

Digital Ecotourism and Mangrove Ecology Training for Coastal Community Empowerment in Gresik

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Abstract

Mangrove ecotourism can link coastal conservation, environmental education, and local economic development, yet community-based destinations often face limited ecological literacy and weak digital-promotion capacity. This community service programme aimed to strengthen the ecological knowledge and digital-promotion skills of stakeholders in the Kalimireng Mangrove Ecotourism Area, Manyarsidomukti Village, Gresik, Indonesia. A one-group pretest-posttest community intervention was conducted on 20 May 2026 and followed by one month of social-media mentoring. The programme involved 30 core community partners—15 ecotourism managers and 15 participants representing fishers, PKK women, waste-bank members, and environmental groups plus 20 accompanying participants. The intervention combined a 30-minute mangrove ecology and conservation session, a 60-minute hands-on tutorial using ChatGPT and digital design tools, collaborative poster production, a digitalisation guidebook, and follow-up mentoring. Outcomes were assessed descriptively using aggregate pretest-posttest percentages documented in programme records and evidence of digital-content production. Knowledge of mangrove vegetation increased from 50% to 90% (+40 percentage points), conservation-based ecotourism from 80% to 100% (+20), digital ecotourism from 10% to 90% (+80), and tourism-village promotion strategies from 50% to 100% (+50). Participants also produced promotional posters during training. The programme showed promising short-term gains, particularly in digitalisation, and demonstrated immediate practical application. However, the absence of a control group, individual-level paired data, documented instrument validity, and post-mentoring outcome data limits causal inference and conclusions about sustainability. Continued mentoring, standardised measurement, and follow-up monitoring of independent content production, digital reach, visitor engagement, and conservation behaviour are recommended.

Keywords: community empowerment; digital ecotourism; mangrove conservation; artificial intelligence; coastal community

Abstrak

Ekowisata mangrove dapat menghubungkan konservasi pesisir, pendidikan lingkungan, dan pengembangan ekonomi lokal, tetapi destinasi berbasis masyarakat sering menghadapi keterbatasan literasi ekologi dan kapasitas promosi digital. Program pengabdian kepada masyarakat ini bertujuan memperkuat pengetahuan ekologi dan keterampilan promosi digital pemangku kepentingan di Kawasan Ekowisata Mangrove Kalimireng, Desa Manyarsidomukti, Gresik, Indonesia. Intervensi one-group pretest-posttest dilaksanakan pada 20 Mei 2026 dan dilanjutkan dengan pendampingan media sosial selama satu bulan. Program melibatkan 30

mitra inti—15 pengelola ekowisata dan 15 peserta dari nelayan, ibu PKK, bank sampah, dan kelompok lingkungan—serta 20 peserta pendamping. Intervensi mencakup edukasi ekologi dan konservasi mangrove selama 30 menit, tutorial praktis penggunaan ChatGPT dan perangkat desain digital selama 60 menit, pembuatan poster kolaboratif, pemberian buku panduan digitalisasi, serta pendampingan lanjutan. Hasil dievaluasi secara deskriptif menggunakan persentase pretest-posttest agregat yang tersedia dalam catatan program dan bukti produksi konten digital. Pengetahuan vegetasi mangrove meningkat dari 50% menjadi 90% (+40 poin persentase), ekowisata berbasis konservasi dari 80% menjadi 100% (+20), ekowisata digital dari 10% menjadi 90% (+80), dan strategi promosi desa wisata dari 50% menjadi 100% (+50). Peserta juga menghasilkan poster promosi selama pelatihan. Program menunjukkan peningkatan jangka pendek yang menjanjikan, terutama pada digitalisasi. Namun, ketiadaan kelompok kontrol, data individual berpasangan, validitas instrumen yang terdokumentasi, dan evaluasi pascapendampingan membatasi kesimpulan kausal dan keberlanjutan.

Kata kunci: pemberdayaan masyarakat; ekowisata digital; konservasi mangrove; kecerdasan artifisial; masyarakat pesisir

INTRODUCTION

Mangrove ecosystems provide multiple ecological and social benefits, including shoreline protection, biodiversity support, fisheries habitat, carbon storage, climate adaptation, and cultural services. Recent syntheses confirm that these ecosystem services are closely linked to human well-being in coastal communities and are increasingly recognised as part of nature-based approaches to coastal risk reduction (Su et al., 2022; Menéndez et al., 2023; Jordan & Fröhle, 2022). In Southeast Asia, mangrove ecotourism has become an important mechanism for connecting conservation incentives with community livelihoods, although long-term benefits depend on equitable participation, local governance, and continuous ecological stewardship (Teka et al., 2024).

