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Strengthening Maritime Safety Culture through Community Counseling in Tambrau Regency

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Abstract

Maritime transportation is essential for mobility, fisheries, and goods distribution in remote coastal regions; however, reliance on small vessels is often accompanied by limited safety knowledge and inconsistent application of basic precautions. This community service program aimed to strengthen maritime safety knowledge and awareness among maritime actors in Tambrau Regency, Southwest Papua, Indonesia. A one-group pretest-posttest intervention was conducted on 9-10 December 2025 with 22 participants, including traditional fishermen, motorboat operators, coastal residents, community leaders, and officers of the Tambrau Regency Transportation Agency. The program combined structured counseling, interactive discussion, practical demonstrations of life-jacket use, recognition of navigation signs, basic emergency-response procedures, and information on formal maritime training opportunities. Knowledge was assessed using a 20-item multiple-choice test administered before and after the activity. The mean score increased from 45.0 (SD 7.15) to 80.0 (SD 5.28), representing a 35-point gain. Knowledge-category distributions shifted from 77% low and 23% moderate at baseline to 73% high and 27% moderate after the program. A paired-samples t-test showed a statistically significant pretest-posttest difference, $t(21) = -26.22$, $p < .001$. These findings indicate a substantial immediate improvement in measured maritime safety knowledge following the intervention. However, the single-group design, absence of a comparison group, unreported validity and reliability coefficients, and lack of behavioral follow-up limit inferences about causality and long-term effects. Periodic refresher training, practical drills, consistent use of safety equipment, and continued coordination with local authorities are recommended to support sustained maritime safety practices and preparedness for routine voyages and emergency situations.

Keywords: maritime safety; safety culture; coastal community; safety education; small vessels

Abstrak

Transportasi laut sangat penting bagi mobilitas, perikanan, dan distribusi barang di wilayah pesisir terpencil, tetapi ketergantungan pada kapal kecil sering disertai keterbatasan pengetahuan keselamatan dan penerapan tindakan pencegahan yang tidak konsisten. Program pengabdian kepada masyarakat ini bertujuan memperkuat pengetahuan dan kesadaran keselamatan pelayaran pada pelaku maritim di Kabupaten Tambrau, Papua Barat Daya, Indonesia. Intervensi satu kelompok pretest-posttest dilaksanakan pada 9-10 Desember 2025 dengan 22 peserta yang terdiri atas nelayan tradisional, operator perahu motor, masyarakat pesisir, tokoh masyarakat, dan pegawai Dinas Perhubungan Kabupaten Tambrau. Program memadukan penyuluhan terstruktur, diskusi interaktif, demonstrasi penggunaan jaket keselamatan, pengenalan rambu navigasi, prosedur dasar tanggap darurat, serta informasi mengenai peluang pendidikan dan pelatihan maritim formal. Pengetahuan dinilai menggunakan tes pilihan ganda 20 butir sebelum dan sesudah kegiatan. Nilai rata-rata meningkat dari 45,0 (SD 7,15) menjadi 80,0 (SD 5,28), atau bertambah 35 poin. Distribusi kategori pengetahuan bergeser dari 77% rendah dan 23% sedang pada awal menjadi 73% tinggi dan 27% sedang setelah program. Uji t berpasangan menunjukkan perbedaan pretest-posttest yang bermakna secara statistik, $t(21) = -26,22$, $p < 0,001$. Temuan menunjukkan peningkatan segera yang substansial pada pengetahuan keselamatan pelayaran yang diukur setelah intervensi. Namun, desain satu kelompok, ketiadaan kelompok pembandingan, koefisien validitas dan reliabilitas yang tidak dilaporkan, serta tidak adanya tindak lanjut

perilaku membatasi interpretasi kausal dan jangka panjang. Pelatihan penyegaran, latihan praktis, penguatan penggunaan alat keselamatan, dan koordinasi berkelanjutan dengan pemerintah daerah direkomendasikan untuk mendukung praktik keselamatan pelayaran yang berkelanjutan dan memperkuat kesiapsiagaan menghadapi pelayaran rutin serta kondisi darurat secara berkelanjutan.

Kata kunci: keselamatan pelayaran; budaya keselamatan; masyarakat pesisir; edukasi keselamatan; kapal kecil

INTRODUCTION

Maritime transportation plays an essential role in supporting daily activities and economic mobility in coastal and island regions. For communities with limited land-transport infrastructure, sea transport often becomes the primary means of access for fishing, passenger movement, and goods distribution. Coastal and island regions therefore depend heavily on maritime transport, particularly where land-based connectivity is limited or unavailable (Boile et al., 2023; Depellegrin et al., 2020; Spadon et al., 2025). Under these conditions, small vessels and motorboats are widely used because they are well suited to local geographic and accessibility constraints.

Small boats are commonly used for fishing, personnel and cargo transfer, border and fishery protection, and local passenger transportation, particularly in shallow waters, canal-like routes, and remote coastal areas where larger vessels cannot operate (Pokusaev et al., 2023). Despite their advantages in speed and accessibility, small vessels also present important safety challenges, including lower comfort, high exposure to noise and vibration, greater vulnerability to adverse weather, and increased crew fatigue. These factors can compromise operational safety and increase the risk of maritime accidents (Pokusaev et al., 2023). Maritime transportation safety should therefore be understood as a multifactorial system shaped by interactions among human behavior, vessel conditions, and environmental factors (Wang et al., 2020).

