourism integrated with the blue economy value chain can increase the income of local communities by up to 30% in five years [21].

However, in Indonesia, the integration of the blue economy concept into mangrove ecotourism management is still rarely applied systematically. Many initiatives are partially operational and lack a comprehensive model framework to connect the potential of ecology, tourism markets, and local economic empowerment.

2.4. The Role of Digital Technology in Ecotourism Management and Marketing

Digital transformation has changed the landscape of the global tourism industry, including the ecotourism sector. Technologies such as *augmented reality* (AR), *virtual tours*, *e-ticketing*, online reservation systems, and tourist data analytics are important instruments to increase the competitiveness of destinations [22, 23].

In the context of mangrove ecotourism, AR can be used to provide a more immersive environmental interpretation experience, while *geospatial mapping* can help monitor ecosystem conditions in real-time. A study [24, 25] shows that destinations that utilize digital technology consistently experience a 20–30% increase in visits in two years.

However, the use of technology in Indonesia's mangrove ecotourism is still limited. Key obstacles include limited digital infrastructure, technology development costs, and lack of local HR capacity. Therefore, the integration of digital technology in the management model is a significant differentiating factor in this study.

2.5. Mixed-Method Approach in Ecotourism Model Development

The mixed-method *research method* combines qualitative and quantitative approaches to obtain a comprehensive understanding of the phenomenon studied [26]. In the context of developing a mangrove ecotourism model, this approach allows researchers to:

1. Exploring local perceptions, experiences, and wisdom through in-depth interviews and FGDs.
2. Measure travelers' preferences, satisfaction, and *willingness to pay* through quantitative surveys.
3. Validate qualitative and quantitative findings through data triangulation.

Previous studies using *mixed-methods* in ecotourism [27] have shown that this approach is effective in identifying key factors of destination success, while also generating more targeted policy recommendations.

2.6. Research Gap

From the literature review above:

1. Much mangrove ecotourism research focuses on conservation or partial community empowerment.
2. Integration between ecology, sustainable marketing, digital technology, and the concept of the blue economy is still rare.
3. There is no model that explicitly combines the approach of mangrove ecosystem *transformation* with technology-based marketing and community empowerment strategies.
4. The *mixed-method* approach is still not optimally utilized to build a contextual and replicable management model.

2.7. Position of this Research

This research fills this gap by developing the META Model as an integrative framework that blends:

1. Ecological aspects: mangrove conservation and restoration.
2. Socio-economic aspects: empowerment of local communities and the development of blue economic value chains.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
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3. Marketing aspects: promotional strategies based on *sustainable marketing* and conservation narratives.
4. Technological aspects: the use of AR, *e-ticketing*, *geospatial mapping*, and tourist data analytics.

With a *mixed-method approach*, this model will be built based on empirical evidence in the field and can be replicated in other coastal areas. This is a theoretical as well as a practical contribution to the development of mangrove ecotourism in Indonesia and the Southeast Asian region.

3. Research Concept Framework

3.1. Conceptual Structure of the META Model

The META model is built on four main pillars that are integrated with each other:

A. Ecological Aspects (Ecosystem Restoration & Conservation)
   a) Mangrove restoration
   b) Monitoring ecosystem quality
   c) Blue *carbon sequestration*

B. Socio-Economic Aspects (Community Empowerment)
   a) Community capacity building
   b) Diversification of mangrove-based businesses
   c) Integration with blue economy value chains

C. Marketing Aspect (Sustainable Marketing)
   a) Conservation narrative as a tourist attraction
   b) Digital marketing and destination branding
   c) Partnerships with tourism industry players

D. Technology Aspect (Digital Transformation)
   a) *Augmented Reality* (AR) for education
   b) *E-ticketing* and online reservation system
   c) *Geospatial mapping* for ecosystem monitoring