Indonesia has extensive experience with community-based mangrove tourism. Studies in Banten and Central Java show that local participation can support mangrove conservation while strengthening tourism-based economic opportunities (Nuraeni & Kusuma, 2023; Afifah et al., 2023). In Gresik Regency, mangrove areas also have recognised ecotourism potential, including sites in Ujung Pangkah, where ecological resources and community involvement have been identified as important foundations for tourism development (Ali et al., 2021). These experiences indicate that mangrove ecotourism should be managed as a social-ecological system rather than merely as a recreational attraction.

Kalimireng Mangrove Ecotourism in Manyarsidomukti Village, Manyar Subdistrict, Gresik Regency, has ecological and educational potential. A preliminary needs assessment identified two priority constraints. First, community partners had limited familiarity with digital promotion, AI-supported content creation, and systematic use of social media for destination communication. Second, ecological understanding was incomplete: mangroves were commonly recognised as barriers to coastal erosion, while their broader functions for biodiversity, fisheries, ecosystem stability, climate resilience, and environmental education were

less consistently understood. These gaps potentially limited both destination visibility and the conservation message communicated to visitors.

Digital promotion has become increasingly important for community-based tourism because destination visibility, branding, visitor engagement, and information access are strongly influenced by online communication. Community-service programmes have demonstrated that online-media and social-media training can improve the promotional capacity of mangrove and ecotourism managers (Tsani et al., 2022; Anugrah et al., 2023). Recent tourism-village studies similarly show the value of structured social-media strategies and community ownership in sustaining digital promotion (Yuanawati & Aji, 2022; Taufik & Tsuroyya, 2022; Fathor et al., 2025).

Generative artificial intelligence adds a new layer to digital tourism promotion. ChatGPT can support rapid drafting, adaptation, and co-creation of tourism marketing materials, but its use should remain guided by local knowledge, factual verification, and human editorial judgement (Carvalho & Ivanov, 2024; Liu et al., 2024). Community technical-assistance programmes in Indonesia have begun incorporating AI-supported content creation into tourism promotion, suggesting that simplified, hands-on training can help community partners explore new digital tools without requiring advanced technical backgrounds (Aliyuddin et al., 2024).

Previous interventions often deliver ecological education and digital-marketing training as separate activities. This programme addressed that gap by integrating mangrove ecology, conservation-based ecotourism, AI-supported copywriting, visual-content production, and one month of social-media mentoring in a single empowerment pathway. The multidisciplinary team combined applied biology and information-systems expertise, while the partner group included ecotourism managers, fishers, PKK women, waste-bank members, and environmental community representatives. The objective was to strengthen short-term ecological understanding and digital-promotion knowledge while enabling immediate production of promotional content. Given the one-group design, causal effectiveness was not inferred.

METHOD

The programme used a one-group pretest-posttest community-intervention design with educational, participatory, persuasive, and empowerment-oriented elements. No untreated or delayed-intervention control group was included. Accordingly, the findings are interpreted as descriptive short-term changes rather than evidence of causal effectiveness.

The face-to-face activity was conducted at Manyarsidomukti Village Hall, Manyar Subdistrict, Gresik Regency, East Java, Indonesia, on 20 May 2026 at 09:00 Western Indonesian Time. The core education and practical training lasted approximately 90 minutes and was followed by one month of social-media mentoring.

The direct community target comprised 30 core partners: 15 Kalimireng Mangrove Ecotourism managers and 15 participants representing fishers, PKK women, waste-bank members, and environmental community groups. Programme records also listed 20 accompanying participants, including students and guest lecturers, for a total attendance of

50. The 30 core partners were treated as the primary beneficiaries. Individual data on age, sex, education, occupation, baseline digital literacy, and formal inclusion or exclusion criteria were unavailable and were not reconstructed retrospectively.

The intervention comprised four linked stages. First, a 30-minute education session covered mangrove vegetation, ecosystem functions, conservation-based ecotourism, and the relationship between ecological quality and destination value. Second, a 60-minute practical tutorial introduced ChatGPT for drafting promotional copy and educational narratives and used digital design tools to convert the text into visual content. Third, participants collaboratively produced promotional posters. Fourth, the team provided a practical digitalisation guidebook and one month of social-media mentoring to support continued application.

Four knowledge domains were evaluated: importance of mangrove vegetation, conservation-based mangrove ecotourism, digitalisation of mangrove ecotourism, and tourism-village promotion strategies. Practical application was represented by the production of digital promotional posters during training. Programme documentation did not specify a predefined quantitative success threshold, the number of independently published posts after mentoring, social-media reach, visitor growth, or a conservation-behaviour target.