Tambrauw Regency is characterized by an extensive coastline and direct exposure to the Pacific Ocean. These geographic conditions make maritime transportation an important means of mobility and connectivity for coastal communities (Statistics Indonesia, Tambrauw Regency, 2025). As in many coastal and island regions, limited land infrastructure and geographic barriers increase local dependence on sea transport (Boile et al., 2023; Depellegrin et al., 2020). Consequently, motorboats and small vessels are widely used to transport passengers, fishery products, and daily necessities between coastal communities (Pokusaev et al., 2023).

High dependence on maritime transportation, however, is not always accompanied by adequate awareness or consistent application of maritime safety principles. In Tambrauw Regency, maritime operations are often shaped by routine practice and accumulated field experience rather than standardized safety procedures. Essential precautions, including the use of life jackets, recognition of navigation signs, and preparedness for emergencies, may therefore be overlooked. Such gaps can increase the risk of maritime accidents and their potential consequences, including material losses, injuries, and fatalities.

Similar safety concerns have been documented in other coastal areas of Southwest Papua. On Doom Island, Sorong, sea-taxi operations were reported to involve overloading, unsafe

passenger positioning, and inadequate life-saving appliances. Many crew members were also unfamiliar with applicable safety regulations before targeted maritime-safety outreach activities (Sumarta et al., 2024). Studies of speedboat operations and small-scale fisheries in Indonesia likewise indicate that consistent life-jacket use remains limited. Passengers may wear life jackets only during inspections and remove them afterward because of discomfort, while operators do not always enforce safety requirements (Saifudin et al., 2024).

A major challenge in coastal communities is limited understanding of maritime safety standards and procedures. Many boat operators and passengers have not received formal maritime-safety education or training. Consequently, safety equipment may not be used optimally, and emergency situations may be handled inconsistently. Knowledge of safe navigation practices, weather awareness, and vessel readiness can also remain limited. At the global level, reviews show that many unintentional coastal fatalities are associated with unsafe behavior and low safety awareness, indicating that equipment and signage alone are insufficient without sustained education and community engagement (Koon et al., 2021).

A further concern is the limited development of a strong maritime safety culture within coastal communities. Maritime safety culture encompasses collective awareness, attitudes, and behaviors that consistently prioritize safety in maritime activities. Without continuous education, reinforcement, and shared expectations, unsafe practices may become normalized. Strengthening safety culture therefore requires sustained efforts through education, counseling, practical reinforcement, and direct engagement with maritime actors at the community level.

Local government, particularly the Transportation Agency, has an important role in supporting maritime safety implementation. Collaboration between maritime actors and government institutions is needed to ensure that safety principles are not only understood conceptually but also applied consistently in practice. Such collaboration is increasingly important in anticipation of new port development in Tambrau Regency, which may increase maritime traffic and associated safety risks if not accompanied by adequate preparedness and capacity building.

Given these conditions, community service focused on maritime safety counseling is both relevant and necessary. Community-based programs provide a practical platform for transferring knowledge, increasing awareness, and encouraging safer practices among maritime actors. Participatory and educational approaches can also connect formal safety principles with the everyday operating conditions experienced by local communities.

This community service program aimed to strengthen maritime safety knowledge and awareness among maritime actors in Tambrau Regency. Specifically, the program sought to improve participants' understanding of safety equipment, emergency-response procedures, navigation signs, and safe navigation practices. It also introduced relevant maritime education and training opportunities as pathways for continued competency development.

The program was expected to provide an initial foundation for stronger safety awareness and preparedness while supporting continued collaboration between maritime actors and local

government. Because the evaluation focused on immediate knowledge change, longer-term improvements in routine behavior and safety culture require additional follow-up evidence.

Recent Indonesian evidence reinforces the need for structured safety capacity building among small-vessel users. A study involving small-scale fishermen in Jember found that sailing-safety practices remained unsafe and recommended government-supported training and appropriate personal protective equipment (Indrayani et al., 2023). Community-service programs in Rembang and Raam Island likewise reported substantial improvements in knowledge following participatory safety education and practical demonstrations (Priyadi et al., 2025; Gumelar et al., 2025). These findings support the relevance of a locally adapted intervention in Tambrau, where formal training opportunities and routine safety reinforcement remain limited.

Current official statistics for Tambrau Regency indicate continuing variation in village infrastructure and access to public services, making reliable transportation particularly important for dispersed communities (Statistics Indonesia, Tambrau Regency, 2025). In such settings, maritime safety interventions should combine formal safety principles with the operational realities of small boats, local weather knowledge, fishing routines, limited equipment, and long travel distances. The present program therefore positioned community members as active participants in safety improvement rather than passive recipients of regulation.

Tambrau Regency is a coastal region in Southwest Papua Province with extensive marine and coastal areas. It forms part of the Bird's Head Seascape and has rich marine biodiversity that supports local livelihoods. Maritime activities are central to community life, particularly for mobility, fisheries, and the transport of goods and people between coastal settlements. This dependence on marine resources and sea transportation makes maritime safety directly relevant to both social and economic activity (Yayasan Konservasi Alam Nusantara (YKAN), 2025).

The program involved 22 participants, including traditional fishermen, motorboat operators, coastal residents, community leaders, and officers of the Tambrau Regency Transportation Agency. These groups represent key stakeholders who interact directly with maritime transportation as users, operators, community representatives, or local authorities. Strengthening their knowledge and application of basic safety practices is therefore relevant to reducing operational risk and supporting safer maritime activities.

Maritime transportation in the coastal areas of Tambrau Regency faces several fundamental safety-related challenges. These are not exclusively technical but also involve limitations in knowledge, skills, perceptions, behavior, and institutional support. Based on field observations and preliminary coordination with local stakeholders, three priority problems were identified within the broad domains of safety education, safety behavior, and institutional support.