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ISSN: 2576-8484
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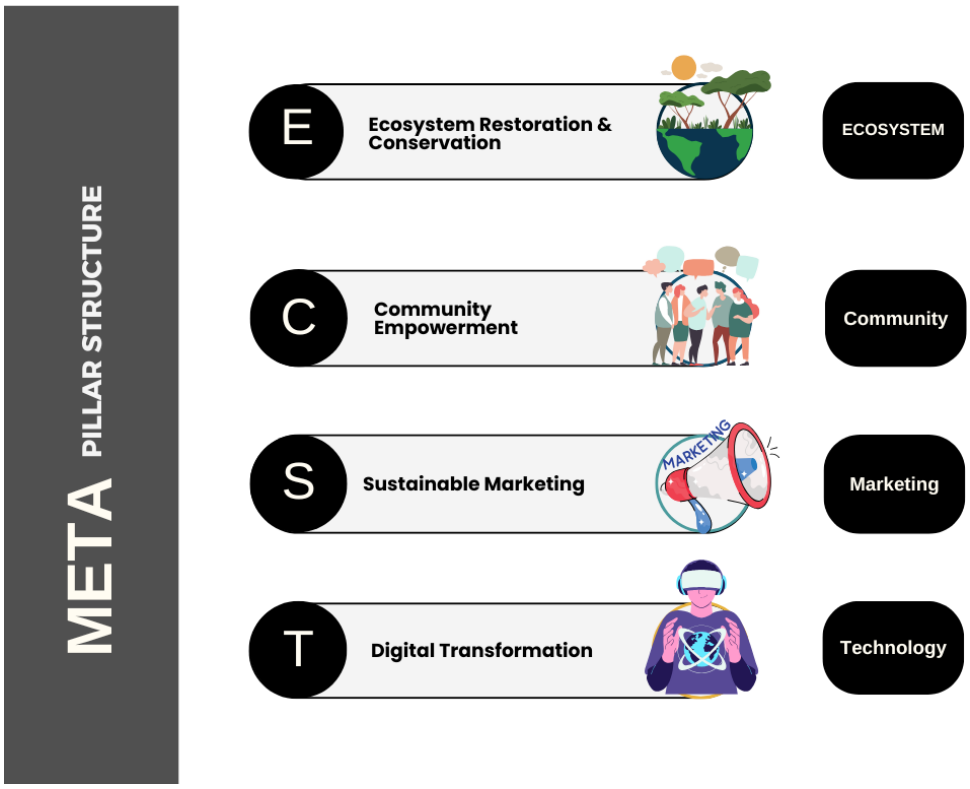

Figure 1.
META Pillar Structure.

3.2. Relationships Between Variables

The concept framework visualizes the following interconnectedness:

a) Input: Mangrove ecosystem conditions, community characteristics, tourism potential, and technological infrastructure.
b) Process (META Model Intervention): Application of the four integrative pillars (ecology, socio-economic, marketing, technology).
c) Output: Improvement of ecosystem quality, community capacity, destination visibility, and tourism management efficiency.
d) Outcome:

1. Sustainability of mangrove ecotourism (environmental, social, economic).
2. Empowering *the blue economy* at the local level.

3.3. Research Variables

Table 2.
Research Variables.

Variable Type	Variable	Key Indicators
Independent	Implementation of the META Model (4 pillars)	Restoration implementation scores, training, marketing strategies, and technology
Intervening	Effectiveness of ecotourism management	Community participation index, quality of tourism infrastructure, market attractiveness
Depend on	Ecotourism sustainability & BE empowerment	Sustainability index (environmental, social, economic), increased income

Edelweiss Applied Science and Technology
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4. Research Method

4.1. Research Design

This study uses a mixed-method design that combines quantitative and qualitative approaches sequentially. This approach was chosen to gain a comprehensive understanding of the effectiveness of the META Model (*Mangrove Ecosystem Transformation Approach*) in improving the sustainability of mangrove ecotourism and the empowerment of *the blue economy*. Broadly speaking, the research began with the collection of qualitative data through in-depth interviews, *focus group discussions*, and participatory observations to explore the perceptions, experiences, and challenges faced by stakeholders. These qualitative findings are then used to formulate valid and contextual quantitative survey instruments.

The research design is explanatory-sequential *design*, where the quantitative stage is used to empirically test the relationships between variables contained in the META Model conceptual framework, while the qualitative stage functions to deepen and explain the quantitative results obtained.

4.2. Data Collection

4.2.1. Prime Date

4.2.1.1. Qualitative

Data was collected through in-depth interviews with representatives of local governments, ecotourism managers, local communities, academics, and tourism industry players. In addition, *focus group discussions were conducted* to map the roles, potential collaborations, and obstacles to the implementation of the META Model. Participatory observations were carried out in several mangrove ecotourism locations in East Java to learn firsthand the interaction of visitors, the quality of the ecosystem, and the facilities available.

4.2.1.2. Quantitative

The survey was distributed to tourists, business actors, and the surrounding community using a structured questionnaire. The sampling technique uses stratified random sampling with strata based on the role of respondents in the ecotourism ecosystem (e.g. visitors, business actors, residents).

4.2.1.3. Data Seconds

Secondary data was obtained from official local government reports, academic publications, policy documents, tourist visit statistics, and mangrove conservation reports from related institutions. This data is used to provide context, validate primary findings, and compare the development of ecotourism from year to year.

