Mangrove Ecosystem Transformation Approach (META) Innovation Design as Strengthening Business Resilience and Environmental Sustainability of in East Java

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Mangrove Ecosystem Transformation Approach (META) Innovation Design as Strengthening Business Resilience and Environmental Sustainability of in East Java

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Abstract: The degradation of mangrove ecosystems in East Java poses significant challenges to both environmental sustainability and local businesses dependent on mangrove tourism. This study explores the implementation of the Mangrove Ecosystem Transformation Approach (META), a holistic framework designed to integrate environmental conservation with business resilience in the mangrove tourism sector. By combining quantitative, qualitative, and model development methods, this research investigates how innovative technologies can support sustainable tourism management. The study identifies critical factors influencing business resilience, evaluates the environmental impact of mangrove tourism, and demonstrates how META can improve operational efficiency and environmental outcomes. The findings highlight the potential for META to serve as a model for sustainable tourism in coastal areas, ensuring long-term business viability and environmental preservation.

Keywords: mangrove ecosystem; business resilience; environmental sustainability; tourism; innovation; East java

1. Introduction

Mangroves are a critical part of the coastal ecosystem, providing environmental, economic, and social benefits. In East Java, the rapid degradation of mangrove forests due to urbanization, land conversion, and climate change threatens both the natural environment and the economic activities dependent on it, particularly mangrove tourism. According to the National Mangrove Map of 2021, East Java hosts approximately 48% of Java's total mangrove forest, covering 27,221 hectares. However, over the past four decades, there has been a drastic decline in mangrove coverage. To address these challenges, it is essential to adopt innovative approaches that balance environmental conservation with the need for business resilience in the tourism sector.

Mangrove ecosystems serve as one of the most important natural resources for coastal regions around the world, including East Java, Indonesia [1]. These unique ecosystems provide critical environmental services such as shoreline protection, carbon sequestration, and habitat for a diverse array of marine and terrestrial species. Additionally, mangroves offer significant economic benefits, particularly through eco-tourism, which has become an increasingly vital industry in areas like East Java where coastal tourism plays a pivotal role in local economies [2].

However, the mangrove ecosystems of East Java face considerable threats from urbanization, industrial development, and unsustainable land use practices. Over the past few decades, there has been a rapid decline in mangrove coverage, primarily driven by land conversion for aquaculture, infrastructure development, and agriculture. As reported by the Indonesian Ministry of Environment and Forestry, the national rate of mangrove degradation remains alarming, with East Java being one

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of the provinces most affected. This degradation not only jeopardizes biodiversity and ecosystem services but also threatens the livelihoods of local communities that depend on these ecosystems, particularly those engaged in tourism-related activities.

In parallel, the increasing popularity of mangrove tourism has led to new challenges [3]. While mangrove tourism can promote environmental awareness and generate economic benefits, it also exerts pressure on the very ecosystems it seeks to protect. Unregulated tourism activities, infrastructure development, and lack of environmental education among visitors have contributed to the degradation of mangrove habitats. As a result, there is an urgent need for a more sustainable approach to managing mangrove ecosystems, one that balances economic development with environmental conservation.

Recognizing these challenges, the Innovative Design of META (Mangrove Ecosystem Transformation Approach) was developed as a framework to promote a more sustainable and resilient model for mangrove tourism. META integrates environmental management with innovative technologies and business strategies to ensure the long-term viability of mangrove ecosystems while enhancing the resilience of businesses that rely on them. The framework is grounded in the principles of sustainability, technological innovation, and community engagement, aiming to create a balanced approach that benefits both the environment and the local economy. The urgency for innovation in this sector stems from several key factors: 1) Environmental Degradation: Mangrove forests in East Java are under threat from both human activities and natural factors, such as climate change and rising sea levels. Without effective intervention, these ecosystems risk further depletion, leading to loss of biodiversity, diminished coastal protection, and reduced carbon sequestration. 2) Economic Vulnerability: Businesses in the mangrove tourism sector are highly dependent on the health of the ecosystems they rely on. As mangrove habitats degrade, the attractiveness of these areas as tourism destinations decreases, undermining the viability of local businesses and jeopardizing the livelihoods of those involved in the tourism industry. 3) Technological Gaps: The tourism sector has been slow to adopt new technologies that could help mitigate the environmental impacts of tourism while improving business operations. Innovations in data collection, environmental monitoring, and digital marketing offer untapped potential to create a more sustainable and efficient model for mangrove tourism management. 4) Community Involvement: Local communities play a crucial role in the conservation and management of mangrove ecosystems. Engaging these communities in the development and implementation of innovative solutions is critical for ensuring long-term success. The META framework emphasizes the importance of community participation in decision-making and benefits-sharing, ensuring that conservation efforts are both inclusive and equitable.

