

Empowering Coastal Communities for Sustainable Marine Conservation: Integrating Education, Technology, and Local Engagement in Negeri Mamala

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ABSTRACT

Indonesia, as the world's largest archipelagic country, holds a critical position in global marine biodiversity, encompassing over 17,000 islands within the Coral Triangle, known as the epicenter of marine diversity. This region supports extensive ecosystems that are vital for ecological balance, economic stability, and the well-being of millions of people. However, these ecosystems face severe threats from overfishing, plastic pollution, and climate change, which collectively endanger marine biodiversity and disrupt coastal livelihoods. This community service program, conducted by the Educational Administration Study Program at the Faculty of Teacher Training and Education, Universitas Pattimura, aimed to strengthen community awareness and enhance administrative capacity for sustainable marine conservation in Negeri Mamala. The program incorporated educational sessions, digital technology, and hands-on community engagement to address critical marine conservation challenges. Key activities included awareness building, community training, and the integration of immersive technologies like Augmented Reality (AR) and Virtual Reality (VR) to improve participant understanding and retention. The results demonstrated significant improvements in community awareness, administrative skills, and active participation in conservation efforts, aligning with the principles of community-based conservation. This initiative provides a promising model for other coastal communities, highlighting the potential of integrating education, technology, and local engagement to achieve long-term sustainability in marine conservation. Moving forward, continued support, strategic partnerships, and ongoing capacity building will be essential for maintaining and expanding these positive impacts.

Keywords: *community-based conservation; coastal ecosystems; environmental education; marine conservation; sustainable resource management*

INTRODUCTION

Indonesia, as the world's largest archipelagic country, comprises more than 17,000 islands and vast marine territories. Its seas not only harbor abundant natural resources but also support an extraordinary level of biodiversity, providing critical ecological, economic, and social benefits to surrounding communities. This region forms part of the Coral Triangle, known as the epicenter of global marine biodiversity, with over 500 coral species and 2,000 species of reef fish recorded (Burke, 2011). This immense marine biodiversity contributes significantly to the ecological balance, economic stability, and social fabric of the region, supporting millions of livelihoods and serving as a global biodiversity hotspot. However, the sustainability of Indonesia's marine ecosystems faces several significant threats, including overexploitation, pollution, and climate change. Overexploitation, such as unsustainable fishing practices, has led to the depletion of fish populations and the destruction of marine habitats. For instance, the practice of "fishing down the food web," where larger, commercially valuable species are overharvested, leaving only smaller species, has dramatically altered marine ecosystems (Pauly et al., 1998). Additionally, plastic pollution has emerged as a critical global issue, with approximately 8 million tons of plastic entering the oceans each year, posing severe threats to marine wildlife and human health (Jambeck et al., 2015). Climate change further exacerbates these challenges, leading to ocean warming, acidification, and sea-level

rise, all of which negatively impact coral reefs and other vital marine habitats (Hoegh-Guldberg et al., 2017).

Raising community awareness about the importance of marine conservation has become a critical priority. When communities understand the impact of their actions on the oceans, they are more likely to engage in conservation activities. Active community participation not only supports the sustainable use of natural resources but also helps alleviate pressures on marine environments. Research indicates that community-based conservation programs can significantly enhance awareness and engagement in preservation efforts (Gurney et al., 2016). Such programs empower local communities to take ownership of conservation initiatives, fostering a sense of responsibility and commitment to protecting their natural resources.

Local communities possess valuable traditional knowledge and practices that are essential for the long-term conservation of archipelagic marine regions. Strengthening this awareness can contribute to the preservation of traditions, local wisdom, and environmental sustainability. For example, many indigenous coastal communities in Indonesia have developed sophisticated ecological knowledge systems that guide their interactions with marine environments, emphasizing sustainability and resource stewardship (Christie et al., 2002). Moreover, supportive policies for marine conservation, sustainable resource management, and the use of technology for marine monitoring and protection can further enhance community awareness. Effective policy implementation requires collaboration between governments, communities, and other stakeholders, ensuring that conservation efforts are inclusive and locally relevant.