Table 1. Partner profile and priority problem

Target	Characteristics	n	Priority problem
Maritime stakeholders	Traditional fishermen, motorboat operators, coastal residents, community leaders, and Transportation Agency officers	22	Limited safety knowledge, inconsistent compliance with safety procedures, and low emergency preparedness

The first problem concerns limited understanding of standardized maritime safety procedures. Traditional fishermen and motorboat operators generally have substantial practical experience in vessel operation and local navigation; however, activities are often guided by accumulated experience and traditional practices rather than formal safety standards. Knowledge of safety equipment, navigation signs, emergency procedures, and accident-prevention measures may therefore remain incomplete. Similar conditions have been reported in artisanal and small-scale fisheries, where safety practice depends heavily on traditional knowledge and informal routines rather than standardized systems or written procedures (Saldanha et al., 2020; Utama et al., 2024).

The second problem concerns inconsistent implementation of maritime safety practices and limited emergency preparedness. Although many maritime actors are familiar with routine vessel operations, basic safety procedures are not always applied consistently. Life jackets may be neglected, navigation rules may not be followed systematically, and preparedness for emergency situations can remain limited. Such patterns reflect a weak safety culture in which unsafe practices become normalized through habit, perceived inconvenience, or insufficient supervision. Indonesian evidence indicates, for example, that passengers may wear life jackets only during inspections and remove them afterward despite requirements for continuous use during voyages (Saifudin et al., 2024).

The third problem concerns institutional support, particularly limited dissemination of maritime safety information and limited access to structured training at the local level. Coordination between maritime actors and local authorities, including the Transportation Agency, has not yet been fully utilized as a continuous educational platform. As a result, opportunities for capacity building through formal maritime training (diklat) remain underused. This issue is increasingly important in anticipation of growing maritime activity associated with planned port development. Policy analyses in Indonesia identify human error and weaknesses in human-resource management as important contributors to maritime accidents and position functional maritime-transport training as a policy instrument for improving safety performance (Lamatokan et al., 2024).

The program response was designed as a structured and participatory intervention addressing the priority maritime safety problems identified in Tambrauw Regency. The intervention was organized into sequential stages to connect needs assessment, knowledge transfer, practical learning, behavioral reinforcement, institutional coordination, and evaluation.

The first stage involved preparatory coordination and needs assessment with local stakeholders, including the Tambrauw Regency Transportation Agency and participant representatives. This process helped align the intervention with locally identified safety

priorities. Similar approaches in inclusive maritime planning emphasize the importance of identifying and validating relevant stakeholders through participatory processes so that the perspectives of fishers and community members are adequately represented (Papageorgiou et al., 2024).

The second stage focused on knowledge transfer through maritime safety counseling covering safety equipment, navigation signs, emergency-response procedures, and safe navigation practices. These topics correspond to key competency areas for accident prevention and onboard emergency management (Bulgakov et al., 2025; Frias et al., 2022; Irwan, 2020). The material was delivered using accessible explanations and practical examples related to participants' everyday maritime experiences.

The third stage emphasized practical skill development through demonstrations and participatory discussion. Participants practiced the correct use of life jackets, learned to recognize navigation lights and buoys, and discussed basic emergency-response procedures. Basic safety training is intended to develop life-saving competencies, including correct life-jacket use and safe abandonment procedures (Chiong, 2023). Interactive discussion also enabled participants to reflect on unsafe practices and consider more appropriate responses.

The fourth stage focused on reinforcing safety awareness and safer behavior. Repeated reminders and discussion were used to encourage consistent safety practices. Behavior-based safety approaches emphasize observation, feedback, and reinforcement as mechanisms for reducing unsafe practices (Subramanyam & Dhankher, 2022; Gumelar et al., 2025). Safety awareness is also associated with safety behavior and safety citizenship behavior among maritime personnel (Prasetiawan et al., 2024; Wibawanti et al., 2025). In addition, regulatory involvement through supervision, training, and enforcement can contribute to stronger safety standards and compliance (Baig et al., 2024; Hasibuan et al., 2025; Priyadi et al., 2025; Størkersen et al., 2017).

The fifth stage encouraged continued capacity building through participation in formal maritime training (diklat). Participants were informed about technical maritime-transport education and training programs that could support further professional competency development. In Indonesia, functional technical maritime-transport training is positioned as an important policy instrument for strengthening knowledge, skills, and professional development in the maritime sector (Lamatokan et al., 2024).

The final stage evaluated immediate knowledge change using a pretest-posttest design. Similar community-empowerment programs in maritime settings have reported substantial post-training knowledge gains using one-group pretest-posttest evaluations (Amanda et al., 2024). In the present program, pretest and posttest scores served as the primary measurable educational outcome.

Through these integrated stages, the program sought to improve maritime safety knowledge, reinforce awareness and emergency preparedness, and strengthen collaboration between maritime actors and local government. The immediate evaluation focused on

knowledge acquisition; sustained changes in behavior, preparedness, and safety culture require longer-term follow-up.

Table 2. Priority problems, program responses, and intended indicators

Priority problem	Program response	Intended indicator
Limited understanding of standardized maritime safety procedures	Maritime safety counseling and educational materials	Improved pretest-posttest knowledge scores
Inconsistent safety practices and emergency preparedness	Demonstration, mentoring, and participatory discussion	Improved awareness and correct use of safety equipment
Limited dissemination, training access, and coordination	Information on formal maritime training and coordination with Transportation Agency	Greater awareness of training opportunities and stronger institutional collaboration

METHODS

This community service program was conducted in Tambrauw Regency, Southwest Papua Province, on 9-10 December 2025. It aimed to strengthen maritime safety knowledge and awareness among coastal maritime actors through counseling, practical demonstrations, and participatory discussion.