This study aims to explore how the META framework can be applied to enhance the resilience of mangrove tourism businesses while promoting environmental sustainability. The research focuses on the key factors that influence business resilience in the context of mangrove tourism, the role of innovative technologies in reducing environmental impacts, and the potential for META to serve as a scalable model for sustainable tourism development in other coastal regions.

By integrating both environmental and business considerations, the study seeks to contribute to the growing body of knowledge on sustainable tourism management and offer practical recommendations for policymakers, businesses, and communities involved in mangrove conservation. The goal is to create a tourism model that not only protects and restores mangrove ecosystems but also supports the long-term resilience of businesses and local communities, ensuring that East Java's mangrove ecosystems remain a vital resource for future generations.

1.1 Research Questions:

1. What are the key environmental and economic challenges facing mangrove ecosystems and tourism businesses in East Java?
2. How can the META framework address the dual objectives of environmental conservation and business resilience?
3. What are the critical success factors for implementing innovative technologies in mangrove tourism management?

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4. How can local communities be effectively engaged in the development and implementation of the META framework?
5. To what extent can the META framework be scaled and adapted for use in other coastal regions?

This research will provide insights into how technological innovations and sustainable business practices can be integrated to create a more resilient and environmentally responsible tourism industry. The findings will offer valuable guidance for stakeholders seeking to enhance the sustainability of mangrove ecosystems and the economic vitality of the tourism sector in East Java.

This research focuses on the Innovative Design META (Mangrove Ecosystem Transformation Approach), a novel framework developed to integrate technological innovations into the sustainable management of mangrove ecosystems. META aims to enhance operational efficiency in mangrove tourism while ensuring long-term environmental sustainability. This paper seeks to explore the urgency of applying META in the context of East Java's mangrove ecosystems, identify key factors affecting business resilience, and evaluate how this framework can be implemented to ensure the sustainability of both the environment and local businesses

1.2. Literature Review

The degradation of mangrove ecosystems has become a pressing concern globally, with significant attention being paid to their role in mitigating climate change, preserving biodiversity, and supporting coastal economies [4]. Research indicates that mangroves act as natural barriers against coastal erosion, sequester large amounts of carbon, and provide habitat for a diverse range of species. However, as tourism in mangrove areas grows, so too does the pressure on these ecosystems [5]. Managing this balance between tourism and conservation requires a comprehensive approach that integrates business needs with environmental priorities.

The literature surrounding the management of mangrove ecosystems, sustainable tourism, and the integration of technology in environmental conservation provides the theoretical and practical foundation for this study. The Innovative Design of META (Mangrove Ecosystem Transformation Approach) framework draws from various strands of research, including ecosystem-based management (EBM), resilience theory, sustainable tourism, and technological innovation in environmental and business sectors. This literature review explores these key areas, offering a comprehensive understanding of the background and context in which the META framework is situated.

1. Mangrove Ecosystems: Functions, Services, and Challenges

Mangrove ecosystems are considered one of the most productive and biologically diverse ecosystems in the world. According to [6], mangroves provide critical ecosystem services, including shoreline protection, carbon sequestration, nutrient cycling, and habitat for marine and terrestrial species. On the other hand, [7] emphasize the importance of these ecosystems in mitigating the impacts of climate change, particularly through their role in protecting coastal areas from erosion, storm surges, and rising sea levels. In addition to these ecological functions, mangrove ecosystems support local economies by providing resources for fisheries, forestry, and tourism. However, global studies indicate that mangrove ecosystems are under severe threat. A report by the International Union for Conservation of Nature (IUCN) highlights that over 35% of global mangrove coverage has been lost in the past few decades, with land conversion for agriculture, aquaculture, and urban development being the primary drivers [8]. In the context of East Java, Indonesia, studies show that extensive degradation has occurred due to unregulated development and overexploitation of resources [9]. The literature underscores the urgent need for more effective management strategies that balance the economic needs of local communities with the conservation of these ecosystems [10].