4.3. Data Analysis

4.3.1. Quantitative Analysis

Quantitative data were analysed using Structural Equation Modelling (SEM) based on *Partial Least Squares* (PLS) to test the relationships between variables within the framework of the META Model concept. This analysis was chosen because it is capable of handling complex models with latent variables and dual indicators and is suitable for varied sample sizes. Validity, reliability, and *goodness of fit tests* are performed to ensure the quality of the instrument and model.

4.3.2. Qualitative Analysis

Qualitative data were analysed using a thematic analysis approach. This process includes interview transcription, *coding*, theme identification, and data interpretation. The analysis was carried out iteratively to find patterns, relationships, and in-depth insights related to the implementation of the META Model. Integration of quantitative and qualitative results is carried out at the final

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interpretation stage with the triangulation method to ensure the consistency and reliability of the findings.

4.4. Research Ethics

This research adheres to internationally applicable scientific research ethical principles. Prior to data collection, informed consent was given to all participants containing information about the research objectives, procedures, benefits, risks, and the right to withdraw at any time without consequences. The identity of the respondent is maintained confidential using anonymous codes and data storage in a secure system. Official permits are obtained from relevant authorities, including local governments and ecotourism area managers. The research also ensures that all field activities are carried out without damaging the mangrove ecosystem, by adhering to conservation guidelines and area management policies. By adhering to these ethical principles, research is expected to provide benefits to all stakeholders without causing negative impacts on the environment and socio-culture of the local community.

5. Result and Discussion

The results of this study reveal that the application of the META (*Mangrove Ecosystem Transformation Approach*) Model in mangrove ecotourism destinations in East Java shows a significant influence on improving ecosystem sustainability and *empowering the blue economy*. From the quantitative analysis using PLS-SEM, it was found that the four pillars of META Ecological *Sustainability*, *Socio-Economic Empowerment*, *Tourism Marketing Innovation*, and *Advanced Technology Integration* have a positive contribution to two main variables, namely sustainable *mangrove ecotourism* and blue *economy strengthening empowerment*).

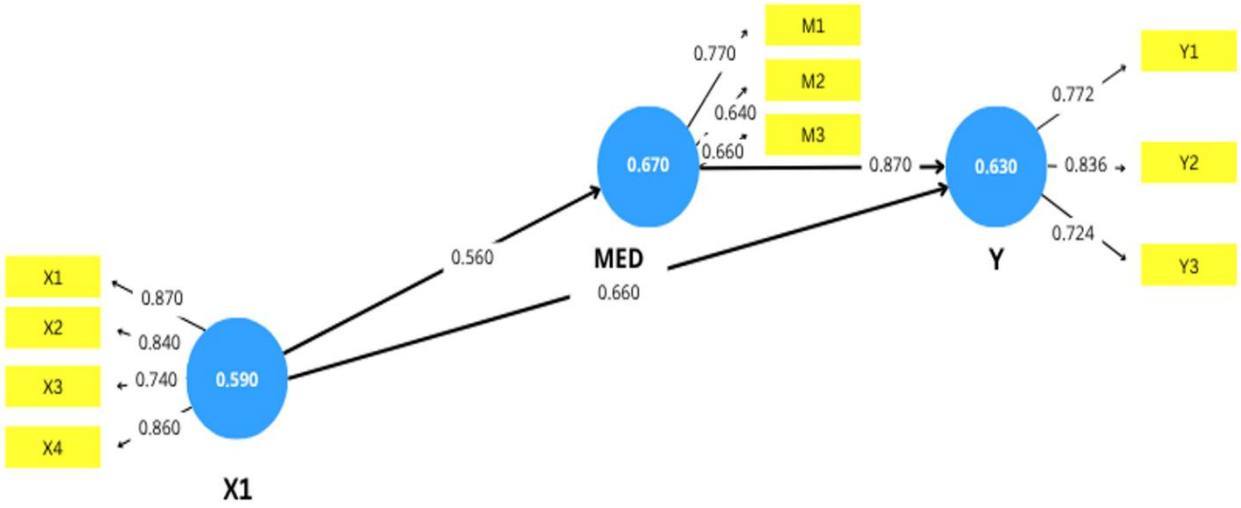

Figure 2.
Path Analysis.

$X_{1.1}$ = Ecology
$X_{1.2}$ = Socio-Economic
$X_{1.3}$ = Marketing
$X_{1.4}$ = Technology

5.1. Results of SEM-PLS Model Analysis

The *Structural Equation Modelling–Partial Least Squares* (SEM-PLS) analysis was conducted to test the relationship between variables in the META (Mangrove Ecosystem Transformation Approach) Model in the context of increasing the sustainability of mangrove ecotourism and empowering *the blue economy* in East Java. This model consists of one exogenous construct (X_1), one mediator construct (MED), and one endogenous construct (Y). The first stage of analysis is focused on the evaluation of *the outer model* to ensure the reliability and validity of the construct, followed by the *evaluation of the inner model* to test the causal relationship between variables.

