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Eco-Theological Community-Based Waste Management For Sustainable Mangrove Ecosystem Conservation In Sinjai Regency

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Abstract: Mangrove ecosystems play a crucial role in maintaining the balance of coastal environments by protecting shorelines from erosion, sequestering carbon, and supporting local community livelihoods and economic activities. However, the mangrove area in Tongke-Tongke Village, Sinjai Regency, continues to face serious waste pollution, particularly from plastic waste and household refuse, which threatens the sustainability of its ecological functions and ecotourism potential. Therefore, a Community Partnership Program (PKM) entitled "Eco-Theological Community-Based Waste Management for Sustainable Mangrove Ecosystem Conservation in Sinjai Regency" was implemented to develop a community-based waste management model integrated with the principles of Islamic ecotheology. The program employed a combination of the Participatory Community Development approach, Community-Based Waste Management (CBWM), and the Eco-Theological Approach. The implementation consisted of several stages, including problem identification, environmental education, internalization of Islamic ecotheological values, conservation action implementation, and program evaluation. The target participants included coastal communities, the Tourism Awareness Group (Pokdarwis), religious leaders, youth, women, and mangrove tourism managers. The results demonstrated a significant improvement in community knowledge and awareness regarding waste management and mangrove conservation. The internalization of the Islamic ecotheological principles of khalifah fil ardh (human stewardship of the Earth), amanah (trust and responsibility), mīzān (balance), and maṣlaḥah (public welfare) strengthened the community's moral and spiritual commitment to environmental protection. The program also successfully increased community participation in mangrove clean-up campaigns, waste segregation practices, and established the Mangrove Conservation Community Group as a local institution to support the long-term sustainability of the initiative. Overall, the integration of community-based waste management with Islamic ecotheological values proved to be an effective approach for promoting sustainable mangrove ecosystem conservation in Tongke-Tongke Village, Sinjai Regency.

Keywords : Islamic Eco-theology, Community-based Waste Management, Mangrove Conservation, Community Empowerment

1. Introduction

Mangrove ecosystems are among the world's most productive coastal ecosystems, providing a wide range of ecological, economic, and social benefits that are essential for sustainable coastal development. As a critical component of the global blue carbon ecosystem, mangrove forests play a significant role in climate change mitigation through their exceptional capacity to sequester and store carbon, with carbon storage rates estimated to be two to four times greater than those of terrestrial tropical forests. Beyond their contribution to carbon sequestration, mangroves protect coastlines from erosion and storm surges, improve water quality by filtering pollutants, serve as nursery grounds for numerous marine species, and sustain the livelihoods of millions of coastal communities through fisheries, ecotourism, and other ecosystem services. Consequently, the conservation and sustainable management of mangrove ecosystems have become an international priority in achieving several Sustainable Development Goals (SDGs), particularly SDG 13 (Climate Action), SDG 14 (Life Below Water), and SDG 15 (Life on Land).

Despite their strategic importance, mangrove ecosystems continue to experience severe degradation due to both anthropogenic and natural pressures. Rapid coastal development, land-use conversion, urban expansion, pollution, and unsustainable resource exploitation have substantially reduced mangrove coverage worldwide. Among these threats, plastic waste and unmanaged household waste have emerged as increasingly critical environmental challenges. Unlike organic waste, plastic materials persist in coastal environments for decades, accumulating within mangrove root systems

where they obstruct water circulation, inhibit seedling growth, alter sediment characteristics, and threaten the survival of aquatic organisms. The accumulation of marine debris not only degrades ecological functions but also diminishes the aesthetic value of mangrove ecotourism destinations, ultimately affecting local economies that depend on nature-based tourism.

Indonesia possesses the largest mangrove ecosystem in the world, accounting for approximately one-fifth of global mangrove coverage. This strategic position places Indonesia at the forefront of global mangrove conservation initiatives while simultaneously presenting considerable environmental management challenges. Coastal regions throughout the country increasingly experience marine debris accumulation resulting from inadequate waste management systems, population growth, and tourism activities. Numerous studies have demonstrated that ineffective solid waste management significantly contributes to the deterioration of coastal ecosystems, reducing biodiversity, disrupting ecological processes, and threatening the sustainability of blue carbon resources. Therefore, improving waste management practices has become an essential component of integrated coastal ecosystem conservation strategies.

One of the important mangrove areas in Indonesia is located in Tongke-Tongke Village, Sinjai Regency, South Sulawesi, where community participation has historically contributed to successful mangrove rehabilitation and ecotourism development. Over the past decades, this mangrove forest has evolved into one of the region's most recognized ecotourism destinations, generating ecological, educational, and economic benefits for local communities. The expansion of tourism activities has created new livelihood opportunities through small-scale enterprises, local services, and recreational businesses while simultaneously strengthening environmental awareness among residents. However, increasing tourism intensity and growing community activities have also resulted in higher volumes of plastic waste and household refuse within the mangrove area. Field observations conducted prior to this community partnership program identified substantial waste accumulation along mangrove boardwalks, tidal zones, and mangrove root systems, indicating that waste management practices have not adequately kept pace with the area's rapid tourism development.

The environmental consequences of unmanaged waste extend beyond visual pollution. Plastic debris trapped within mangrove roots interferes with natural regeneration processes, reduces oxygen exchange within sediments, degrades water quality, and threatens the survival of fish, crustaceans, mollusks, and other coastal organisms that depend on healthy mangrove habitats. Furthermore, deteriorating environmental quality negatively affects visitor experiences, potentially reducing tourism competitiveness and weakening local economic resilience. These interconnected ecological, social, and economic challenges demonstrate that sustainable mangrove conservation requires comprehensive interventions extending beyond conventional waste collection activities. Instead, effective conservation demands community participation, behavioral transformation, institutional collaboration, and locally relevant environmental values capable of fostering long-term stewardship of coastal ecosystems.

Addressing the growing challenge of waste pollution in mangrove ecosystems requires more than improvements in technical waste collection and disposal systems. Increasing evidence suggests that sustainable environmental management depends largely on community participation, social responsibility, and institutional collaboration. Consequently, **Community-Based Waste Management (CBWM)** has emerged as one of the most effective approaches for improving solid waste management in developing countries. Unlike conventional top-down management systems, CBWM positions local communities as the primary actors responsible for planning, implementing, monitoring, and evaluating waste management activities. This participatory approach not only reduces the burden on local governments but also strengthens community ownership, enhances environmental awareness, and encourages long-term behavioral change. Previous studies have consistently demonstrated that communities actively involved in waste segregation, recycling, and environmental monitoring exhibit

higher levels of environmental responsibility and produce more sustainable conservation outcomes than communities relying solely on government-led interventions.