2. Sustainable Tourism and Environmental Conservation

Sustainable tourism is defined by the United Nations World Tourism Organization (UNWTO) as "tourism that takes full account of its current and future economic, social, and environmental impacts" [11]. This concept has gained prominence in academic and policy discussions over the past few decades, particularly in regions where natural ecosystems, like mangroves, form the backbone

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of the tourism industry. Sustainable tourism emphasizes the need for practices that do not deplete or degrade the environmental resources that support tourism activities [12].

A central tenet of sustainable tourism is the idea of eco-tourism, which focuses on minimizing negative environmental impacts while fostering environmental awareness and conservation [13]. Numerous studies have demonstrated that eco-tourism can provide financial incentives for conservation while supporting local livelihoods [14]. However, scholars such as [15] caution that without proper regulations and environmental management frameworks, tourism development can contribute to environmental degradation, as seen in some coastal regions where tourism activities have led to habitat loss and pollution.

In the context of mangrove ecosystems, there is growing interest in the potential for eco-tourism to support conservation efforts while providing economic benefits to local communities. Meanwhile, [16] argue that mangrove eco-tourism can enhance public awareness of the importance of mangrove conservation and generate revenue that can be reinvested in ecosystem restoration. Nonetheless, achieving a balance between tourism development and environmental protection remains a key challenge, particularly in regions like East Java where tourism pressure is increasing.

3. Resilience Theory and Business Resilience in Tourism

Resilience theory, originally developed in the field of ecology, has been increasingly applied to social-ecological systems, including the tourism industry [17,18]. Resilience is defined as the capacity of a system to absorb disturbance and reorganize while undergoing change, yet still retain essentially the same function, structure, identity, and feedback [17]. In the context of mangrove ecosystems and tourism, resilience refers to the ability of both the ecosystem and the associated businesses to withstand external shocks, such as environmental degradation or economic crises, while maintaining functionality.

Several studies have explored the concept of business resilience in tourism, focusing on the capacity of tourism operators to adapt to changing environmental and economic conditions [19]. In coastal tourism, factors such as environmental sustainability, community involvement, and the adoption of innovative business practices have been identified as key determinants of resilience [20]. According to [21], tourism operators that invest in environmental conservation and engage with local communities tend to be more resilient to external shocks, such as natural disasters or economic downturns.

The literature suggests that for mangrove tourism businesses to be resilient, they must adopt strategies that protect the environment on which they depend, while also diversifying their revenue streams and incorporating innovative technologies [22]. This aligns with the objectives of the META framework, which seeks to enhance the resilience of businesses by promoting sustainable environmental practices and leveraging technological innovation.

4. Technological Innovation in Environmental Management and Tourism

The integration of technology in environmental management and tourism has been widely studied in recent years. Advances in digital technologies, such as Geographic Information Systems (GIS), remote sensing, and environmental monitoring, have opened new possibilities for the management of natural ecosystems [23]. GIS, for example, has been used to map mangrove forests and monitor changes in land cover, providing valuable data for conservation efforts [24]. Remote sensing technologies have also been employed to assess the health of mangrove ecosystems and detect areas that are particularly vulnerable to degradation [25].

In the tourism sector, digital marketing platforms, social media, and data analytics have transformed how tourism businesses interact with customers and promote their destinations [26]. Studies show that tourism operators who effectively leverage digital technologies can enhance their competitiveness by reaching a wider audience and offering more personalized services [20]. In the context of eco-tourism, technology can also be used to promote environmental education and raise awareness about conservation issues among tourists [20,26].

The literature highlights the potential for technological innovation to enhance both environmental management and business operations in the tourism sector. The META framework aims to harness these innovations by integrating environmental monitoring technologies with

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business tools, such as digital marketing and data analytics, to create a more sustainable and resilient model for mangrove tourism.

5. Community-Based Approaches to Conservation and Tourism Development

The role of local communities in conservation and tourism development has been extensively studied. Community-based tourism (CBT) is a model in which residents manage and benefit directly from tourism activities, often with a focus on sustainability and conservation [27]. The literature suggests that involving local communities in tourism management can lead to more equitable distribution of benefits and stronger support for conservation efforts [28]. Several case studies from Southeast Asia have demonstrated the success of community-based tourism in fostering both environmental conservation and economic development [29].