The evaluation used interactive interviews or questionnaire-based assessment before and after the intervention and referred to a five-point Likert classification from very poor to very good. However, the exact item wording, number of items per domain, method used to convert Likert responses into the reported percentages, validity and reliability evidence, and individual-level response data were unavailable. Only the aggregate percentages documented in programme records are therefore reported.

Pretest and posttest results were analysed descriptively as percentages and post-minus-pre percentage-point changes. Because individual-level paired data were unavailable, paired statistical tests, effect sizes, confidence intervals, and participant-level response distributions could not be calculated validly. No between-group comparison was performed because the original activity had no comparison group.

Programme documentation did not include a formal ethics-committee approval number, written informed-consent procedure, or image consent documentation. All activity photographs were removed from this publication-ready version. Before publication, the authors should confirm the applicable institutional permission and consent procedures in accordance with journal and institutional requirements.

Sustainability was supported through one month of mentoring, provision of a digitalisation guidebook, and involvement of local institutions such as Pokdarwis and Pokmawas. The intended continuation pathway is independent preparation and publication of ecological and promotional content by community partners, with periodic technical assistance from the university team.

RESULTS

The programme reached 30 core community partners and 20 accompanying participants, for a total attendance of 50. The 30 core partners represented the direct empowerment target

and consisted equally of Kalimireng Mangrove Ecotourism managers and members of supporting coastal and community groups. The intervention combined ecological education, AI-supported digital-promotion training, practical content production, and one month of follow-up mentoring.

Table 1. Participant profile and programme roles

Group	Role	n	%
Kalimireng Mangrove Ecotourism managers	Primary economic/ecotourism target	15	50.0 of core partners
Fishers, PKK women, waste-bank and environmental community members	Supporting community target	15	50.0 of core partners
Core community partners	Primary beneficiaries	30	100.0
Students and guest lecturers	Accompanying participants	20	-
All attendees	Total attendance	50	-

All four reported knowledge domains improved descriptively after training. The largest change occurred in digitalisation of mangrove ecotourism, which increased from 10% to 90%, an 80-percentage-point gain. Tourism-village promotion strategy increased from 50% to 100% (+50 points), knowledge of mangrove vegetation from 50% to 90% (+40 points), and conservation-based mangrove ecotourism from 80% to 100% (+20 points). The relatively high baseline for conservation-based ecotourism suggests prior familiarity, whereas digital ecotourism represented the largest knowledge gap at baseline.

Table 2. Aggregate pretest-posttest outcomes

Outcome domain	Pretest	Posttest	Change (pp)	Interpretation
Importance of mangrove vegetation	50%	90%	+40	Improved
Conservation-based mangrove ecotourism	80%	100%	+20	Improved
Digitalisation of mangrove ecotourism	10%	90%	+80	Improved
Tourism-village promotion strategy	50%	100%	+50	Improved

Participants also produced digital promotional posters during the practical session using ChatGPT-assisted text and digital design tools. Programme records indicate that participants discussed applying the same skills to other village communication needs, including community-event announcements, PKK invitations, and village information. These outputs demonstrate immediate practical application, although the number and quality of posters, publication frequency, and post-mentoring social-media metrics were not documented.

The one-month mentoring period was intended to support independent content management, but quantitative follow-up outcomes were unavailable. The results therefore do not establish sustained independent digital production, increased social-media engagement, visitor growth, income change, or conservation-behaviour change.

DISCUSSION

The programme showed positive descriptive change across all four measured domains, with the greatest gain in digital ecotourism. This pattern is consistent with the baseline problem: community familiarity with AI-supported tourism promotion was very low before training. The increase from 10% to 90% suggests that guided demonstration and immediate practice addressed the partners' learning needs. However, because the percentages are aggregate, the scoring transformation is incompletely documented, and no control group was used, the finding should be interpreted as a promising short-term programme outcome rather than definitive evidence of effectiveness.

The ecological component is important because mangrove ecotourism depends on community understanding of the ecosystem being promoted. Mangroves provide coastal protection, habitat, climate-regulation functions, and cultural and livelihood services (Su et al., 2022; Menéndez et al., 2023). Community-based tourism can strengthen conservation when local people have meaningful roles in management and perceive benefits from ecosystem protection (Nuraeni & Kusuma, 2023; Afifah et al., 2023). In the present programme, knowledge of mangrove vegetation increased by 40 percentage points, while conservation-based ecotourism increased by 20 points from an already high baseline of 80%. This pattern is consistent with reinforcement of existing conservation awareness combined with broader ecological education.