The program involved 22 maritime actors, including traditional fishermen, motorboat operators, coastal residents, community leaders, and officers of the Tambrauw Regency Transportation Agency. Participants were selected based on their direct involvement in maritime transportation and coastal activities in Tambrauw Regency.

Implementation consisted of preparation and coordination, pretest administration, maritime safety counseling, practical demonstrations, interactive discussion, and posttest evaluation. The implementation stages are summarized in Table 4.

The intervention combined educational, participatory, persuasive, empowerment-oriented, and evidence-informed approaches. Maritime safety counseling addressed safety equipment, navigation signs, emergency procedures, and safe navigation practices. Participants were actively engaged through interactive discussion and practical demonstrations designed to relate the material to local maritime conditions.

Evaluation used a one-group pretest-posttest design and a 20-item multiple-choice knowledge test. Item validity was assessed using product-moment correlations, and internal consistency was assessed using Cronbach's alpha. Pretest and posttest scores were summarized descriptively and compared using a paired-samples t-test. Detailed validity coefficients, the reliability coefficient, knowledge-category cut-points, and test-assumption diagnostics were not available in the program records and are therefore not reported.

Table 3. Participant profile

Variable	Description
Total participants	22 persons
Participant categories	Traditional fishermen, motorboat operators, coastal residents, community leaders, and officers of the Tambrauw Regency Transportation Agency
Location	Tambrauw Regency, Southwest Papua Province

Variable	Description
Selection criteria	Individuals directly involved in maritime transportation and coastal activities

RESULTS

The program evaluated immediate changes in maritime safety knowledge among 22 participants representing traditional fishermen, motorboat operators, coastal residents, community leaders, and officers of the Tambrauw Regency Transportation Agency. The assessment focused on essential safety topics introduced during the program, including safety-equipment use, emergency-response procedures, navigation signs, and safe navigation practices. Participants' knowledge scores were classified into low, moderate, and high categories. The distribution of knowledge levels before and after the counseling activity is presented in Table 5. Table 5 shows a marked shift in knowledge categories after the counseling activity. Before the program, 17 participants (77%) were classified in the low-knowledge category and 5 (23%) in the moderate category; none were classified as high. After the program, no participants remained in the low category, 6 (27%) were classified as moderate, and 16 (73%) reached the high-knowledge category. This pattern indicates a substantial immediate improvement in measured maritime safety knowledge.

To assess whether the observed score change was statistically significant, pretest and posttest scores were compared using a paired-samples t-test. The results are presented in Table 4.

Table 4. Maritime safety knowledge levels before and after counseling

Knowledge level	Pretest n	Pretest %	Posttest n	Posttest %
Low	17	77	0	0
Moderate	5	23	6	27
High	0	0	16	73
Total	22	100	22	100

Table 5 Paired pretest-posttest knowledge results

Measure	n	Mean	SD	t	df	p
Pretest	22	45.0	7.15			
Posttest	22	80.0	5.28	-26.22	21	< .001

The paired-samples analysis showed a statistically significant difference between pretest and posttest knowledge scores, $t(21) = -26.22$, $p < .001$. The mean score increased from 45.0 (SD 7.15) to 80.0 (SD 5.28), representing an immediate within-group gain of 35 points. Because the evaluation did not include a comparison group, this statistically significant change should be interpreted as an association with the program rather than definitive evidence of a causal intervention effect.

DISCUSSION

The program was followed by a substantial immediate improvement in participants' maritime safety knowledge. Mean scores increased from 45.0 to 80.0, and the categorical distribution shifted from predominantly low knowledge at baseline to predominantly high

knowledge after the intervention. These findings support the educational value of combining structured counseling, participatory discussion, and practical demonstrations. However, because the evaluation used a single-group pretest-posttest design, the observed change should not be interpreted as definitive proof of intervention effectiveness.

The direction of the findings is consistent with previous studies showing that limited safety knowledge and reliance on traditional experience without formal safety systems can increase maritime risk, particularly in small-scale and artisanal operations (Saldanha et al., 2020; Utama et al., 2024). In such settings, operational decisions may rely on personal experience and informal sensemaking rather than standardized procedures. Indonesian evidence also indicates that inconsistent life-jacket use and weak enforcement of safety requirements remain common behavioral concerns among small-vessel operators (Saifudin et al., 2024).

The participatory approach used in this program is consistent with behavior-based safety principles, which emphasize observation, feedback, and reinforcement to reduce unsafe practices (Subramanyam & Dhankher, 2022; Gumelar et al., 2025). Safety awareness is also associated with safety behavior and safety citizenship behavior among maritime personnel (Prasetiawan et al., 2024; Wibawanti et al., 2025). Involving regulatory authorities can further strengthen institutional reinforcement through supervision, training, and enforcement, all of which contribute to stronger safety standards and compliance (Baig et al., 2024; Hasibuan et al., 2025; Priyadi et al., 2025; Størkersen et al., 2017).

The integration of knowledge transfer, practical demonstration, and institutional engagement therefore provides a feasible approach to strengthening maritime safety capacity in Tambrauw Regency. The observed improvement in test scores supports the immediate educational value of structured and participatory safety counseling, while sustained reductions in risky behavior and longer-term changes in safety culture require longitudinal observation.