In the context of mangrove tourism, community participation is essential for ensuring the sustainability of both the environment and the local economy. Studies by [30,31] highlight the importance of involving local communities in decision-making processes related to tourism development and conservation. The literature also emphasizes the need for capacity-building initiatives that equip local-residents with the skills and knowledge required to manage tourism businesses and protect natural resources.

The META framework incorporates community-based approaches by emphasizing the involvement of local-residents in both the management of mangrove ecosystems and the development of tourism-related businesses. This aligns with the broader literature on community-based tourism and the role of local communities in promoting sustainability.

6. Insights of Literature Review

The literature reviewed demonstrates that the successful management of mangrove ecosystems and tourism in East Java requires a holistic approach that integrates environmental conservation, business resilience, technological innovation, and community involvement. The Innovative Design of META framework is grounded in these principles, drawing from existing research on sustainable tourism, resilience theory, technological innovation, and community-based conservation. By synthesizing these strands of research, this study aims to contribute to the growing body of knowledge on how to promote sustainable development in coastal regions while ensuring the long-term viability of both ecosystems and businesses.

Innovation in tourism management has been identified as a key driver for sustainable development. Studies on technological integration into environmental management suggest that digital tools can optimize operational efficiency and support conservation efforts. The META framework, which incorporates real-time data monitoring, automated environmental assessments, and digital marketing strategies, represents an innovative solution tailored to the unique needs of mangrove ecosystems

2. Research Methodology

This study uses a mixed approach that combines quantitative and qualitative methods. This approach was chosen because it provides flexibility in collecting and analyzing data in depth from various perspectives. The focus of this research is to develop and test the META (Mangrove Ecosystem Transformation Approach) Innovation Design which aims to strengthen business resilience and environmental sustainability in mangrove tourism in East Java.

1. Research Design

This research is carried out in several stages, with each stage having its own goals and methods. Overall, the research design is divided into four major stages:

a. **Initial Exploration and Literature Study**: This stage includes the collection and analysis of secondary data from literature studies related to mangrove ecosystems, sustainable tourism management, the application of technology in business, and resilience theory. Data from scientific journals, reports of international organizations, and environmental policy documents are used to build a theoretical foundation in the development of innovation models.

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b. **META Model Development**: At this stage, the META Innovation Design is developed using a theoretical approach combined with relevant empirical data. The important elements of this model are adapted to the needs of the mangrove tourism business and environmental dynamics in East Java. META-based technologies are integrated to address key challenges, such as climate change, ecosystem degradation, and tourism market dynamics.
c. **Primary Data Collection**: This stage involves surveys and interviews with various stakeholders, including mangrove tourism businesses, local communities, local governments, and tourists. Quantitative surveys are distributed to businesspeople to measure factors that affect business resilience, perception of technological innovation, and acceptance of the META model. Then in-depth interviews were conducted with local communities and the government to understand the social, economic, and environmental dynamics faced in mangrove tourism management. The focus of the interview was the exploration of the social and environmental impacts of the application of technology as well as the views of stakeholders on the sustainability of the innovation model.
d. **Model Testing and Validation**: The model that has been developed has been tested on a limited basis in several mangrove tourism sites in East Java. The initial implementation of the META Innovation Design was carried out using a case study approach at the test site. The goal is to identify the suitability of the model to conditions in the field, as well as evaluate the effectiveness of the technology applied in improving environmental sustainability and business resilience. Performance analysis was carried out by collecting data related to ecosystem conditions, business growth, and tourist satisfaction before and after the implementation of the model. The results of these tests are then analyzed to ensure the success of the model and determine if adjustments are required before they are widely implemented.

2. Data Collection Techniques

The methods used for data collection in this study include:

a. Quantitative Survey

1. The survey was conducted using a questionnaire designed to measure stakeholder perception and acceptance of technological innovation and the sustainability of the mangrove tourism business. The questionnaire was distributed online and offline to businesspeople, local communities, and tourists.
2. The Likert Scale is used to measure perceptions, satisfaction, and expectations related to the implementation of META Innovation Design in various aspects, such as environmental sustainability, business profitability, and added value for local communities.

b. Qualitative Interview

1. Semi-structured interviews are conducted with businesspeople, local governments, and representatives of local communities. This interview aims to deepen their understanding of social and economic dynamics, challenges faced in mangrove tourism management, and the impact of technology on business continuity and the environment.
2. The resulting data was analyzed using thematic analysis methods to find important patterns relevant to the research objectives.

c. Direct Observation and Environmental Measurements

Direct observation was carried out in the field to observe the physical condition of the mangrove ecosystem before and after the implementation of technological innovations. Several environmental parameters, such as water quality, biodiversity, and mangrove cover area, are measured periodically. This data is used to assess the environmental impact of the applied innovation model.

d. Secondary Data Analysis

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Secondary data, such as government reports, policy documents, and tourism statistics, are used to provide context and complement the findings from the primary data. This data is also used to compare mangrove tourism locations in East Java that have implemented or have not implemented technological innovations in their business.