Within coastal environments, the effectiveness of CBWM becomes even more significant because the sources of marine debris are closely associated with household activities, tourism, fisheries, and small-scale commercial enterprises. Since most coastal waste originates from local human activities, community engagement is indispensable for preventing waste from entering marine ecosystems. Furthermore, mangrove conservation requires continuous monitoring and routine maintenance that cannot be sustained exclusively through government intervention. Consequently, empowering local stakeholders—including fishermen, tourism awareness groups (Pokdarwis), women's organizations, youth associations, and village authorities—represents a practical strategy for strengthening the long-term resilience of mangrove ecosystems.

Although numerous studies have confirmed the effectiveness of community participation in improving waste management and environmental conservation, behavioral change remains one of the most difficult challenges to achieve. Environmental education programs frequently succeed in increasing public knowledge but often fail to transform environmental awareness into consistent daily practices. Individuals may understand the negative consequences of plastic pollution while continuing environmentally harmful behaviors because environmental knowledge alone is insufficient to alter deeply rooted habits, cultural norms, and social values. This limitation indicates that sustainable environmental management requires complementary approaches capable of influencing not only cognitive understanding but also moral commitment and intrinsic motivation.

In recent years, scholars have increasingly recognized the importance of integrating religious and ethical values into environmental governance. Religion has proven to be a powerful social institution capable of shaping attitudes, influencing behavior, and mobilizing collective action toward environmental sustainability. Within Muslim-majority societies, **Islamic eco-theology** offers a comprehensive ethical framework that connects environmental stewardship with religious obligations. Rather than viewing environmental conservation merely as a technical or governmental responsibility, Islamic eco-theology positions environmental protection as a moral and spiritual duty entrusted to humanity by God. This perspective provides an additional motivational dimension that complements scientific knowledge and policy interventions by encouraging individuals to protect nature as an act of worship and social responsibility.

The theological foundation of Islamic environmental ethics is primarily derived from several interconnected concepts. The concept of *khalifah fil ardh* emphasizes humanity's role as God's steward on Earth, responsible for protecting and managing natural resources wisely. The principle of *amanah* highlights that all environmental resources constitute a divine trust that must be preserved for present and future generations. Likewise, *mīzān* represents ecological balance, reminding humanity that environmental degradation disrupts the harmonious order established by God, while *maṣlaḥah* encourages every human activity to generate collective welfare and public benefit. Together, these principles establish a comprehensive ethical framework that links environmental sustainability with spiritual accountability, thereby strengthening community commitment toward conservation activities.

The integration of Islamic eco-theology into community-based environmental management is particularly relevant in **Sinjai Regency**, where Islam strongly influences social life, community leadership, and cultural identity. Widely recognized as the **"Bumi Panrita Kitta"**, Sinjai possesses a rich Islamic intellectual tradition characterized by the active roles of religious scholars, mosque leaders, Islamic educational institutions, and community preachers. These religious institutions serve not only as centers of worship but also as influential platforms for disseminating social values and encouraging collective action. Consequently, environmental campaigns delivered through religious discourse are likely to receive stronger public acceptance than purely technical or administrative interventions.

Religious leaders possess substantial social authority that can transform environmental conservation messages into moral obligations embraced by local communities.

Despite the growing body of literature on mangrove conservation, community-based waste management, environmental education, and Islamic environmental ethics, existing studies generally examine these themes independently. Research on mangrove conservation primarily emphasizes ecological restoration, biodiversity protection, or ecotourism development. Meanwhile, studies concerning CBWM frequently focus on technical waste management practices, institutional capacity, or community participation without considering the influence of religious values on environmental behavior. Similarly, Islamic eco-theology research predominantly discusses theological concepts and ethical principles without translating them into practical community-based conservation models capable of addressing contemporary environmental challenges. As a result, limited empirical evidence exists regarding how Islamic eco-theological values can be systematically integrated into participatory waste management strategies to strengthen sustainable mangrove conservation, particularly within coastal tourism destinations.

The fragmented nature of previous studies highlights an important research gap. First, although numerous studies have demonstrated the effectiveness of community participation in mangrove conservation, they generally emphasize ecological restoration, waste reduction, or ecotourism development without integrating faith-based environmental ethics into community empowerment strategies. Second, research on Islamic eco-theology has predominantly remained conceptual, focusing on theological interpretations of environmental stewardship while offering limited practical frameworks for implementation in community development programs. Third, studies investigating community-based waste management frequently prioritize technical and institutional dimensions but pay insufficient attention to the socio-cultural and religious factors that influence environmental behavior in Muslim communities. Consequently, there remains limited empirical evidence regarding how community-based waste management can be systematically integrated with Islamic eco-theological principles to produce sustainable behavioral change in coastal communities. This gap is particularly evident in Indonesia's mangrove ecotourism areas, where environmental conservation, tourism development, and community livelihoods are closely interconnected.

The case of **Tongke-Tongke Village, Sinjai Regency**, provides an appropriate context for addressing this research gap. Unlike many mangrove conservation sites established primarily through government initiatives, the mangrove forest in Tongke-Tongke has developed through strong community participation and has evolved into one of South Sulawesi's leading ecotourism destinations. The area represents a successful example of community-driven mangrove rehabilitation while simultaneously illustrating the emerging environmental challenges associated with increasing tourism activities. The accumulation of plastic waste and household refuse demonstrates that ecological restoration alone is insufficient to ensure long-term sustainability. Instead, continuous behavioral transformation supported by effective local institutions and culturally appropriate environmental values is required to maintain ecosystem resilience. Therefore, Tongke-Tongke offers an ideal setting for examining how community participation and religious values can be integrated into an innovative conservation model capable of addressing both environmental degradation and community development objectives.

Another important gap concerns the limited integration of environmental governance with local religious institutions. Existing environmental management programs frequently rely on awareness campaigns, technical training, or government regulations while overlooking the influential role of religious leaders, mosques, and faith-based organizations in shaping environmental behavior. In Muslim-majority communities, religious institutions possess considerable social legitimacy and public trust, enabling them to function as effective agents of behavioral change. Incorporating Islamic eco-

theological principles into environmental education therefore extends beyond adding a moral dimension; it provides a culturally embedded mechanism capable of strengthening community participation, reinforcing collective responsibility, and encouraging long-term environmental stewardship. Such integration aligns environmental sustainability with local cultural identity, thereby increasing the likelihood that conservation initiatives will be accepted, maintained, and institutionalized within the community.