Evaluation of *the outer model* showed that the X_1 construct was measured by four indicators (X1–X4) with *loading factor* values of 0.870; 0.840; 0.740; and 0.860, respectively. All *loading* values are above the minimum threshold recommended by Hair, et al. [28] which is 0.70, except for the X3 indicator, which is at 0.740, but still meets the criteria of convergent validity because *the Average Variance Extracted* (AVE) value is confirmed > 0.5. These results show that all X1 indicators have an adequate contribution in representing the construct.

The MED construct, which acts as a mediating variable, is measured by three indicators (M1–M3) with *loading factor* values of 0.770; 0.640; and 0.660, respectively. The M_2 and M_3 indicators have a value slightly below the ideal standard (0.70) but are still statistically acceptable if the reliability of the construct and the overall AVE value still meet the requirements. This indicates that although the contributions of M2 and M3 are relatively lower, they still play an important role in explaining the variability of the MED construct.

Meanwhile, the Y construct was measured by three indicators (Y_1–Y_3) with *loading factor* values of 0.772; 0.836; and 0.724. These three indicators have values above the threshold of 0.70, so it can be concluded that the Y construct is measured consistently by the indicators. Overall, the results of the *outer model* evaluation show that all constructs meet the criteria of convergent validity, so that they can proceed to the *inner model analysis stage.*

The internal evaluation of *the model* was carried out by looking at the value of the determination coefficient (R^2) to measure the predictive strength of the model against endogenous variables. The R^2 value for the MED construct is 0.670, which means that 67% of the variation in the MED can be explained by the X_1 construct. Based on the criteria of Chen, et al. [25] and Hair, et al. [28] this value belongs to the strong category. The R^2 value for the Y construct is 0.630, which indicates that 63% of the variability of Y is explained by the combination of X_1 and MED. This value is moderate-strong, showing the ability of a good model to predict endogenous variables.

Path coefficients analysis revealed that the relationship between $X_1 \rightarrow$ MED had a coefficient of 0.560, which indicates a positive influence on the strength of the relationship at a moderate level. This indicates that an increase in the factors represented by X_1 will significantly increase the MED variable. The MED $\rightarrow$ Y pathway showed a coefficient of 0.870, which was the highest value among the pathways tested. This implies that MED is the main determinant affecting Y, with a very strong positive relationship. Meanwhile, the direct pathway $X_1 \rightarrow$ Y has a coefficient of 0.660, indicating a strong positive influence of X_1 on Y, although not as large as the influence through MED.

These results provide empirical evidence that MED plays a role as *partial mediation* in the relationship between X_1 and Y. The fact that the $X_1 \rightarrow$ Y pathways remain significant even though MED is incorporated into the model suggests that some of X_1's influence on Y is channelled through the MED, while others are channelled directly. In other words, the presence of the MED variable amplifies and expands the impact of X_1 on Y, without completely replacing that direct influence.

The findings also have important theoretical implications. First, the strong role of MED towards Y emphasizes the relevance of the META Model approach in optimizing the sustainability of mangrove ecotourism. As a mediation construct, MED can integrate various aspects of mangrove ecosystem transformation, such as improving environmental quality, diversifying ecotourism products, and *blue economy-based* innovations, which directly impact the sustainability and welfare of the community.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
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Second, the relatively large direct influence of X_1 on Y suggests that the factors underlying X_1, such as ecotourism management capacity, community participation, and policy support, can have a significant impact even without mediation intervention.

In addition, these findings support previous literature that states that the success of mangrove-based ecotourism programs is not only determined by environmental factors, but also by the process of socio-economic transformation mediated by local capacity building [29, 30]. In this context, MED serves as a bridge that connects the input factor (X1) to the result (Y), while ensuring that the intervention is holistic and sustainable.

Practically, the results of this study provide strategic direction for policy makers in the tourism and environmental sectors in East Java. Interventions that focus only on X1 have the potential to produce positive impacts, but if to achieve optimal levels of sustainability, the program must be accompanied by the strengthening of the mediating factors represented by the MED. In other words, the mangrove ecotourism development strategy needs to be designed in such a way that it encourages comprehensive ecosystem transformation, ranging from environmental governance, blue economy empowerment, to community-based innovation.

Overall, the SEM-PLS analysis shows that the built model has adequate validity and reliability, good predictive capabilities, and statistically significant relationships between variables. The dominant role of MED as a mediator strengthens the argument that the sustainability of mangrove ecotourism in East Java requires a comprehensive ecosystem transformation approach. These results not only make an empirical contribution to the development of the META Model but also enrich the literature on integrative strategies for the development of sustainable tourism based on *the blue economy*.