The observed direction of change is consistent with community maritime-safety interventions in other Indonesian coastal settings. Simulation-based training for fishermen on Raam Island substantially increased mean safety-knowledge scores, while a two-day participatory safety program for traditional fishers in Tasikagung, Rembang, also reported a large pretest-posttest improvement (Gumelar et al., 2025; Priyadi et al., 2025). Basic onboard-safety socialization in Sapa Timur likewise highlighted the practical value of combining explanation with hands-on training (Saifudin et al., 2024). Together, these findings suggest that locally adapted safety education can address immediate knowledge gaps, although sustained change depends on continued practice, access to equipment, and institutional reinforcement.

Practical demonstrations are particularly important because maritime safety requires procedural competence as well as factual knowledge. Correctly fitting a life jacket, interpreting navigation signs, recognizing hazardous conditions, and responding to emergencies require practice. Maritime education research identifies training as an important safety-improvement factor, while community programs increasingly use simulation to make learning more transferable to real operating conditions (Frias et al., 2022; Gumelar et al., 2025). Future Tambrauw programs should therefore retain practical demonstrations and add structured

observation checklists so that procedural performance can be assessed directly rather than inferred from written-test scores.

Safety culture is a broader construct than knowledge alone. Research among maritime personnel indicates that safety competence and safety culture can influence safety behavior through safety awareness (Prasetiawan et al., 2024). Knowledge gain may therefore represent an early step toward safer routine practice, but it does not by itself demonstrate consistent life-jacket use, emergency preparedness, or compliance during actual voyages. This distinction is important because repeated exposure to risk without immediate adverse consequences can normalize unsafe behavior among experienced operators. Sustainable safety culture requires shared expectations, equipment availability, supervision, feedback, and visible institutional commitment.

The involvement of the Tambrauw Regency Transportation Agency is an important program strength. Inclusive maritime-planning literature emphasizes the participation of local authorities, fishers, and coastal communities in decisions affecting marine safety and access (Papageorgiou et al., 2024). In practical terms, institutional involvement creates opportunities for periodic refresher training, referral to formal maritime technical education, safety campaigns before high-risk seasons, and coordinated equipment checks. These activities could help transform a one-time counseling program into a continuing local safety mechanism.

Several methodological limitations should be considered. The program documentation states that the 20-item questionnaire underwent product-moment validity testing and Cronbach's alpha reliability testing, but the corresponding coefficients and acceptance criteria were not available. The cut-points used to define low, moderate, and high knowledge were also not documented. These omissions limit assessment of instrument quality and reproducibility. Future program reporting should therefore include the number of valid items, item-correlation criterion, Cronbach's alpha value, scoring range, and knowledge-category thresholds.

The paired-samples t-test also requires cautious interpretation. The available program records did not include the distribution of paired differences, normality assessment, outlier review, or participant-level scores. Consequently, the assumptions underlying the test could not be independently evaluated. The reported t statistic and degrees of freedom were retained, and $p = 0.000$ is appropriately reported as $p < .001$. Additional effect sizes or confidence intervals should be reported only when they can be calculated from the original participant-level dataset.

Future evaluation should use a staged outcome framework. Immediate measures can include knowledge and observed demonstration skills. Outcomes assessed after one to three months could include life-jacket use, safety-checklist adoption, emergency-procedure recall, and participation in formal training. Six- to twelve-month follow-up could document routine compliance, near-miss reporting, safety violations, and local coordination activities. Where feasible, a delayed-intervention or non-equivalent comparison group would strengthen causal

interpretation and reduce the risk of attributing all pretest-posttest change to the counseling session alone.

The Tambahauw model may be transferable to other remote coastal communities because it relies on relatively low-complexity educational methods, practical demonstrations, and local institutional partnership rather than equipment-intensive simulation facilities. Replication should nevertheless begin with a local needs assessment because vessel types, trip duration, weather exposure, passenger patterns, and available emergency resources vary substantially across settings. Standardized documentation of participant characteristics, baseline knowledge, practical performance, follow-up behavior, and institutional actions would strengthen accountability and the evidence base for community maritime-safety programs.

CONCLUSION

Maritime safety counseling in Tambahauw Regency was followed by a substantial immediate improvement in knowledge among 22 maritime actors. The mean score increased from 45.0 (SD 7.15) to 80.0 (SD 5.28), and 73% of participants reached the high-knowledge category after the program. The paired-samples analysis showed a statistically significant pretest-posttest difference, $t(21) = -26.22$, $p < .001$. The combination of counseling, participatory discussion, practical demonstration, and local-government involvement provides a feasible model for community-based maritime safety education. However, the single-group design, incomplete reporting of instrument validity and reliability, and absence of behavioral or long-term follow-up mean that the findings should be interpreted as immediate knowledge improvement rather than evidence of sustained safety-culture change or reduced maritime accidents.

RECOMMENDATIONS

Within the next 3-6 months, the Tambahauw Regency Transportation Agency and local maritime leaders should conduct refresher counseling and practical drills and document correct life-jacket use, emergency-response performance, and navigation-safety knowledge using standardized checklists. Formal maritime training opportunities should be communicated regularly to fishermen and motorboat operators. Future program cycles should retain participant-level pretest-posttest data, report instrument validity and reliability coefficients, define knowledge-category thresholds, and, where feasible, include a comparison or delayed-intervention group. Six- to twelve-month monitoring should track routine safety-equipment use, near-miss reporting, safety violations, and local coordination activities.