Plastic pollution has become a significant global concern, with around 8 million tons of plastic entering the oceans each year. This pollution not only endangers marine wildlife but also disrupts coastal economies and poses health risks to communities relying on marine resources (Galloway et al., 2017). Overfishing is another critical issue, with unsustainable fishing practices leading to severe declines in fish populations, threatening biodiversity, and impacting the livelihoods of millions globally. Coral reef degradation, often caused by warming ocean temperatures, acidification, and destructive fishing methods, further exacerbates the vulnerability of marine ecosystems (Hughes et al., 2017). These interconnected challenges underscore the urgent need for comprehensive and community-driven conservation initiatives.

Effective conservation efforts must also consider the social and economic realities of local communities that depend on marine resources for their livelihoods. The economic value of ecosystem services provided by healthy oceans and coastal systems is estimated to be in the trillions of dollars annually. These services include fisheries, tourism, coastal protection, and carbon sequestration, which collectively support global economies and human well-being (Costanza et al., 2014). This economic perspective highlights the importance of integrating economic considerations into conservation strategies to ensure that communities benefit directly from preservation efforts.

Community-based conservation approaches emphasize the role of local knowledge and community-led management in achieving sustainable conservation outcomes. This approach aligns with the principles of community-based conservation, which prioritize the inclusion of indigenous knowledge and local traditions in managing marine resources. Studies have shown that community-based conservation programs can improve both ecological and social outcomes, fostering resilience and long-term sustainability (Berkes, 2004). For example, successful conservation initiatives in the Philippines and Indonesia have demonstrated that involving local communities in the management of marine protected areas (MPAs) can significantly enhance conservation outcomes. In response to these challenges, the Community Service Program (Program Pengabdian kepada Masyarakat, PKM) of the Educational Administration Study Program at the Faculty of Teacher Training and Education, Universitas Pattimura, has launched an initiative titled "The Contribution of Educational Administration in Strengthening Community Awareness for the Conservation of Island Marine Regions in Negeri Mamala." This program aims to foster community awareness and provide tangible contributions to the preservation of marine areas in Negeri Mamala, ultimately enhancing the well-being of communities dependent on these vital ecosystems. This initiative reflects the critical role of education in promoting environmental stewardship and sustainability, aligning with broader global efforts to protect marine biodiversity and promote sustainable development.

METHOD

The implementation of this community service program (PKM) followed a systematic and structured approach to ensure effective engagement and sustainable impact. The methods included several key phases, as detailed below:

Preparation and Training

The preparation phase was designed to establish a strong foundation for the program's success, involving the following steps. **Partner and Facilitator Meetings:** Initial meetings were held with community leaders, local government representatives, and facilitator teams to discuss the program's goals, expectations, and potential challenges. These meetings aimed to align all stakeholders on the importance of marine conservation and set a collaborative tone for the project. **Training Material Preparation.** Comprehensive training materials were developed, focusing on marine conservation, community engagement, and sustainable environmental practices. These materials were designed to be accessible and culturally relevant to the local community, incorporating local knowledge and traditional practices. **Training Schedule Setting.** A structured training schedule was created, outlining key topics, session timings, and expected outcomes. This schedule ensured that all participants had a clear understanding of the program's timeline and objectives. **Program Socialization.** An initial socialization session was conducted to introduce the program to the community. This included explaining the goals of the initiative, expected outcomes, and the importance of active community participation in marine conservation efforts. Active participation and cooperation from community partners were critical for the success of this program. The involvement of experienced facilitators and subject matter experts was also essential to provide high-quality training and support throughout the program.