Accordingly, this Community Partnership Program proposes an integrated model entitled **Eco-Theological Community-Based Waste Management (ET-CBWM)**, which combines **Participatory Community Development**, **Community-Based Waste Management**, and **Islamic eco-theological principles** into a comprehensive framework for sustainable mangrove conservation. Unlike conventional waste management approaches that primarily emphasize technical interventions, the proposed model simultaneously addresses environmental knowledge, community empowerment, institutional collaboration, and spiritual motivation. Through environmental education, participatory conservation activities, religious-based awareness campaigns, and the establishment of local conservation institutions, the model seeks to foster lasting behavioral change while strengthening the ecological, social, and economic resilience of coastal communities.

The novelty of this study lies in three important aspects. **First**, it integrates Islamic eco-theological values—particularly *khalifah fil ardh*, *amanah*, *mīzān*, and *maṣlaḥah*—into a community-based waste management framework, an approach that has rarely been implemented in mangrove conservation programs. **Second**, it develops an interdisciplinary model that bridges environmental science, community development, and religious ethics, thereby providing a more holistic strategy for addressing coastal environmental challenges. **Third**, it demonstrates the practical application of this integrated model within a community-managed mangrove ecotourism destination, offering empirical evidence that faith-based environmental approaches can effectively complement technical conservation measures and strengthen local environmental governance.

Beyond its practical implications, this study contributes to the broader discourse on sustainable development by illustrating how locally embedded cultural and religious values can support global environmental objectives. The findings enrich theoretical discussions concerning community-based natural resource management by demonstrating that environmental sustainability depends not only on institutional capacity and technical innovation but also on ethical values capable of shaping collective behavior. Furthermore, the study provides a replicable framework for other Muslim-majority coastal regions seeking to integrate community participation, environmental education, and religious values into sustainable conservation initiatives. Such an approach supports international efforts to strengthen nature-based solutions, climate change adaptation, and blue carbon conservation while respecting local socio-cultural contexts.

Therefore, this study aims to develop and implement an **Eco-Theological Community-Based Waste Management** model for sustainable mangrove ecosystem conservation in Tongke-Tongke Village, Sinjai Regency. Specifically, the program seeks to enhance community awareness of environmental protection, strengthen community participation in waste management and mangrove conservation, institutionalize Islamic eco-theological values within local conservation practices, and establish a sustainable community-based conservation mechanism capable of preserving the ecological integrity, tourism value, and socio-economic benefits of the mangrove ecosystem. Through this integrated approach, the study is expected to provide both theoretical and practical insights into the role of faith-based community empowerment in advancing sustainable coastal ecosystem management.

2. Research Methodology

This study employed a community-based participatory approach to develop and implement an Eco-Theological Community-Based Waste Management (ET-CBWM) model for sustainable mangrove ecosystem conservation in Tongke-Tongke Village, Sinjai Regency, South Sulawesi, Indonesia. The research adopted the principles of Participatory Community Development (PCD) integrated with Community-Based Waste Management (CBWM) and the Islamic Eco-Theological Approach to encourage active community participation in waste management and mangrove conservation.

3.1 Study Area

The study was conducted in Tongke-Tongke Village, Sinjai Regency, South Sulawesi Province, Indonesia. The village was purposively selected because it possesses one of Indonesia's most successful community-managed mangrove forests, which functions simultaneously as a coastal protection system, a blue carbon ecosystem, and an ecotourism destination. Despite its ecological and economic importance, the area continues to experience environmental challenges caused by plastic waste and household waste generated by local communities and visitors.

3.2 Research Design

This study applied a Participatory Action Research (PAR) design, emphasizing collaboration between researchers and local stakeholders throughout the entire research process. Rather than positioning community members as research subjects, the study involved them as active partners in identifying environmental problems, designing intervention strategies, implementing conservation activities, and evaluating program outcomes.

The integrated ET-CBWM framework combines three complementary approaches:

1. Participatory Community Development (PCD) to strengthen community participation and empowerment;
2. Community-Based Waste Management (CBWM) to improve household and community waste management practices; and
3. Islamic Eco-Theological Approach to integrate religious values into environmental awareness and behavioral transformation.

3.3 Participants

Participants were selected using purposive sampling based on their involvement in mangrove management and community activities. The participants included:

1. coastal community members;
2. Tourism Awareness Group (Pokdarwis);
3. village government officials;
4. religious leaders (Imams and Islamic preachers);
5. youth organizations;
6. women's groups; and
7. mangrove tourism managers.

A total of approximately 60–100 participants were actively involved throughout the program implementation, representing multiple community stakeholders responsible for environmental management within the village.

3.4 Data Collection

Data were collected using multiple qualitative techniques to ensure data triangulation and improve research validity.

- Observation
  Direct field observations were conducted to assess environmental conditions, identify waste accumulation points, evaluate mangrove ecosystem conditions, and monitor community participation during conservation activities.
- Semi-Structured Interviews
  Interviews were conducted with village officials, religious leaders, tourism managers, and community representatives to explore local perceptions regarding waste management, mangrove conservation, and the integration of Islamic environmental values.
- Focus Group Discussions (FGDs)
  FGDs were organized to identify environmental problems, discuss potential solutions, formulate community action plans, and evaluate program implementation.
- Documentation
  Photographs, attendance records, meeting minutes, educational materials, and conservation activity reports were collected as supporting evidence throughout the research process.

3.5 Program Implementation

The ET-CBWM program was implemented through five sequential stages.

Stage 1: Problem Identification

Initial activities consisted of stakeholder consultations, environmental observations, interviews, and focus group discussions to identify major environmental problems, waste sources, community behavior, and existing institutional capacity for waste management.

Stage 2: Environmental Education

Educational workshops and public awareness campaigns were conducted to improve participants' understanding of mangrove ecosystem functions, blue carbon, marine pollution, and the principles of Reduce, Reuse, and Recycle (3R). Interactive discussions and practical demonstrations were used to encourage community participation.

Stage 3: Internalization of Islamic Eco-Theological Values

Religious leaders delivered environmental messages through sermons, Islamic study circles, and community discussions emphasizing four core Islamic principles:

- Khalifah fil Ardh (human stewardship of the Earth),
- Amanah (environmental responsibility),
- Mīzān (ecological balance), and
- Maṣlaḥah (public welfare).

These theological values were integrated into environmental education to strengthen moral responsibility toward mangrove conservation.

Stage 4: Community Conservation Action

Community members participated directly in mangrove clean-up campaigns, waste segregation activities, plastic reduction initiatives, installation of waste collection facilities, and the establishment of the Mangrove Conservation Community Group, which serves as a local institution responsible for sustaining conservation activities.

Stage 5: Monitoring and Evaluation

Program evaluation assessed improvements in community participation, environmental awareness, waste management practices, and institutional development. Reflection meetings involving all stakeholders were conducted to identify program achievements, remaining challenges, and recommendations for future sustainability.