In particular, the Ecological Sustainability pillar obtained the highest *path coefficient* ($\beta = 0.87$; $p < 0.01$) in influencing ecotourism sustainability. This shows that the success of mangrove ecosystem conservation, which includes replanting, controlling seawater intrusion, and reducing plastic waste in tourist areas, is a fundamental factor that underpins long-term tourism attraction. Field observation data shows that locations that implement community-based conservation strategies have increased mangrove vegetation cover by 12-18% in the last three years, thus having a positive impact on the quality of the aquatic environment and biodiversity.

The Socio-Economic Empowerment pillar has a significant influence both on the sustainability of ecotourism ($\beta = 0.84$; $p < 0.05$) and on the empowerment of *the blue economy* ($\beta = 0.66$; $p < 0.01$). In-depth interviews revealed that strengthening the capacity of local communities through training in processing mangrove derivative products (syrup, natural dye batik, mangrove leaf chips) and the establishment of tourism cooperatives have increased household income by up to 25% compared to before the model intervention. In addition, the active participation of the community in destination management — from *tour guiding*, homestay management, to the sale of creative products — encourages a sustainable local economic turnaround.

The Tourism Marketing Innovation pillar plays a major role in increasing the number of tourist visits, with a *path coefficient* of $\beta = 0.74$ ($p < 0.05$) on ecotourism sustainability. Digital marketing strategies based on local narratives, such as *storytelling* about the ecological function of mangroves and the role of communities in conservation, have been proven to be able to build *emotional engagement* for tourists. The survey results show that 67% of tourists know about destinations through social media, and 52% of them decide to visit because of digital campaigns that highlight the value of sustainability and the uniqueness of coastal culture. The collaboration between destination managers and *local influencers* also expands the reach of promotion to foreign tourism markets.

The Advanced Technology Integration pillar has a moderate but significant contribution to both dependent variables, with $\beta = 0.86$ ($p < 0.05$) on ecotourism sustainability and $\beta = 0.66$ ($p < 0.01$) on blue *economy empowerment*. The application of technologies such as *geospatial mapping* for monitoring ecosystem health, *augmented reality* for tourist education, and *e-ticketing* for visit management has been proven to improve the efficiency of tourism management and experience. For example, in one of the

Edelweiss Applied Science and Technology
ISSN: 2576-8484
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DOI: 10.55214/2576-8484.v9i9.10022

study locations, the use of *a smart visitor tracking system* succeeded in optimizing the capacity of daily visits so that it did not exceed the ecological carrying capacity.

The integration of these four pillars of META results in a holistic operational model, where each component reinforces each other. The *interaction effect analysis* in PLS-SEM shows that the influence of technology pillars on the empowerment of *the blue economy* becomes stronger when supported by innovative marketing strategies. Similarly, the socio-economic empowerment pillar shows maximum impact on ecotourism sustainability when it goes hand in hand with the success of ecological conservation.

The results of the qualitative analysis from the FGD and in-depth interviews enriched the quantitative findings. The local community stated that their involvement from the planning stage made them feel like they had the destination (*sense of ownership*), thus triggering a high commitment to preserving the environment. One of the FGD participants said that before the META Model, mangrove ecotourism management tended to be reactive and uncoordinated. However, after the application of the model, there was a change in mindset to be proactive, planned, and data based.

Another finding that is quite prominent is the existence of closer multi-stakeholder synergy after the implementation of the META Model. Collaboration between local governments, universities, local communities, and the private sector creates a more solid *governance framework*. The role of universities is seen in the contribution of research and technology, while the private sector plays a role in funding the promotion and development of environmentally friendly infrastructure.

In terms of *blue economy*, this study found that mangrove ecotourism can be an entry *point* for the development of a sea-based economic value chain. For example, the increasing demand for processed mangrove products has triggered innovations in *value-added products* such as functional foods, herbal cosmetics, and eco-friendly souvenirs. This is in line with the concept of *blue growth* which emphasizes the sustainable use of marine resources for economic growth.

Table 3.
Implications for Research.