3. Data Analysis

a. Quantitative Analysis

1. Quantitative data from the survey was analyzed using statistical software such as SPSS or SmartPLS. The analysis techniques used included multiple regression to test the relationship between independent variables (technological innovation, business resilience) and dependent variables (profitability, tourist satisfaction, environmental sustainability).
2. Inferential statistical analysis, such as t-test and path analysis, is used to evaluate whether the application of innovation models has a significant impact on the variables measured.

b. Qualitative Analysis

1. Qualitative data from the interviews were analyzed using thematic analysis methods, in which key themes were identified and interpreted to generate insights into social, economic, and environmental dynamics.
2. This data provides a deeper understanding of the challenges and opportunities faced by stakeholders in implementing META Innovation Design.

c. Environmental Impact Evaluation

Environmental impacts are evaluated based on field measurements that include changes in mangrove cover, water quality, and biodiversity. This data is compared before and after the implementation of the innovation model to assess the effectiveness of the approach in maintaining the sustainability of mangrove ecosystems.

4. Validity and Reliability Testing

The validity of the survey instrument was tested using the validity of the content and the validity of the construct. Reliability tests were conducted using Cronbach's Alpha coefficients to ensure the internal consistency of the questionnaires. Data triangulation is applied to validate findings from various sources, such as survey results, interviews, and field measurements.

5. Research Ethics

All respondents in this study were given clear information about the purpose of the research, the right to privacy, and data confidentiality. Respondents' participation was carried out voluntarily with their consent. The researcher also ensured that any data collected was treated anonymously and not used for any purpose other than this study.

This methodology is expected to provide a comprehensive overview of the effectiveness of META Innovation Design and its contribution to strengthening business resilience and environmental sustainability of mangrove tourism in East Java

3. Results

This research aims to develop and test the META (Mangrove Ecosystem Transformation Approach) Innovation Design as a strategy to strengthen business resilience and sustainability of the mangrove tourism environment in East Java. The results of this study cover three main aspects: business resilience, environmental sustainability, and acceptance of technological innovation.

1. Mangrove Tourism Business Resilience

a. Business Performance Before and After the Implementation of META Innovation

The results of the analysis show that the mangrove tourism business in East Java, before the implementation of innovation, experienced significant challenges in terms of resilience to climate

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change, market competition, and fluctuations in the number of tourists. Quantitative data shows that the average annual income from mangrove tourism businesses has stagnated or even decreased in recent years due to several factors, such as the decline in the quality of mangrove ecosystems and the lack of innovation in tourism promotion.

After the implementation of the META Innovation Design, there has been a significant improvement in several business performance indicators. Based on survey data analyzed using multiple regression, the application of META-based technology is proven to be able to increase business competitiveness by facilitating increased tourist engagement and expanding market segments through more effective digital promotions. Specifically, there was an average revenue increase of 20-25% in tourist locations that adopted this innovation, compared to locations that have not implemented it.

The survey results also show that 80% of businesses report improvements in operational management and cost efficiency after using technology to automate several aspects of tourism services, such as online reservation systems, visit management, and evaluation of tourist experiences through digital platforms. The use of technology in managing visitor capacity helps reduce the burden on the mangrove ecosystem, especially during the peak period of tourist visits.

b. Improving Business Sustainability

One of the indicators of business resilience analyzed in this study is operational sustainability. META innovation contributes to business sustainability by offering a diversified model of tourism products that utilize local resources and environmentally friendly technologies. Several tourist sites that became trial locations succeeded in introducing educational tourism programs that teach tourists about the importance of mangrove ecosystems and environmental management.

For example, in one of the mangrove tourism sites in Probolinggo, the income from this educational activity accounts for 15% of the total annual income after the program is implemented. This shows that tourism product innovation can play an important role in strengthening business resilience to volatile market risks.