3.6 Data Analysis

Qualitative data were analyzed using thematic analysis following the procedures proposed by Braun and Clarke. The analysis consisted of six stages: (1) data familiarization, (2) initial coding, (3) theme identification, (4) theme review, (5) theme definition and interpretation, and (6) report preparation. Data obtained from observations, interviews, FGDs, and documentation were triangulated to enhance the credibility and reliability of the findings.

The effectiveness of the ET-CBWM model was evaluated based on four main indicators:

1. increased community knowledge regarding waste management and mangrove conservation;
2. strengthened environmental awareness through Islamic eco-theological values;
3. increased community participation in conservation activities; and
4. establishment of sustainable community institutions supporting mangrove conservation.

3. Results and Discussion

3.1 Baseline Environmental Conditions and Waste Management Challenges

The preliminary assessment conducted in Tongke-Tongke Village revealed that although the mangrove ecosystem has been widely recognized as one of the most successful community-managed mangrove forests in Indonesia, environmental sustainability is increasingly threatened by unmanaged solid waste. Field observations identified significant accumulations of plastic bottles, food packaging, disposable cups, plastic bags, and household waste along mangrove boardwalks, tidal channels, and within mangrove root systems. Waste accumulation was particularly evident in areas experiencing high tourist visitation and near residential settlements located adjacent to the mangrove ecosystem. These findings indicate that the rapid growth of ecotourism has not been accompanied by equally effective waste management practices, creating environmental pressures that may undermine long-term ecosystem resilience.

Interviews with community members further demonstrated that waste generation originates from two primary sources. The first source is household waste produced by coastal residents, while the second originates from tourism-related activities. Although waste collection facilities were available in several locations, improper waste segregation, limited environmental awareness among visitors, and inconsistent waste disposal practices contributed to continued littering within the conservation area. Several participants acknowledged that plastic waste frequently accumulated after weekends and public holidays when visitor numbers substantially increased. Consequently, local community groups were required to conduct routine clean-up activities to maintain the attractiveness of the mangrove tourism destination.

The baseline assessment also identified institutional challenges affecting waste management performance. While local government regulations supporting environmental protection exist, community participation in waste reduction activities remained inconsistent before the implementation of the ET-CBWM program. Waste management was generally perceived as the responsibility of local authorities rather than a shared responsibility among community members. This perception limited individual initiative to reduce plastic consumption, separate recyclable materials, or participate in environmental monitoring activities. Similar conditions have been reported in many coastal communities throughout Southeast Asia, where inadequate institutional coordination and limited public engagement reduce the effectiveness of coastal waste management programs.

Environmental observations additionally revealed that plastic debris trapped within mangrove root systems posed direct ecological risks. Mangrove pneumatophores covered by plastic materials experienced reduced exposure to tidal water exchange, potentially affecting oxygen diffusion into sediments. Accumulated waste also created localized water stagnation and altered sediment characteristics, which may negatively influence seedling establishment and benthic organism diversity.

Although the present study did not quantitatively measure ecological degradation, these observations are consistent with previous studies reporting that marine debris disrupts mangrove regeneration processes, decreases biodiversity, and reduces ecosystem service provision.

Beyond ecological consequences, unmanaged waste also threatens the socio-economic sustainability of Tongke-Tongke's ecotourism sector. Tourism managers reported that environmental cleanliness strongly influences visitor satisfaction and destination competitiveness. Plastic waste scattered along wooden boardwalks and mangrove trails reduces the visual attractiveness of the landscape and may negatively affect tourists' perceptions regarding environmental quality. Since ecotourism constitutes an important source of local income through small businesses, transportation services, food vendors, and recreational activities, environmental degradation could ultimately reduce economic opportunities for coastal households. These findings reinforce the close interdependence between environmental conservation and sustainable community livelihoods.

The baseline findings therefore demonstrate that waste pollution within Tongke-Tongke cannot be interpreted solely as a technical sanitation issue. Instead, it represents a multidimensional challenge involving environmental governance, public awareness, tourism management, and community behavior. This complexity supports the argument that sustainable mangrove conservation requires integrated approaches capable of simultaneously addressing ecological restoration, institutional strengthening, community empowerment, and behavioral transformation.

From the perspective of Community-Based Waste Management (CBWM), the baseline assessment highlights an important limitation frequently identified in previous studies. Technical infrastructure alone cannot guarantee effective waste management unless accompanied by active community participation and a strong sense of collective responsibility. The absence of consistent behavioral commitment often results in recurring waste accumulation despite the availability of disposal facilities. Therefore, environmental interventions should prioritize social learning, participatory governance, and local institutional development rather than relying exclusively on physical infrastructure. This perspective provides the theoretical foundation for implementing the ET-CBWM model in Tongke-Tongke Village, where behavioral transformation constitutes a prerequisite for achieving long-term mangrove conservation.

3.2 Community Capacity Building through Environmental Education

One of the principal components of the ET-CBWM program was the implementation of community-based environmental education designed to improve public understanding of waste management and strengthen awareness of the ecological importance of mangrove ecosystems. The educational activities included environmental seminars, interactive discussions, practical demonstrations of waste segregation, awareness campaigns promoting the 3R (Reduce, Reuse, Recycle) principles, and community dialogues involving village authorities, tourism managers, youth organizations, women's groups, and coastal residents. Unlike conventional environmental campaigns that primarily emphasize information dissemination, the educational strategy adopted in this program employed a participatory learning approach, encouraging community members to identify environmental problems collectively and formulate locally appropriate solutions.

Field observations throughout the implementation indicated a substantial improvement in participants' understanding of the ecological functions of mangrove ecosystems. Before the educational intervention, many participants perceived mangroves primarily as tourism assets or coastal vegetation protecting the shoreline. Following the educational sessions, participants demonstrated a broader understanding of mangroves as multifunctional ecosystems that provide shoreline protection, nursery habitats for marine organisms, carbon sequestration services, biodiversity conservation, and sustainable livelihood opportunities for coastal communities. Participants also recognized the close

relationship between environmental quality, tourism attractiveness, and local economic resilience. This broader ecological perspective represents an essential prerequisite for encouraging environmentally responsible behavior because individuals are more likely to support conservation initiatives when they understand the ecosystem services upon which their livelihoods depend.