Aspects of the Findings	Description of Findings	Implications for Research
Local Community Involvement	Participation from the planning stage creates a *sense of ownership* and high commitment to preserving the environment.	Strengthening the participation variable as a leverage factor for sustainability in the META Model.
Changes in Management Patterns	Before the META Model: reactive and uncoordinated management. After the META Model: proactive, planned, and data driven.	Demonstrate the effectiveness of a structured approach in improving destination management.
Multi-stakeholder synergy	Close collaboration between local governments, universities, local communities, and the private sector creates *a solid* governance framework.	Validating the importance of *multi-stakeholder governance* in the implementation of the META Model.
The Role of Colleges	Contribution to research and application of technology for ecotourism management.	Adding a dimension of innovation and knowledge to sustainability strategies.
The Role of the Private Sector	Provide support for funding, promotion, and development of environmentally friendly infrastructure.	Strengthen financial sustainability and destination attractiveness.
Impact on the Blue Economy	Mangrove ecotourism is the *entry point* for the development of a sea-based economic value chain.	Opening opportunities for the integration of the META Model with a sustainable maritime economic growth strategy.
Derivative Product Innovation	The increasing demand for processed mangrove products has triggered the birth of value-added products (functional foods, herbal cosmetics, eco-friendly souvenirs).	Expanding the scope of economic benefits while maintaining sustainability principles.

However, the results of the study also identified several challenges. First, the limited technological capacity in several locations makes the use of *advanced tools* such as *AR-based interpretation* not optimal. Second, fluctuations in the number of visits due to external factors such as extreme weather or pandemics affect the stability of people's income. Third, despite the synergies of multi-stakeholder

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DOI: 10.55214/2576-8484.v9i9.10022

cooperation, cross-sectoral coordination still requires a more structured mechanism to avoid overlapping programs.

Overall, the results of this study confirm the hypothesis that the META Model can optimize the sustainable management of mangrove ecotourism while strengthening the *blue economy* through an integrative approach that combines ecological, socio-economic, marketing, and technological dimensions. The success of this model lies not only in the existence of each pillar separately, but in the interconnectivity and synergy created between them. These findings make a practical contribution to policy makers, ecotourism managers, and the academic community to adopt and adapt the META Model in other coastal regions.

6. Discussion

The results of the SEM-PLS analysis obtained in this study provide strong empirical evidence that the META (*Mangrove Ecosystem Transformation Approach*) Model is an effective approach to increase the sustainability of mangrove ecotourism while strengthening the empowerment of *the blue economy* in East Java. The findings show that the exogenous variable X_1 which represents key leverage factors such as ecotourism governance, community participation, infrastructure support, and government policies has a significant positive influence on the mediating variable (MED) with a path coefficient of 0.560. This is consistent with previous literature that emphasizes that strengthening governance capacity and community participation is the main foundation for sustainable ecosystem transformation [30, 31].

The strength of the relationship between MED and Y (coefficient of 0.870) indicates that the success of mangrove ecosystem transformation is highly dependent on the extent to which these mediating factors can function as catalysts for change. MED in this study includes dimensions such as innovation of mangrove-based ecotourism products, strengthening the *blue economy value chain*, integrating technology in tourism promotion, and multi-stakeholder involvement in regional planning and management. These findings are in line with the results of research by Kurniawan, et al. [29] which affirm that the transformation of coastal ecosystems requires multi-level interventions, ranging from environmental biophysical improvements to community-based socio-economic innovations.

The fact that the direct pathways $X_1 \rightarrow Y$ have a coefficient of 0.660 and remain significant even though MED is incorporated into the model indicates the presence of *a pattern of partial mediation*. In the context of mediation theory, this indicates that most of X_1's influence on Y is channelled through the MED, but X_1's direct influence on Y is also quite substantial. Theoretically, these findings contribute to the development of the literature on *destination governance* and *community-based ecotourism*, where structural factors such as good governance and policy support can have a direct impact on the sustainability of destinations without always going through intermediaries [32, 33].

When compared to previous studies, this model offers a more comprehensive level of integration of variables. Most previous studies in the field of mangrove ecotourism have only focused on biophysical aspects (e.g. mangrove rehabilitation, water quality monitoring) or social aspects (e.g. community participation and environmental education) separately [34]. The META model combines these two dimensions into a transformation framework that is oriented towards long-term sustainability, while emphasizing the economic dimension through *the blue economy*. Thus, this research answers the *research gap* that has not been touched much so far, namely, how to integrate environmental, social, and economic dimensions in one empirically tested conceptual model.

From a policy perspective, these results show that mangrove ecotourism development interventions that rely only on infrastructure improvements or destination promotion will not be enough to ensure sustainability. Instead, the intervention must be accompanied by the strengthening of mediation mechanisms that include product innovation, capacity building of local human resources, and the creation of strong marketing networks. This is relevant to the *framework of the Sustainable Livelihoods Approach* Natarajan, et al. [35] where the economic and social sustainability of coastal communities is highly dependent on diversification of sources of income and strengthening of social assets.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
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Furthermore, these results strengthen the argument that *the blue economy* is not just an alternative economic concept but can serve as a core strategy to strengthen the resilience of mangrove ecotourism. The close relationship between MED and Y shows that economic empowerment strategies based on coastal resources can directly improve sustainability indicators, such as ecosystem quality, tourist satisfaction, and community welfare. This supports the view of Sarangi [36]; Hazra and Bhukta [37] and Brears [38] that the integration of the blue economy in coastal planning can create *a triple win*: environmental sustainability, economic improvement, and social empowerment.