2. Mangrove Environmental Sustainability

a. Environmental Impact Evaluation

One of the main goals of META Innovation Design is to ensure that the development of the mangrove tourism business does not sacrifice environmental sustainability. The results of field measurements of the condition of the mangrove ecosystem show that there is an improvement in environmental quality after the implementation of innovation. At the test site, measurements were made of environmental parameters such as mangrove cover, water quality, and biodiversity before and after the application of the technology.

Data showed that in some pilot sites, mangrove cover increased by up to 10% over the course of one year after the implementation of a community-based conservation program that is part of the innovation model. The use of technology to monitor ecosystem health, such as the use of drones to map degraded mangrove areas and the application of satellite image processing to monitor changes in mangrove cover, has proven effective in accelerating conservation interventions.

In addition, the water quality around the mangrove ecosystem where the test was conducted also improved, which was measured through a decrease in the content of organic pollutants and an increase in dissolved oxygen levels in the waters. This improvement occurred because of better tourism waste management, which was initiated through this innovation model.

b. The Role of Local Communities in Environmental Conservation

This innovation also includes strengthening the role of local communities in environmental conservation. In qualitative interviews, 70% of respondents from local communities stated that their involvement in mangrove conservation programs increased after the integration of technology that supports real-time reporting of mangrove damage through mobile applications. This technology

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allows local communities to participate in monitoring the health of mangrove ecosystems and report potential threats, such as illegal logging or industrial waste spills, to authorities quickly.

The involvement of local communities has also had an impact on reducing conflicts between tourism businesspeople and residents, which previously often occurred due to unclear boundaries in natural resource management. With a collaborative approach facilitated by technology, this model encourages more inclusive and sustainable ecosystem management.

3. Acceptance of Technological Innovation

a. Response of Business Actors and the Government

The survey results show that most businesspeople and local governments have accepted the application of META technology. 85% of respondents from the business sector stated that this innovation is very helpful in improving operational efficiency and supporting the sustainability of their business. On the other hand, local governments welcome this innovation because it can be a more effective tool for monitoring and evaluating environmental policies.

However, research also found that the adoption rate of this technology varies depending on the scale of the business. Small and medium-sized businesses tend to face greater challenges in adopting META technology, especially in terms of initial investment costs and technical capacity. This shows that there is a need for stronger policy support, both in terms of technology subsidies and technical training for small business actors to optimize the use of this technology.

b. Traveler Response

Tourists who were part of this study also gave a positive response to the application of technology in mangrove tourism. The survey showed that 78% of tourists felt more satisfied with their travel experience after the integration of technology in the reservation system and visit management. Tourists appreciate the efforts of businesspeople in providing information about environmental sustainability and conservation activities that they can participate in during their visit.

Tourists also show great interest in educational programs offered through digital technology, such as mobile applications that provide virtual tours of mangrove ecosystems and the importance of preserving them. This shows that technology not only helps in improving business performance, but also contributes to increasing environmental awareness among tourists.

4. Discussion

a. Implications for Business Resilience

The results of this study show that META Innovation Design can increase the resilience of the mangrove tourism business in East Java by introducing diversification of products and services, as well as technology integration in business operations. Product diversification, especially through educational tourism and ecotourism programs, can add new sources of income that are more stable and sustainable. Technology also plays an important role in improving management efficiency and effectiveness, allowing businesses to better adapt to changing market conditions.

b. Positive Impact on Environmental Sustainability

The use of technology in environmental monitoring and conservation programs has yielded significant results on the sustainability of mangrove ecosystems. With more intensive and real-time monitoring, businesses and local communities can respond quickly to potential threats to the ecosystem. This proves that technology can be an effective tool in supporting more adaptive and responsive environmental management.

c. Challenges in Implementation

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Although the results of the study show the successful implementation of innovation, there are still some challenges in its implementation, especially in terms of technology accessibility for small businesses. The study identified that support from governments and other stakeholders is needed to ensure that all parties can access these technologies equally. In addition, increasing the technical capacity of businesspeople is also an important issue that needs to be overcome so that this innovation can be widely adopted.

Overall, the results of this study make a significant contribution to the development of a more resilient and sustainable mangrove tourism business model in East Java. META-based technology has been proven to be able to improve business performance while supporting environmental conservation efforts, with the active involvement of various stakeholders.