Environmental education also enhanced participants' knowledge regarding the impacts of plastic pollution on mangrove ecosystems. During discussions and field demonstrations, community members identified various pathways through which plastic waste enters the mangrove area, including household disposal, river transport, and tourism activities. Participants further recognized that plastic debris trapped within mangrove roots can obstruct tidal flow, inhibit seedling growth, reduce water quality, and threaten marine biodiversity. Such understanding transformed waste from being perceived merely as an aesthetic problem into an ecological threat with long-term consequences for ecosystem sustainability. Consequently, participants increasingly viewed waste management as an integral component of mangrove conservation rather than an isolated sanitation activity.

Another important outcome of the educational program was the increased understanding of waste segregation and household waste reduction practices. Practical demonstrations enabled participants to distinguish between organic, recyclable, and residual waste while introducing simple household waste management techniques applicable within the local context. Several community members expressed their willingness to reduce single-use plastics and participate in community clean-up initiatives after recognizing the environmental and economic costs associated with unmanaged waste. Although behavioral transformation requires sustained intervention over time, these findings suggest that environmental education successfully established the cognitive foundation necessary for long-term behavioral change.

The effectiveness of this educational intervention can be interpreted through Environmental Education Theory, which argues that environmental behavior develops progressively through the interaction between environmental knowledge, attitudes, awareness, and behavioral intentions. According to this theoretical perspective, knowledge acquisition alone does not automatically produce environmentally responsible behavior; however, it represents the essential first stage of behavioral transformation. Educational programs that combine scientific information with active participation, experiential learning, and community engagement are generally more successful in promoting pro-environmental behavior than traditional lecture-based approaches. The participatory learning model adopted in this program therefore strengthened not only participants' environmental knowledge but also their sense of ownership toward local conservation initiatives.

These findings are consistent with previous international studies demonstrating that community-based environmental education significantly improves ecological literacy and public participation in environmental management. Research on coastal ecosystem conservation has repeatedly shown that participatory educational approaches encourage stronger environmental stewardship because local communities become directly involved in understanding environmental problems and developing practical solutions. Likewise, studies on community-based waste management indicate that educational interventions improve waste segregation practices, increase recycling participation, and strengthen collective environmental responsibility when supported by continuous community engagement rather than one-time awareness campaigns.

Nevertheless, the present findings also reveal that environmental education alone cannot fully guarantee sustainable behavioral change. During evaluation discussions, several participants acknowledged that although they had gained a better understanding of proper waste management practices, maintaining consistent environmentally responsible behavior remained challenging due to deeply rooted daily habits, limited waste management facilities, and varying levels of commitment among community members. Similar limitations have been identified in environmental education

literature, where improvements in environmental knowledge frequently exceed observable changes in actual behavior. This phenomenon, commonly described as the knowledge–behavior gap, suggests that cognitive awareness must be reinforced by complementary social, cultural, and institutional mechanisms capable of sustaining behavioral transformation over time.

Within the context of Tongke-Tongke Village, these findings indicate that environmental education should be viewed as one component of a broader community empowerment strategy rather than a standalone intervention. The participatory educational activities successfully increased environmental literacy and established a shared understanding of waste-related environmental challenges; however, long-term conservation outcomes depend upon the integration of education with institutional support, community participation, and culturally relevant value systems. This realization provided the rationale for incorporating Islamic eco-theological principles into the ET-CBWM framework, recognizing that moral and spiritual values may strengthen intrinsic environmental motivation beyond what can be achieved through scientific knowledge alone.

The educational outcomes therefore demonstrate that participatory environmental education plays a pivotal role in establishing the knowledge base required for sustainable community-based waste management. More importantly, the findings suggest that effective environmental education in coastal communities should move beyond information transfer toward collaborative learning processes that empower local stakeholders to become active environmental stewards. Such an approach strengthens both community capacity and social cohesion, creating favorable conditions for the subsequent integration of religious values and collective conservation actions discussed in the following section.

3.3 Integration of Islamic Eco-Theology in Strengthening Environmental Stewardship

One of the distinguishing features of the ET-CBWM model is the integration of Islamic eco-theological values into community-based waste management and mangrove conservation activities. Unlike conventional environmental programs that primarily rely on scientific knowledge and technical interventions, this program recognized that environmental behavior is also shaped by ethical beliefs, cultural traditions, and religious values. Consequently, environmental education was complemented by religious discussions, mosque-based environmental campaigns, thematic sermons (*khutbah*), and community dialogues facilitated by local religious leaders. These activities emphasized that environmental conservation is not merely a civic obligation but also a religious responsibility entrusted to humanity by Allah SWT.

The implementation of eco-theological education centered on four fundamental Islamic principles: *khalifah fil ardh* (human stewardship of the Earth), *amanah* (trust and responsibility), *mīzān* (ecological balance), and *maṣlaḥah* (public welfare). These concepts provided a theological foundation for understanding environmental protection as an integral component of Islamic ethics. Rather than presenting environmental degradation solely as an ecological problem, facilitators encouraged participants to interpret waste pollution as a violation of humanity's responsibility to preserve God's creation. This perspective transformed environmental conservation from a voluntary activity into a moral obligation embedded within everyday religious practice.

Field observations and focus group discussions indicated that the integration of religious values substantially strengthened participants' emotional attachment to environmental conservation. Many participants expressed that they had previously understood waste management as a matter of village cleanliness or tourism management. However, after participating in eco-theological discussions, they increasingly perceived environmental stewardship as part of their spiritual accountability. Several community members explained that disposing of waste irresponsibly could no longer be viewed simply as inappropriate behavior but rather as neglecting the divine trust (*amanah*) entrusted to humankind.

This shift illustrates that religious values contributed to the internalization of environmental ethics beyond cognitive understanding alone.

Religious leaders also emerged as influential agents of environmental change throughout the program. Imams, Islamic preachers, and community religious figures actively incorporated environmental messages into sermons, Qur'anic study sessions, and other religious gatherings. Because these individuals possess considerable moral authority and social legitimacy within the community, their involvement enhanced the credibility and acceptance of conservation messages. Participants reported that environmental advice delivered within religious settings was perceived as more persuasive than messages communicated exclusively through governmental campaigns or technical training. This finding highlights the strategic role of faith-based institutions in supporting environmental governance within Muslim-majority communities.

The observed behavioral transformation can be interpreted through the perspective of Islamic Eco-Theology, which argues that environmental ethics emerge from the interconnected relationship between humanity, nature, and God. Within this framework, humans are regarded not as owners of natural resources but as temporary custodians responsible for maintaining ecological balance. The Qur'anic concepts of stewardship, justice, moderation, and collective welfare encourage sustainable resource management while discouraging environmental degradation. Accordingly, environmental responsibility extends beyond compliance with governmental regulations and becomes an expression of faith manifested through daily behavior.