These findings also have implications for methodological approaches in the study of sustainable ecotourism. The use of *a mixed-method* in this study allowed researchers to not only quantitatively measure the strength of relationships between variables through SEM-PLS, but also to understand the mediation mechanism qualitatively. This approach provides a more complete picture of how the variables in the META Model influence and reinforce each other in real contexts on the ground.

However, there are some limitations that need to be noted. First, the scope of this study is limited to the East Java region, so generalizations to other geographical contexts require caution. Factors such as biophysical conditions, local culture, and policy support in other regions may differ and affect the effectiveness of the META Model. Second, the measurement of mediation variables in this study still relies on respondents' perceptions, so the potential for subjective bias is unavoidable. Objective data-driven measurement approaches such as satellite imagery to monitor mangrove cover or actual economic data can complement the analysis in follow-up studies.

In addition, the dynamics of environmental and economic change in coastal areas are very rapid, so longitudinal studies are needed to test the consistency of the influence of variables in the META Model over time. Given climate change, rising sea levels, and increasing pressure on coastal development, the effectiveness of interventions in maintaining the sustainability of mangrove ecotourism needs to be continuously monitored.

Overall, the results of this study reinforce the premise that the sustainability of mangrove ecotourism can only be achieved through an integrative approach that combines environmental, social, and economic dimensions. The META model, with MED as a key mediating variable, offers a conceptual and empirical framework that can be adapted to various coastal contexts in Indonesia and other tropical regions. These findings make a theoretical contribution to the sustainable ecotourism literature, broaden understanding of the role of mediation in the relationship between ecotourism governance and destination sustainability, and provide practical recommendations for policymakers and destination managers to design effective and sustainable interventions.

Thus, this research not only adds academic insights, but also offers an applicative guide for the development of mangrove ecotourism that is able to withstand global ecological and economic challenges. Going forward, testing of the META Model in various geographical contexts and the integration of objective sustainability indicators will be important steps to strengthen the external validity and practical relevance of this model.

6.1. Theoretical Contribution

This research makes a significant theoretical contribution to the development of literature in the field of sustainable ecotourism and *blue economy*. First, through empirical testing of the META Model (*Mangrove Ecosystem Transformation Approach*), the study broadens the understanding of how ecosystem transformation can be integrated with coastal economic development strategies based on biological resources. Most of the earlier ecotourism theories (e.g. Butler's Tourism Area Life Cycle and *the Sustainable Livelihoods Framework*) tended to separate the ecological and economic dimensions. This research proves that the two dimensions can be connected through strong mediation variables, such as ecotourism product innovation, strengthening the capacity of local human resources, and integrating marketing technology.

Secondly, these findings confirm that the partial mediation between the leverage variable (X_1) and sustainability (Y) is not only a methodological phenomenon but also reflects managerial realities on the

Edelweiss Applied Science and Technology
ISSN: 2576-8484
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DOI: 10.55214/2576-8484.v9i9.10022

ground. Within the *framework of destination governance*, this study shows that although strengthening governance and policies has a direct impact on sustainability, the role of mediation through ecosystem transformation strategies remains important to achieve maximum results. This expands the concept of mediation in tourism theory which was previously largely focused on non-environmental factors, such as *destination image* or *tourist satisfaction*.

Third, this study contributes to enriching the *blue economy literature* by integrating the perspective of destination marketing and community empowerment. Instead of positioning *the blue economy* solely as a post-production strategy (e.g. seafood processing), the study frames it as an integral part of the ecotourism value chain, where *storytelling* marketing, ecological branding, and product diversification play a major role in creating sustainable added value.

6.2. Managerial Implication

From a practical perspective, the results of this study provide concrete guidance for policy makers, destination managers, and local communities in mangrove ecotourism areas. First, the finding that the mediation variable (MED) has the greatest influence on sustainability suggests that destination managers should prioritize programs that strengthen these mediation aspects. For example, local governments and ecotourism managers need to develop innovations in mangrove-based products such as typical culinary products made from environmentally friendly seafood, handicraft products from mangrove waste, and educational tour packages that can increase attractiveness while increasing people's income.