The local context of Gresik makes this integration especially relevant. Ali et al. (2021) identified substantial potential for mangrove-based ecotourism in Ujung Pangkah, demonstrating that coastal resources in Gresik can support tourism when ecological quality and community involvement are maintained. Kalimireng similarly requires promotion that does not separate destination branding from conservation literacy. The programme therefore positioned digital communication as a tool for explaining ecological value rather than merely attracting visitors.

Digital-promotion training is increasingly common in community tourism development. Tsani et al. (2022) reported that online-media training helped mangrove ecotourism managers use websites and social-media channels, while Anugrah et al. (2023) showed that social-media education can strengthen promotion for MSMEs and ecotourism. Tourism-village studies also highlight coordinated social-media communication, community ownership, and sustained content management (Yuanawati & Aji, 2022; Taufik & Tsuroyya, 2022; Fathor et al., 2025). The 50-point increase in tourism-village promotion knowledge in Kalimireng therefore aligns with evidence supporting digital capacity building for community tourism.

The use of ChatGPT adds a contemporary dimension. Research on generative AI in tourism indicates that ChatGPT can support marketing-content creation and co-creation, but effective use requires human oversight, local contextualisation, and verification of generated information (Carvalho & Ivanov, 2024; Liu et al., 2024). In this programme, ChatGPT was used as a drafting aid rather than an autonomous content producer, and the text was then combined with visual-design tools. This approach keeps local participants involved in message selection and allows ecological information to be checked before publication.

Immediate poster production was a meaningful implementation output because the activity went beyond lecture-based knowledge transfer. Participants converted new ecological and digital concepts into tangible communication products during the session. Nevertheless, programme records did not document the number or quality of posters or whether participants independently created additional content afterward. Future evaluation should use a simple competency rubric covering prompt formulation, factual accuracy, visual clarity, conservation messaging, branding consistency, and the ability to publish content without facilitator assistance.

Multidisciplinary facilitation was another strength. Applied biology expertise supported the ecological content, while information-systems expertise supported AI and digital design. Such integration is appropriate for community-based ecotourism because the management problem is simultaneously ecological, educational, technological, and economic. Recent mangrove-ecotourism literature likewise emphasises that conservation outcomes are more sustainable when ecological management, local participation, governance, education, and livelihood benefits are addressed together (Teka et al., 2024).

The main limitations concern measurement and follow-up. Individual paired responses were unavailable, preventing inferential testing, effect-size estimation, confidence intervals, and examination of response variation. The instrument's exact items, scoring conversion, validity, and reliability were not documented. Participant characteristics were limited to community-group membership, and the evaluation did not include social-media reach, visitor engagement, economic outcomes, or conservation behaviour after mentoring. The strongest defensible conclusion is therefore short-term descriptive improvement and immediate practical application.

Future programme cycles should retain individual-level pretest-posttest data, document the measurement instrument, and conduct follow-up after the one-month mentoring period. Where feasible, a non-equivalent comparison group or delayed-intervention design would strengthen interpretation. Sustainability indicators should include independently produced posts, publication frequency, reach and engagement, visitor enquiries, conservation-message accuracy, partner ownership of social-media accounts, and evidence of ongoing ecological monitoring. This would support development of a measurable, community-owned digital ecotourism system.

CONCLUSION

The Kalimireng community-service programme produced promising short-term descriptive gains in ecological and digital-promotion knowledge. Aggregate scores increased from 50% to 90% for mangrove vegetation, 80% to 100% for conservation-based ecotourism, 10% to 90% for digital ecotourism, and 50% to 100% for tourism-village promotion. Participants also produced digital promotional posters, demonstrating immediate application of ChatGPT-assisted copywriting and digital-design skills. The largest improvement occurred in digital ecotourism, the domain with the lowest baseline familiarity. However, the one-group design, lack of individual-level paired data, incomplete instrument documentation, and absence of

post-mentoring metrics limit causal and sustainability conclusions. The programme provides a relevant foundation for community-based mangrove ecotourism empowerment, but future implementation should use standardised measurement and follow-up indicators of independent content production, digital engagement, visitor response, and conservation behaviour.

RECOMMENDATIONS

Pokdarwis, Pokmawas, and Kalimireng managers should maintain a shared monthly content plan combining tourism promotion with verified mangrove-conservation messages. Within the next 1-3 months, community partners should record independently produced posts, publication frequency, reach, engagement, and visitor enquiries. The university team should conduct a follow-up competency assessment after mentoring and provide periodic technical review. Future evaluations should retain individual paired data, document questionnaire validity and scoring, and, where feasible, use a non-equivalent comparison or delayed-intervention group.

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