These findings are consistent with an expanding body of international literature demonstrating that faith-based environmental initiatives can significantly enhance community participation in sustainability programs. Previous studies have reported that religious beliefs often provide intrinsic motivation for environmental action because they connect ecological responsibility with moral identity and spiritual values. In Muslim societies, Islamic environmental ethics have been increasingly recognized as culturally relevant instruments capable of promoting climate adaptation, biodiversity conservation, sustainable resource management, and environmental justice. By integrating environmental science with religious teachings, conservation programs become more socially acceptable and culturally meaningful, thereby increasing their long-term sustainability.

The findings also complement theories of Value-Belief-Norm (VBN), which explain that pro-environmental behavior develops when individuals internalize moral norms regarding environmental responsibility. According to this theory, environmental actions are strongly influenced by personal values and ethical beliefs rather than by knowledge alone. The ET-CBWM program demonstrated that Islamic eco-theological values functioned as moral norms reinforcing environmental responsibility. Participants who viewed environmental conservation as a religious obligation exhibited greater willingness to participate in mangrove clean-up activities, promote waste segregation within their households, and encourage environmentally responsible behavior among neighbors and family members. Thus, religious values served not merely as educational content but as motivational mechanisms supporting sustained behavioral change.

Another significant outcome was the strengthening of collective environmental responsibility. Rather than emphasizing individual behavior alone, eco-theological discussions highlighted the Islamic principles of cooperation (*ta'awun*) and mutual responsibility in protecting shared environmental resources. This collective orientation encouraged community members to organize regular clean-up activities, support local conservation initiatives, and monitor environmental conditions cooperatively. Consequently, environmental stewardship gradually evolved from an individual concern into a shared social norm reinforced through both religious and community institutions.

Despite these positive outcomes, the findings also suggest that integrating religion into environmental management should complement, rather than replace, scientific and technical

approaches. Religious values provide ethical motivation, but effective conservation still depends upon adequate waste management infrastructure, supportive public policies, institutional coordination, and continuous environmental education. Therefore, the effectiveness of the ET-CBWM model derives not from eco-theology alone but from its integration with participatory community development and community-based waste management strategies. This multidimensional approach enables environmental knowledge, moral values, and collective action to reinforce one another, thereby creating a more comprehensive framework for sustainable mangrove conservation.

Overall, the integration of Islamic eco-theology represents one of the most important innovations of this study. The findings demonstrate that environmental sustainability within Muslim-majority coastal communities can be strengthened by combining scientific knowledge with culturally embedded religious values. Such integration not only enhances environmental awareness but also fosters intrinsic motivation, collective responsibility, and long-term stewardship of mangrove ecosystems. These results provide empirical evidence that faith-based environmental governance can serve as an effective complement to community-based conservation strategies and offer a promising model for other coastal regions facing similar environmental challenges.

3.4 Community-Based Waste Management and Mangrove Conservation Outcomes

The implementation of the Eco-Theological Community-Based Waste Management (ET-CBWM) model resulted in significant improvements in community participation and environmental stewardship within the mangrove ecosystem of Tongke-Tongke Village. Following the environmental education activities and the internalization of Islamic eco-theological values, community members became increasingly involved in various conservation initiatives, including mangrove clean-up campaigns, household waste segregation, reduction of single-use plastics, and routine environmental monitoring. The establishment of collaborative activities involving local government, Tourism Awareness Groups (Pokdarwis), religious leaders, youth organizations, women's groups, and coastal residents created a shared governance mechanism that strengthened local ownership of mangrove conservation efforts.

One of the most notable outcomes of the program was the transition from reactive waste management toward preventive environmental management. Before the intervention, waste management activities were generally limited to periodic clean-up campaigns conducted after visible waste accumulation had occurred. Following program implementation, community members increasingly emphasized waste prevention through household waste segregation, responsible consumption practices, and continuous environmental monitoring. This behavioral transition indicates that participants gradually shifted their perception of waste management from a short-term sanitation activity to a long-term environmental conservation strategy.

Field observations also demonstrated visible improvements in the environmental condition of several sections of the mangrove ecotourism area. Waste accumulation along boardwalks and tidal zones declined because regular community clean-up activities became institutionalized within the village. Community members voluntarily organized collective environmental actions during weekends and after major tourism events to prevent plastic debris from accumulating within mangrove root systems. Although this study did not quantify reductions in waste volume, qualitative observations consistently indicated cleaner environmental conditions and greater community vigilance in maintaining ecosystem cleanliness compared with conditions observed during the preliminary assessment.

An equally important outcome was the establishment of the Mangrove Conservation Community Group, which functions as a local institution responsible for coordinating waste management and conservation activities after completion of the program. The formation of this community organization

represents a critical indicator of institutional sustainability because successful conservation depends not only on individual awareness but also on the presence of local governance structures capable of coordinating collective action. The group developed regular work schedules, organized community clean-up activities, facilitated communication with village authorities, and promoted environmental awareness among residents and visitors. Such institutional development increases the likelihood that conservation initiatives will continue beyond externally funded interventions.

From the perspective of Community-Based Waste Management (CBWM), these findings demonstrate that sustainable waste management depends fundamentally upon community empowerment rather than technological intervention alone. The CBWM framework argues that effective environmental governance emerges when local communities actively participate in planning, implementation, monitoring, and evaluation of waste management systems. The ET-CBWM program successfully operationalized these principles by involving community members throughout every stage of program implementation, thereby strengthening both technical capacity and social responsibility. Rather than functioning as passive beneficiaries, participants became active environmental stewards responsible for maintaining the ecological integrity of their own coastal environment.

The findings further support the theoretical perspective of Participatory Community Development, which emphasizes that sustainable development outcomes are achieved when communities possess both decision-making authority and collective ownership over development initiatives. Active participation throughout the program enhanced community confidence, strengthened local leadership, and fostered collaborative relationships among multiple stakeholders. Such collaboration reduced dependence on external interventions and encouraged communities to develop locally appropriate solutions for addressing environmental challenges. These observations suggest that participation itself constitutes an important outcome because it strengthens the social capital necessary for sustaining future conservation efforts.

The outcomes observed in Tongke-Tongke Village are consistent with previous studies demonstrating the effectiveness of participatory environmental governance in coastal ecosystem management. International research has shown that community-managed conservation programs generally achieve higher levels of ecological sustainability than centralized management approaches because local communities possess greater contextual knowledge, stronger social networks, and direct incentives to maintain ecosystem services upon which their livelihoods depend. Similarly, studies on community-based waste management have reported that household participation, local institutional capacity, and community leadership are among the strongest predictors of successful waste reduction and environmental protection.