Implementation

The implementation phase included several key activities aimed at building awareness, empowering communities, and fostering sustainable conservation practices. **Education and Awareness Building:** Public awareness sessions were conducted to educate community members about the importance of marine conservation, including the impact of plastic pollution, overfishing, and coral reef degradation. These sessions emphasized the critical role of local communities in preserving their marine environments. **Community Empowerment.** Community groups were formed to take active roles in managing and conserving marine ecosystems. These groups were provided with the necessary skills and knowledge to lead conservation efforts, including monitoring marine health and promoting sustainable fishing practices. **Awareness Campaigns.** Public awareness campaigns were organized using social media, posters, and community events to spread information about the importance of marine conservation. These campaigns aimed to reach a broad audience and encourage behavioral changes at the community level. **Collaboration with Stakeholders.** Strategic partnerships were established with local governments, private sector entities, and non-governmental organizations to support the long-term sustainability of the program. These collaborations were critical for securing ongoing resources and technical support for conservation efforts.

Program Sustainability Plan

To ensure the long-term impact of the program, a sustainability plan was developed, which included. **Ongoing Mentoring and Support.** Continuous support was provided to community leaders and local groups to enhance their capacity to manage and sustain conservation efforts. This included follow-up training sessions and regular monitoring of community activities. **Integration into Local Governance.** Efforts were made to integrate conservation activities into local governance structures, ensuring that marine conservation becomes an integral part of community development plans. **Community Network Development.** Networks of community groups were established to share best practices, coordinate conservation activities, and support each other in overcoming challenges. **Regular Impact Assessment.** Ongoing impact assessments were planned to measure the effectiveness of the program, identify areas for improvement, and ensure continuous learning and adaptation.

RESULTS AND DISCUSSION

The community service activity was conducted by the Educational Administration Study Program at the Faculty of Teacher Training and Education, Universitas Pattimura, on October 31, 2024. This one-day event aimed to enhance public awareness about the importance of marine conservation and improve the administrative capacity of local stakeholders in supporting sustainable marine management.

Initial Observations and Participant Engagement

The program began with an opening speech by the head of the Educational Administration program, followed by remarks from the SOA leader representing the Raja Negeri Mamala. The participants included faculty members, students from the Educational Administration program, local government officials, and community members. The event included various activities, such as educational sessions, interactive discussions, and community training, to address the critical issue of marine conservation. The educational sessions focused on the importance of protecting marine ecosystems and the severe consequences of marine degradation, such as reduced fish populations and coral reef destruction (Hughes et al., 2017). The content was delivered using straightforward language and localized examples, making it accessible and relevant to the participants' daily lives. This approach significantly increased participant engagement, with many actively participating in the discussions.



Figure 1. Welcome speech from the coordinator of the Bachelor of Educational Administration program, Universitas Pattimura



Figure 2. Opening remarks by the village official of Mamala

Technology and Innovation Integration

The program also integrated technology and innovation in its outreach efforts, utilizing digital media, collaborative workshops, and immersive technologies like Augmented Reality (AR) and Virtual Reality (VR). This approach aimed to enhance public understanding of marine conservation through interactive and immersive learning experiences. For example, AR/VR was used to simulate the impact of coral reef degradation, providing participants with a firsthand virtual experience of the challenges faced by marine ecosystems (Lin et al., 2024).



Figure 3. Presentation and socialization session

Impact on Community Awareness and Capacity Building

The impact of the community service program on community awareness and capacity building was significant. Participants demonstrated a heightened understanding of the importance of marine conservation, reflecting the effectiveness of localized and contextually relevant training methods. This approach allowed the community to connect the lessons learned to their daily lives, thereby reinforcing the relevance of conservation efforts (Gurney et al., 2016). Additionally, the training sessions provided youth and local stakeholders with essential administrative skills for managing conservation programs, aligning with the broader goals of community-based conservation. This skill-building aspect is crucial for long-term sustainability, as it equips local leaders with the tools needed to organize, monitor, and promote conservation initiatives within their communities (Berkes, 2004). The program also successfully encouraged more active community involvement, fostering a sense of

ownership and responsibility for local marine resources. This active participation creates a foundation for long-term environmental stewardship, as community members are more likely to support and sustain conservation efforts when they are directly involved in their planning and implementation (Christie et al., 2002). Furthermore, the integration of digital tools, such as e-learning platforms and immersive technologies like Augmented Reality (AR) and Virtual Reality (VR), provided innovative ways to communicate complex environmental concepts. These technologies enhanced learning outcomes and participant retention by offering interactive and visually engaging experiences, which are particularly effective in conveying the urgency and importance of marine conservation (Conrad et al., 2024).