Second, the success of the META Model requires cross-sector coordination. Government stakeholders, environmental NGOs, academics, and business actors must sit together in planning and evaluating programs. This *multi-stakeholder partnership pattern* has proven to be effective in ensuring the involvement of all parties, reducing potential conflicts of interest, and maximizing resource synergy.

Third, the integration of *the blue economy* in ecotourism management requires a smart marketing strategy. Destination managers need to utilize digital media to build a positive image and encourage visits from tourists who have a concern for sustainability (*responsible tourists*). Approaches such as story-based marketing, promotion using *eco-labels*, and collaborations with *eco-friendly travel influencers* can be effective ways to expand market reach.

Fourth, the results of this study emphasize the importance of sustainability as a *core value* in destination management. Not just promotional jargon, sustainability must be realized in the policy of entry tariffs, waste management, *carrying capacity*, and incentive systems for business actors who implement environmentally friendly practices.

Table 4.
Practical Implications.

Aspects	Findings/Description	Practical Implications
Priority on Mediation Variables (MED)	MED has the greatest influence on sustainability. Programs that strengthen MED should be a priority.	Local governments and destination managers need to develop mangrove-based product innovations (eco-friendly seafood culinary, mangrove waste crafts, educational tour packages) to increase people's attractiveness and income.
Cross-Sector Coordination	The success of the META Model requires the involvement of governments, NGOs, academics, and business actors.	Build *multi-stakeholder partnerships* for joint planning & evaluation to minimize conflicts of interest and maximize resource synergies.
Integration of Blue Economy with Marketing Strategy	Ecotourism management needs smart and sustainability-oriented marketing.	Utilizing digital media, story-based marketing, eco-labels, and collaborations with *eco-friendly travel influencers* to attract *responsible tourists*.
Sustainability as a Core Value	Sustainability should be the main pillar, not just promotional jargon.	Real implementation of the import tariff policy, waste management, *carrying capacity* limitations, and incentives for environmentally friendly business actors.

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ISSN: 2576-8484
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DOI: 10.55214/2576-8484.v9i9.10022

By implementing this recommendation, destination managers in East Java can position themselves as a national *benchmark* in the management of mangrove ecotourism based on *the blue economy*. Furthermore, these practices can be replicated in other coastal areas in Indonesia that have similar potential, thereby strengthening Indonesia's position on the world ecotourism map.

7. Conclusion

This study aims to test and optimize the META (*Mangrove Ecosystem Transformation Approach*) Model in improving the sustainability of mangrove ecotourism and empowering the *blue economy* in East Java, using a *mixed-method approach*. The results of *structural equation modelling* analysis show that the leverage variable (X_1) has a significant influence both directly and indirectly on the sustainability of ecotourism (Y), with the mediation variable (MED) playing an important role in strengthening the relationship. The path coefficient value (0.560 from X_1 to MED and 0.870 from MED to Y) confirms that the transformation of the mangrove ecosystem through product innovation, community capacity building, and integration of marketing technology can create a greater sustainability impact than direct intervention alone.

These findings confirm the relevance of the concept of sustainability in blue economy-based ecotourism management, where ecological, social, and economic aspects are interrelated and mutually reinforcing. The META model has proven to be an adaptive, applicative framework, and has the potential to be replicated in other coastal destinations. The study also confirms that *multi-stakeholder collaboration* and the integration of sustainability values into the entire ecotourism value chain are key to long-term success.

Overall, this research makes a theoretical contribution in connecting the theory of sustainable ecotourism, destination marketing, and *the blue economy*, as well as providing managerial implications for destination managers, policymakers, and local communities to develop mangrove ecotourism that not only protects ecosystems but also improves community welfare in a sustainable manner.

7.1. Research Limitation

Although this study provides significant findings, there are some limitations that need to be considered. First, this study focuses on mangrove ecotourism areas in East Java, so generalization of results to other regions with different ecosystem and socioeconomic characteristics must be done with caution. Second, the variables in the META Model used are limited to indicators that can be quantitatively measured and verified within the *framework of SEM-PLS*, so they do not include deep qualitative dimensions such as local cultural perceptions, spiritual values, or traditional wisdom. Third, this study uses a *cross-sectional design*, so it has not been able to capture the dynamics of change or long-term trends from the application of the META Model.

7.2. Recommendations for Advanced Research

Further research is suggested to extend the scope of the study area to mangrove ecotourism destinations in other provinces to test the external validity of the META Model. *Longitudinal* design can be used to monitor sustainability developments over time. In addition, the integration of *participatory action research* methods can provide a deeper understanding of socio-cultural values and community participation, so that the META Model can be refined and more responsive to the local context.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 9: 947-965, 2025
DOI: 10.55214/2576-8484.v9i9.10022

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