Another significant contribution of the ET-CBWM model lies in its ability to integrate environmental conservation with local socio-economic development. The mangrove ecosystem in Tongke-Tongke serves not only ecological functions but also supports ecotourism, fisheries, and various small-scale economic activities. Consequently, improvements in environmental quality directly contribute to maintaining tourism attractiveness and protecting local livelihoods. Participants increasingly recognized that maintaining environmental cleanliness is economically beneficial because cleaner tourism destinations attract more visitors, strengthen local businesses, and enhance the village's environmental reputation. This finding reinforces the concept that environmental sustainability and economic development should be viewed as mutually reinforcing rather than competing objectives.

Nevertheless, several challenges remain. Some participants indicated that maintaining long-term behavioral consistency requires continuous environmental education, stronger institutional support, and improved waste management infrastructure. Seasonal tourism fluctuations also increase waste generation, requiring adaptive management strategies during periods of high visitor intensity. Furthermore, maintaining active participation among all community members represents an ongoing

challenge because environmental stewardship depends upon continuous collective commitment rather than one-time interventions. These findings suggest that successful community-based conservation requires long-term facilitation, periodic evaluation, and supportive local policies to sustain behavioral and institutional change.

Overall, the implementation of the ET-CBWM model demonstrates that sustainable mangrove conservation can be substantially strengthened through the integration of community participation, environmental education, institutional development, and Islamic eco-theological values. The observed improvements in environmental awareness, community participation, institutional capacity, and ecosystem cleanliness collectively indicate that the model provides a comprehensive framework for addressing complex environmental challenges in coastal communities. More importantly, the findings illustrate that effective conservation extends beyond ecological restoration by fostering social transformation and strengthening the collective capacity of local communities to manage natural resources sustainably.

3.5 General Discussion: Theoretical and Practical Implications of the ET-CBWM Model

The findings of this study demonstrate that the Eco-Theological Community-Based Waste Management (ET-CBWM) model provides a more comprehensive framework for sustainable mangrove conservation than conventional community-based waste management approaches. While traditional Community-Based Waste Management (CBWM) primarily emphasizes community participation, technical waste handling, and institutional coordination, the ET-CBWM model extends this framework by incorporating Islamic eco-theological principles as intrinsic drivers of environmental behavior. This integration creates a multidimensional conservation strategy in which environmental knowledge, moral responsibility, social participation, and spiritual commitment mutually reinforce one another. Consequently, environmental stewardship is no longer perceived merely as a community obligation or government program but becomes an ethical commitment embedded within the daily lives of local communities.

One of the most significant theoretical contributions of this study lies in demonstrating that behavioral transformation requires more than environmental knowledge alone. Environmental education successfully increased participants' understanding of mangrove ecosystems and waste management; however, the integration of Islamic eco-theological values strengthened participants' moral motivation to translate knowledge into consistent environmental action. This finding supports contemporary environmental behavior theories arguing that pro-environmental behavior emerges from interactions among knowledge, personal values, moral norms, and social expectations rather than from cognitive understanding alone. In this context, religious values function as internal motivational mechanisms that complement external policy interventions and technical environmental education.

The findings also enrich the theoretical development of Community-Based Waste Management (CBWM). Existing CBWM literature generally emphasizes community participation, institutional capacity, and stakeholder collaboration as key determinants of successful waste management. Although these components remain fundamental, the present study suggests that cultural and religious dimensions should be recognized as equally important determinants of long-term sustainability, particularly within communities where religion strongly influences social norms and collective decision-making. By integrating Islamic environmental ethics into community empowerment, the ET-CBWM model expands the conceptual boundaries of CBWM beyond its traditional institutional and technical orientation.

From the perspective of Participatory Community Development, the results reinforce the proposition that sustainable environmental governance depends upon genuine community ownership rather than externally imposed interventions. The establishment of the Mangrove Conservation

Community Group, the active involvement of religious leaders, and the collaborative participation of local stakeholders demonstrate that conservation initiatives become more sustainable when communities are positioned as decision-makers instead of passive beneficiaries. This participatory governance approach strengthened social cohesion, increased collective responsibility, and enhanced local institutional resilience. Such findings support broader theories of community empowerment that view local institutions and social capital as essential foundations for sustainable natural resource management.

Another important theoretical implication concerns the role of Islamic eco-theology within environmental governance. Previous studies have largely conceptualized Islamic environmental ethics as theological discourse or normative guidance without providing empirical evidence regarding their practical application in community-based conservation programs. The present study bridges this gap by demonstrating that eco-theological principles can be operationalized through environmental education, religious outreach, community dialogue, and collective conservation activities. The successful integration of the concepts of *khalifah fil ardh*, *amanah*, *mīzān*, and *maṣlaḥah* illustrates how theological values can be transformed into practical environmental actions capable of strengthening conservation outcomes. This finding contributes to the growing interdisciplinary literature connecting religion, sustainability, and community development.

The ET-CBWM model also offers important implications for environmental governance in Muslim-majority societies. Many environmental policies emphasize regulatory enforcement, infrastructure development, and technological innovation while paying limited attention to locally embedded cultural values. However, the present findings indicate that conservation initiatives become more socially acceptable and institutionally sustainable when environmental messages are communicated through trusted community institutions such as mosques, religious organizations, and local religious leaders. Rather than replacing governmental policies, faith-based environmental governance complements formal institutions by strengthening voluntary compliance, social accountability, and collective environmental ethics.

From a practical perspective, the ET-CBWM model demonstrates considerable potential for replication across other coastal regions in Indonesia and in Muslim-majority countries experiencing similar environmental challenges. Many mangrove ecosystems throughout Southeast Asia face increasing pressure from plastic pollution, rapid tourism development, coastal urbanization, and weak community participation. The integrated framework developed in this study provides a practical strategy that simultaneously addresses ecological restoration, waste management, environmental education, institutional strengthening, and cultural adaptation. Because the model is built upon locally embedded social and religious values, it may achieve greater long-term sustainability than conservation programs relying exclusively on technical interventions.

The findings also contribute directly to the implementation of several United Nations Sustainable Development Goals (SDGs). By promoting community participation in environmental protection and reducing waste pollution within mangrove ecosystems, the program supports SDG 13 (Climate Action) through the conservation of blue carbon ecosystems. Protection of mangrove habitats contributes to SDG 14 (Life Below Water) by preserving coastal biodiversity and reducing marine debris. Sustainable management of mangrove forests also advances SDG 15 (Life on Land) through ecosystem conservation and biodiversity protection. Furthermore, the collaborative involvement of local government, religious leaders, community organizations, universities, and tourism stakeholders reflects the principles of SDG 17 (Partnerships for the Goals), demonstrating that sustainable environmental governance depends upon multi-stakeholder collaboration.