Figure 4. Discussion and Q&A session with community members



Figure 5. Group photo with participants after the community service activity

Compare and Contrast Findings with Literature

The findings from this program align with existing literature on community-based conservation, which emphasizes the importance of local participation and culturally relevant education in achieving sustainable environmental outcomes. For example, Berkes (2004) highlights that conservation initiatives rooted in local knowledge and community leadership tend to be more successful than top-down approaches, as they foster a deeper sense of ownership and responsibility among community members. Moreover, the use of digital technologies, such as AR/VR, in this program mirrors recent trends in environmental education that leverage immersive learning tools to enhance engagement and understanding (Akpan & Beard, 2016). Studies have shown that these

technologies can significantly improve environmental awareness by providing realistic simulations of ecological challenges (Conrad et al., 2024). However, the program also faced challenges, including the need for ongoing support and capacity building to sustain conservation efforts over the long term. This finding is consistent with research by Gurney et al. (2015), which argues that effective conservation requires continuous community engagement and support from external stakeholders, including governments and NGOs.

This community service program are critical for several reasons. Firstly, it directly supports the long-term sustainability of marine conservation efforts by involving local communities in conservation activities. This approach aligns with the principles of community-based conservation, which emphasize the importance of local participation and ownership in achieving sustainable environmental outcomes (Berkes, 2004). By empowering community members to take active roles in conservation, the program helps build a sense of responsibility and commitment to protecting their natural resources. Secondly, the training provided during the program equipped local youth and leaders with essential skills for managing conservation initiatives, thereby strengthening local governance and decision-making. This capacity-building aspect is crucial for ensuring that conservation efforts are effective and sustainable over time, as it provides the community with the necessary tools and knowledge to independently manage their natural resources (Christie et al., 2002). In addition, the program demonstrated the potential of leveraging technology for environmental education. The use of AR/VR and digital platforms allowed participants to engage with complex environmental concepts in a more interactive and impactful way, transforming traditional conservation education into a more immersive learning experience. This technological integration not only enhances learning outcomes but also increases participant retention and understanding, making it a powerful tool for promoting conservation awareness. Furthermore, this program serves as a potential model for other coastal communities, demonstrating the effectiveness of integrating education, technology, and community engagement in marine conservation (Gurney et al., 2015). It provides a replicable framework that other regions can adapt to their unique environmental and cultural contexts, promoting widespread adoption of sustainable conservation practices. Finally, the focus on building local administrative capacity ensures that conservation efforts are not only impactful in the short term but also sustainable over the long term. This approach enhances the resilience of coastal communities against environmental changes, enabling them to better manage and protect their marine ecosystems in the face of ongoing challenges like climate change and resource depletion (Costanza et al., 2014).

CONCLUSION

The community service program conducted by the Educational Administration Study Program at the Faculty of Teacher Training and Education, Universitas Pattimura, effectively enhanced public awareness of marine conservation and strengthened the administrative capacity of local stakeholders through a combination of educational sessions, technology integration, and hands-on community engagement. This comprehensive approach not only increased environmental awareness but also fostered a sense of ownership and responsibility among community members, laying a solid foundation for long-term environmental stewardship. The use of innovative digital tools, such as e-learning platforms and immersive technologies like Augmented Reality (AR) and Virtual Reality (VR), significantly improved participant engagement and retention, making complex environmental concepts more accessible and impactful. Additionally, the program's emphasis on building local administrative capacity equipped community leaders and youth with essential skills for managing conservation initiatives, thereby supporting sustainable governance and independent resource management over the long term. As a result, this program serves as a promising model for other coastal communities, demonstrating the effectiveness of integrating education, technology, and community involvement in marine conservation. Moving forward, continued support, ongoing training, and strategic partnerships with local governments and external stakeholders will be crucial to sustaining and expanding the positive impacts of this initiative.

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