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Community-Based Healthy Ageing Education and Mental Health Literacy Among Older Adults in Miri, Sarawak

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Abstract

Population ageing is accelerating in Malaysia, creating an urgent need for community-based approaches that strengthen mental-health literacy and social support among older adults. This community engagement programme evaluated a healthy-ageing knowledge-transfer session delivered at a Pusat Aktiviti Warga Emas (PAWE) centre in Miri, Sarawak. A one-group pretest-posttest design was used because the original programme did not include a control group. Nineteen valid questionnaires were analysed after a 2.5-hour face-to-face session on 19 June 2025. The intervention covered healthy ageing, depression in later life, protective factors, and the role of structured social support. The instrument comprised sociodemographic items and 10 knowledge questions administered immediately before and after the session. Because only summary percentages were available, analysis was descriptive and focused on percentage-point changes. Participants were predominantly women (68.4%), with a mean age of 66.16 years. The largest gains occurred for knowledge of major protective factors against depression (+31.5 percentage points), awareness of the proportion of older adults affected by mental-health problems (+26.3), understanding of structured social support (+15.8), and recognition of PAWE's role (+10.5). Three abstract or exception-based items declined after the session. The programme was feasible and showed promising short-term educational gains, but the absence of a control group and paired individual-level data limits causal interpretation. Future programmes should use booster sessions, age-friendly visual materials, and controlled or paired-data evaluation.

Keywords: healthy ageing; mental-health literacy; social support; older adults; community intervention

Abstrak

Penuaan penduduk di Malaysia berlangsung cepat dan meningkatkan kebutuhan akan pendekatan berbasis komunitas untuk memperkuat literasi kesehatan mental serta dukungan sosial pada lansia. Program pengabdian ini mengevaluasi sesi transfer pengetahuan tentang healthy ageing yang dilaksanakan di Pusat Aktiviti Warga Emas (PAWE), Miri, Sarawak. Desain yang digunakan adalah one-group pretest-posttest karena program asli tidak menggunakan kelompok kontrol. Sebanyak 19 kuesioner valid dianalisis setelah sesi tatap muka selama 2,5 jam pada 19 Juni 2025. Intervensi mencakup healthy ageing, depresi pada usia lanjut, faktor protektif, serta peran dukungan sosial terstruktur. Instrumen terdiri atas data sosiodemografi dan 10 pertanyaan pengetahuan yang diberikan segera sebelum dan sesudah sesi. Karena data yang tersedia hanya berupa persentase ringkasan, analisis dilakukan secara deskriptif menggunakan perubahan poin persentase. Peserta didominasi perempuan (68,4%) dengan rerata usia 66,16 tahun. Peningkatan terbesar ditemukan pada pengetahuan tentang faktor protektif utama terhadap depresi (+31,5 poin persentase), proporsi lansia dengan masalah kesehatan mental (+26,3), pentingnya dukungan sosial terstruktur (+15,8), dan peran PAWE (+10,5). Tiga item yang bersifat abstrak atau berbentuk pengecualian mengalami penurunan setelah sesi. Program menunjukkan kelayakan dan nilai edukatif jangka pendek yang menjanjikan, tetapi ketiadaan kelompok kontrol dan data individual berpasangan membatasi interpretasi kausal. Program selanjutnya perlu menggunakan sesi penguatan, materi visual ramah lansia, serta evaluasi dengan kelompok pembandingan atau data berpasangan.

Kata kunci: healthy ageing; literasi kesehatan mental; dukungan sosial; lansia; intervensi komunitas

INTRODUCTION

Population ageing is a major demographic transition with immediate public-health implications. The World Health Organization (WHO) and the United Nations have designated 2021–2030 as the Decade of Healthy Ageing, emphasising environments and systems that allow older people to maintain functional ability, dignity, and social participation (World Health Organization, 2023). In Malaysia, 4.1 million people, or 12.0% of the national population, were aged 60 years and over in 2025, and the country is expected to become an ageing nation when this proportion exceeds 15% (Department of Statistics Malaysia, 2025). This demographic transition increases pressure on health, long-term care, and community-support systems, particularly in settings where ageing is already visible in everyday social life (Khan et al., 2024; Thinley, 2021). Healthy ageing extends beyond the absence of disease. WHO defines it as the process of developing and maintaining functional ability that enables well-being in older age (World Health Organization, 2023). Mental health and social connectedness are therefore central components of ageing well. Approximately 14% of adults aged 70 years and over live with a mental disorder, while loneliness and social isolation are established risk factors for later-life mental-health problems (World Health Organization, 2025). Depression in older age may remain under-recognised, help-seeking can be delayed, and clinic-centred services alone may not adequately address psychosocial needs (Elshaikh et al., 2023; Reynolds et al., 2022). In Malaysia, the reported increase in lifetime prevalence of mental disorders further supports the need for preventive, literacy-oriented, and stigma-sensitive interventions delivered close to where older adults live and interact (Raaj et al., 2021).

Community day services and structured social-support settings may provide practical platforms for such interventions. Evidence indicates that day centres for older adults can support routine, belonging, social participation, and mental well-being (Orellana et al., 2020). Adult day services may also help buffer loneliness and social isolation by providing socially meaningful opportunities for engagement and support (Sadarangani et al., 2024). Social participation and informal or structured social support have been associated with lower depressive symptoms and better mental health among older adults (Dong et al., 2024; Wang et al., 2022). These findings suggest that community-based education may be more meaningful when health information is linked to a setting that participants already recognise and use.