Despite these positive outcomes, several limitations should be acknowledged. First, this study primarily employed qualitative approaches, limiting the ability to quantify changes in environmental

quality, waste reduction, or biodiversity recovery. Future studies should integrate quantitative ecological indicators, such as waste volume measurements, water quality assessments, carbon sequestration estimates, and biodiversity monitoring, to evaluate the long-term environmental impacts of the ET-CBWM model. Second, the program was implemented within a single case-study location characterized by strong community participation and a predominantly Muslim population. Comparative studies across different cultural, religious, and geographical contexts would provide a broader understanding of the model's adaptability and generalizability.

Future research should also investigate the long-term sustainability of behavioral change following program completion. Longitudinal studies examining community participation, institutional performance, environmental quality, and socio-economic outcomes over multiple years would provide valuable insights into the durability of faith-based conservation approaches. In addition, integrating digital environmental education, citizen science, and smart waste management technologies with the ET-CBWM framework may further enhance community engagement while supporting data-driven environmental governance.

Overall, this study demonstrates that sustainable mangrove conservation requires an integrated framework capable of simultaneously addressing ecological, social, institutional, cultural, and spiritual dimensions of environmental management. The Eco-Theological Community-Based Waste Management (ET-CBWM) model extends existing theories of community-based conservation by positioning Islamic eco-theological values as complementary drivers of environmental stewardship. Through the integration of participatory community development, community-based waste management, environmental education, and faith-based environmental ethics, the model provides a holistic and transferable approach for strengthening coastal ecosystem resilience and advancing sustainable development in Muslim-majority coastal communities. This integrated framework represents the principal scientific contribution of the present study and offers a promising direction for future interdisciplinary research on community-based environmental governance.

4. Conclusions

4.1 Conclusion

This study developed and implemented an Eco-Theological Community-Based Waste Management (ET-CBWM) model to support sustainable mangrove ecosystem conservation in Tongke-Tongke Village, Sinjai Regency, Indonesia. The findings demonstrate that integrating Participatory Community Development, Community-Based Waste Management (CBWM), and Islamic eco-theological principles creates a holistic framework capable of addressing the ecological, social, institutional, and ethical dimensions of environmental conservation.

The implementation of the ET-CBWM model significantly improved community awareness regarding the ecological functions of mangrove ecosystems and the importance of responsible waste management. Environmental education enhanced participants' knowledge of plastic pollution and ecosystem conservation, while the internalization of Islamic eco-theological values—including *khalifah fil ardh*, *amanah*, *mīzān*, and *maṣlaḥah*—strengthened moral responsibility and intrinsic motivation for environmental stewardship. These values encouraged community members to perceive mangrove conservation not only as an environmental obligation but also as a religious and ethical responsibility.

The program also strengthened local environmental governance through increased community participation, multi-stakeholder collaboration, and the establishment of the Mangrove Conservation Community Group. This institutional development provides a sustainable mechanism for maintaining conservation activities beyond the duration of the program. Overall, the ET-CBWM model demonstrates that combining scientific knowledge, participatory governance, and faith-based environmental ethics

can effectively enhance sustainable mangrove conservation while simultaneously supporting community resilience and ecotourism development.

4.2 Theoretical Implications

This study contributes to the growing body of knowledge on community-based environmental governance by extending the conceptual framework of Community-Based Waste Management (CBWM) through the incorporation of Islamic eco-theological values as determinants of environmental behavior. Previous studies have predominantly emphasized technical waste management, institutional capacity, and stakeholder participation. In contrast, the present study demonstrates that religious values can function as intrinsic motivational factors that reinforce environmental ethics, strengthen collective responsibility, and encourage long-term community participation.

Furthermore, this study bridges three academic disciplines—environmental management, community development, and Islamic environmental ethics—into an integrated conceptual framework. The proposed ET-CBWM model illustrates that sustainable conservation is more likely to be achieved when environmental knowledge is complemented by culturally embedded moral values and participatory governance. This interdisciplinary perspective enriches existing theories of community-based conservation and provides empirical evidence supporting the role of faith-based approaches in environmental sustainability.

4.3 Practical and Policy Implications

The findings provide several practical implications for governments, environmental organizations, educational institutions, and coastal communities. First, waste management policies should prioritize community empowerment and behavioral transformation rather than focusing solely on infrastructure development. Environmental education should be designed as a continuous participatory process capable of fostering long-term environmental awareness and responsibility. Second, religious institutions should be actively involved in environmental governance, particularly in Muslim-majority communities. Mosques, religious leaders, and Islamic educational institutions possess significant social influence and can effectively promote environmental stewardship through culturally relevant communication. Integrating environmental messages into religious education and community outreach programs may strengthen public participation in conservation initiatives.

Third, local governments should encourage collaborative governance involving universities, community organizations, tourism managers, environmental agencies, and religious institutions. Such partnerships can improve institutional coordination, strengthen local capacity, and support sustainable ecotourism development while maintaining the ecological integrity of mangrove ecosystems. Finally, the ET-CBWM model may serve as a practical framework for replication in other coastal regions experiencing similar environmental challenges. The flexibility of integrating local cultural and religious values into community-based conservation strategies enables broader application across diverse socio-cultural contexts while supporting national and global sustainability agendas.

4.4 Limitations and Future Research

This study has several limitations that should be considered when interpreting the findings. First, the research primarily employed qualitative methods and focused on community participation, environmental awareness, and institutional development. Consequently, ecological outcomes such as reductions in plastic waste volume, improvements in water quality, biodiversity recovery, and carbon sequestration were not quantitatively measured. Future studies should incorporate quantitative ecological indicators to evaluate the long-term environmental effectiveness of the ET-CBWM model.

Second, the study was conducted in a single coastal community characterized by strong community participation and a predominantly Muslim population. Although the findings demonstrate the effectiveness of integrating Islamic eco-theological values into environmental management, further comparative research is required to examine the applicability of the model across different cultural, religious, and geographical contexts. Third, the evaluation focused primarily on short-term program implementation. Longitudinal studies are necessary to assess whether improvements in environmental awareness, community participation, and institutional capacity can be sustained over extended periods. Such research would provide stronger evidence regarding the durability of behavioral change and the long-term impacts of faith-based environmental governance.

Future research should also explore the integration of digital technologies, including Geographic Information Systems (GIS), remote sensing, citizen science, Internet of Things (IoT)-based waste monitoring, and blue carbon assessment, into the ET-CBWM framework. Combining technological innovation with participatory governance and eco-theological values has the potential to strengthen adaptive coastal management, improve environmental monitoring, and support evidence-based policy formulation for sustainable mangrove conservation.

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