5. Conclusions

This research provides significant insights into the application of Innovative Design META (Mangrove Ecosystem Transformation Approach) as a strategic framework to enhance both the resilience of mangrove tourism businesses and the sustainability of mangrove ecosystems in East Java. The findings demonstrate that a well-designed integration of innovative technology, community engagement, and environmental conservation practices can lead to sustainable development in the coastal tourism sector.

The introduction of META has proven effective in reinforcing the resilience of mangrove tourism businesses by addressing key challenges related to fluctuating market demand, operational inefficiencies, and environmental degradation. The ability of businesses to diversify their offerings, particularly through ecotourism and educational programs, has contributed to stabilizing revenues and enhancing customer experiences. The use of digital technologies, including online booking systems and visitor management tools, has not only increased operational efficiency but also optimized resource utilization, reducing the strain on mangrove ecosystems during peak tourist seasons.

Moreover, the integration of META has enabled businesses to remain competitive in an increasingly dynamic tourism market by providing them with the tools to reach new customer segments, engage tourists through interactive and informative platforms, and build stronger relationships with local communities. This holistic approach to business operations, supported by innovative technologies, contributes to the long-term sustainability and profitability of mangrove tourism ventures.

A core component of the META innovation lies in its ability to promote and support environmental conservation. The research demonstrates that technology can play a pivotal role in monitoring and preserving mangrove ecosystems, particularly in preventing environmental degradation caused by human activities and climate change. The use of drones, satellite imagery, and real-time environmental monitoring systems has been instrumental in detecting and responding to potential threats to mangrove ecosystems, such as illegal logging and pollution.

Additionally, the involvement of local communities in conservation efforts, facilitated by the adoption of mobile applications for reporting and tracking environmental conditions, has been critical in maintaining the health of mangrove ecosystems. This collaborative approach ensures that conservation initiatives are not only technology-driven but also community-centered, aligning with the principles of sustainable development and local ownership of environmental protection efforts.

The study underscores the importance of technology as a tool for fostering stakeholder engagement, particularly between business operators, local communities, government agencies, and tourists. By leveraging digital platforms, businesses have been able to engage with tourists in more meaningful ways, providing them with educational content on mangrove conservation and offering immersive experiences through virtual tours. This not only enhances visitor satisfaction but also raises awareness of the critical importance of mangrove ecosystems to environmental sustainability.

However, the research also highlights challenges in the adoption of technology, particularly for small and medium-sized enterprises (SMEs), which may lack the financial and technical resources to fully implement and benefit from these innovations. It is essential for government bodies and

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policymakers to provide targeted support, such as subsidies for technology adoption and capacity-building initiatives, to ensure that all stakeholders can participate in and benefit from the digital transformation of the mangrove tourism sector.

While the outcomes of this research are promising, there remain several challenges that must be addressed to maximize the impact of the META innovation. The study identified barriers related to the accessibility and affordability of technology for smaller businesses, as well as the need for continuous technical support and training to enable businesses to effectively use the tools provided by META.

There are also broader policy implications, as the successful implementation of META requires alignment with regional and national policies on environmental conservation and tourism development. A supportive regulatory framework that incentivizes sustainable tourism practices, combined with local-level initiatives that engage communities in conservation efforts, will be crucial for ensuring the long-term success of the META model.

In conclusion, the META Innovation Design offers a promising framework for enhancing the resilience of mangrove tourism businesses and preserving vital ecosystems. By integrating technological innovation, community engagement, and conservation efforts, META represents a holistic approach to tourism management that aligns economic goals with environmental sustainability. However, its success depends on the continued collaboration between stakeholders, the provision of technical and financial support for SMEs, and the development of policies that encourage the adoption of sustainable practices across the tourism sector. This research lays the foundation for further exploration and application of innovative solutions to ensure the future sustainability of coastal tourism in East Java and beyond.

This study contributes to the growing body of knowledge on the intersection of tourism, technology, and environmental sustainability. The findings offer valuable lessons for policymakers, tourism practitioners, and researchers interested in promoting sustainable tourism models that can simultaneously protect natural ecosystems and support economic development. The successful implementation of META demonstrates the potential of technological innovation to transform traditional tourism practices, making them more adaptable, resilient, and environmentally responsible.

For future research, it will be important to explore the scalability of the META model and assess its applicability in different types of tourism destinations beyond mangrove ecosystems. Additionally, longitudinal studies will be beneficial in measuring the long-term impact of META on both business performance and environmental health, providing deeper insights into how sustainable tourism models can evolve and adapt over time.

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