In Malaysia, Pusat Aktiviti Warga Emas (PAWE) is a community platform where older adults can participate in daily activities within a supportive and developmental environment (Jabatan Kebajikan Masyarakat, 2018). The Miri-based Knowledge Transfer Programme (KTP) addressed three local educational needs: limited understanding of healthy ageing as a functional and psychosocial concept, incomplete recognition of depression-related risks and protective factors, and uneven recognition of PAWE as a structured support resource. Previous evidence supports the potential value of community participation and social support, but individual-level data were unavailable to test mediation between social support and depression. This article therefore focuses on the educational component that can be evaluated transparently using the available pretest and posttest summary data.

The programme's practical contribution lies in integrating healthy-ageing education, depression literacy, social-support concepts, and explicit recognition of PAWE within one short, community-centred session. Rather than treating PAWE merely as a venue, the intervention framed it as an actionable social-support environment. This study aimed to describe immediate changes in older adults' mental-health-related knowledge after the PAWE-based session and to identify knowledge domains that showed the largest gains, no change, or decline. Because the original programme used a one-group design and the available report contained summary rather than paired individual-level data, the objective was descriptive evaluation rather than causal effectiveness testing.

METHOD

A one-group pretest-posttest community-intervention design was used to evaluate immediate educational change. The programme did not include a control or comparison group; therefore, the evaluation was descriptive and does not establish causal effectiveness. The intervention combined structured education, facilitated discussion, reflection on participants' daily experiences at PAWE, and an empowerment-oriented explanation of PAWE as a community resource for mental well-being. This design permits descriptive assessment of short-term knowledge change. The intervention was implemented at a Pusat Aktiviti Warga Emas (PAWE) centre in Miri, Sarawak, Malaysia, on 19 June 2025. The face-to-face session lasted approximately 2 hours and 30 minutes.

The partner was the PAWE management board in Miri. Beneficiaries were older adults who attended the centre during the scheduled KTP activity. Nineteen valid questionnaires were available for analysis. Participants had a mean age of 66.16 years, and 68.4% were women. Facilitators were members of the KTP team, while the PAWE management board coordinated the timing of participation. Formal inclusion and exclusion criteria beyond attendance at the programme were not documented.

The programme comprised preparation with the PAWE management board, baseline pretest administration, a structured educational session, facilitated reflection and discussion, immediate posttest administration, and recommendations for future reinforcement. Educational content covered the UN Decade of Healthy Ageing, the WHO concept of healthy ageing, common mental-health challenges in later life, depression risk and protective factors, and the role of structured social support through PAWE. Discussion invited participants to relate these concepts to their own experiences of social interaction and support at the centre. The primary outcome was item-level change in correct responses across 10 knowledge questions from pretest to immediate posttest. Positive change was defined descriptively as an increase in the percentage of correct responses; no change indicated identical pretest and posttest percentages; negative change indicated lower posttest accuracy. Secondary indicators included participant sociodemographic characteristics and recognition of PAWE as a structured social-support resource. No a priori numerical success threshold was documented.

The questionnaire contained two components: sociodemographic items covering age, gender, occupation status, household status, and average weekly time at PAWE, and 10 knowledge questions covering healthy ageing, depression in older adults, protective factors, and the role of PAWE. The same knowledge items were administered immediately before and after the session. Programme records did not include formal psychometric validity or reliability coefficients for the 10-item knowledge instrument.

Available data were analysed descriptively using frequencies, percentages, means, standard deviations where reported, and post-minus-pre percentage-point changes for each knowledge item. Participant characteristics were summarised using the valid denominator available for each variable. Because only summary percentages were available rather than paired individual-level response records, paired t-tests, Wilcoxon signed-rank tests, McNemar tests, effect sizes, and confidence intervals could not be validly calculated and were not imputed. No between-group analysis was possible because the original programme had no control group.

Permission to conduct the activity was obtained from the PAWE management board, which coordinated the programme schedule. Programme records did not document separate written informed-consent procedures or a formal ethics-committee approval number.

Future implementation was planned conceptually around booster sessions, simplified age-friendly visual materials, repeated reinforcement of abstract concepts, and longer-term follow-up. Future programmes should strengthen PAWE-centred mental-health promotion and retain paired individual-level data for evaluation. Specific financing, local-champion assignments, and routine monitoring schedules were not documented.

RESULTS

The intervention included 19 older adults with valid questionnaires. The mean age was 66.16 years (SD 8.30; range 48–82 years). Women accounted for 68.4% of participants. Homemakers formed the largest occupational category (52.6%), while self-employed, retired, and unemployed participants each represented 15.8%. Six participants (31.6%) lived alone, three (15.8%) lived with a spouse or partner, and ten (52.6%) lived with children. Weekly PAWE attendance data were available for 13 participants, with a mean of 11.31 hours per week.

Table 1. Partner and participant characteristics

Characteristic	Category / summary	n	%
Age	Mean $\pm$ SD = 66.16 $\pm$ 8.30 years; range 48–82	19	100.0
Gender	Male	6	31.6
	Female	13	68.4
Occupation status	Self-employed	3	15.8
	Homemaker	10	52.6
	Retired	3	15.8
	Unemployed	3	15.8
Household status	Living alone	6	31.6
	Living with spouse / partner	3	15.8
	Living with children	10	52.6
Average hours at PAWE per week	Mean = 11.31 hours (13 valid responses; 6 missing)	13	68.4 valid

Item-level pretest-posttest results were heterogeneous. The largest positive change was observed for identifying a major protective factor against depression, increasing from 63.2% to 94.7% (+31.5 percentage points). Awareness of the proportion of older adults affected by mental-health issues increased from 42.1% to 68.4% (+26.3 points), understanding of the importance of structured social support increased from 73.7% to 89.5% (+15.8 points), and recognition of PAWE's role increased from 89.5% to 100.0% (+10.5 points). Smaller gains occurred for identifying a non-component of functional ability (+5.2 points) and recognising the importance of discussing healthy ageing (+5.3 points).

Three items showed lower posttest accuracy: knowledge of the UN Decade for Healthy Ageing decreased by 15.8 percentage points, the WHO definition of healthy ageing decreased by 10.5 points, and recognition of a symptom not commonly associated with depression decreased by 10.5 points. The item on depression risk factors remained unchanged at 52.6%. Because only aggregated percentages were available, statistical significance and individual-level change could not be determined.

Table 2. Item-level pretest and posttest performance (n = 19)

Knowledge item	Pretest n (%)	Posttest n (%)	Change (pp)	Interpretation
UN Decade for Healthy Ageing	13 (68.4)	10 (52.6)	-15.8	Declined
WHO definition of healthy ageing	10 (52.6)	8 (42.1)	-10.5	Declined
NOT a component of functional ability	6 (31.6)	7 (36.8)	+5.2	Improved
Importance of discussing healthy ageing	16 (84.2)	17 (89.5)	+5.3	Improved
% of older adults with mental-health issues	8 (42.1)	13 (68.4)	+26.3	Improved
Symptom NOT commonly associated with depression	13 (68.4)	11 (57.9)	-10.5	Declined
Risk factor for depression	10 (52.6)	10 (52.6)	+0.0	No change
Major protective factor against depression	12 (63.2)	18 (94.7)	+31.5	Improved
Role of PAWE	17 (89.5)	19 (100.0)	+10.5	Improved
Importance of structured social support	14 (73.7)	17 (89.5)	+15.8	Improved

DISCUSSION

The findings indicate that a short PAWE-based educational programme can produce meaningful descriptive gains in selected domains of mental-health literacy, particularly those that are concrete, closely related to participants' experiences, and directly connected with social participation. The strongest gains concerned protective factors against depression, the burden of mental-health problems among older adults, structured social support, and PAWE's role as a support environment. These domains are closely aligned with the practical realities of participants who already attend the centre, suggesting that local relevance may facilitate comprehension and immediate recall. However, the one-group design and aggregated data mean that these changes should be interpreted as descriptive educational signals rather than causal proof of intervention effectiveness.

The pattern is consistent with evidence that social participation and support are relevant to older adults' mental health. Dong et al. (2024) reported that informal social support is associated with mental-health outcomes in older adults, while Wang et al. (2022) described relationships between social-participation types and depression. Reviews of day centres and adult day services similarly emphasise routine, belonging, social connection, and opportunities for meaningful engagement (Orellana et al., 2020; Sadarangani et al., 2024). Within this context, the gains observed for structured social support and depression-protective factors are coherent with the broader evidence base, although this study measured knowledge rather than depression symptoms or actual social-support behaviour.

The posttest result showing 100% recognition of PAWE's role is particularly relevant for community-development practice. Educational programmes are more actionable when they connect health information to an accessible local resource. PAWE was not introduced as an abstract institutional concept but as a setting that participants already use for routine activity, interaction, and informal support. Reinforcing the centre's role may strengthen the perceived relevance of continued participation and peer connection. Nevertheless, continued attendance, help-seeking, belonging, and changes in social-support behaviour were not measured, so the present findings should not be extended to these downstream outcomes.

In contrast, three items declined after the intervention, including the UN Decade for Healthy Ageing, the formal WHO definition of healthy ageing, and an exception-based depression-symptom item. This pattern suggests that abstract policy terminology and negatively worded or exception-based questions may be harder to retain in a one-off session. For older-adult education, the findings support a more concrete pedagogical strategy using shorter messages, visual reinforcement, examples drawn from daily routines, recap activities, and repeated exposure. The unchanged depression-risk-factor item further indicates that some concepts may require more than a single educational contact.

From an implementation perspective, the programme demonstrated feasibility within a real-world community setting. Nineteen older adults completed valid questionnaires after a 2.5-hour session, and the content could be delivered through the existing PAWE structure. This is relevant because community interventions that fit within established routines are more likely to be practically sustainable than stand-alone activities requiring new infrastructure. The programme also used facilitated discussion rather than lecture alone, allowing participants to connect healthy-ageing concepts to their experiences at PAWE. This participatory element is consistent with the empowerment orientation of community development, even though empowerment itself was not measured as a separate outcome.

Several methodological limitations remain important. First, the study used a one-group pretest-posttest design without a control group, so maturation, testing effects, chance variation, or other influences cannot be excluded. Second, only immediate posttest knowledge was assessed, providing no evidence about retention. Third, only summary percentages were available rather than paired individual-level records. This prevented valid paired statistical testing, confidence intervals, effect-size estimation, and assessment of whether the same individuals changed their responses. Fourth, the 10-item knowledge instrument was not accompanied by reported psychometric validation or reliability coefficients. Finally, the sample was small and drawn from one PAWE centre, limiting generalisability.

These limitations also clarify the direction for programme improvement. A future evaluation should use either a non-equivalent comparison group or, at minimum, retain paired individual-level pretest and posttest data so that within-person change can be tested. If a control group is feasible, baseline comparability, contamination risk, and group allocation procedures should be documented. Follow-up measurement after several weeks would help determine retention, while validated scales could assess perceived social support, depressive symptoms, loneliness, or help-seeking alongside knowledge. Such additions would strengthen the evaluation while preserving the programme's community-centred and PAWE-based character.

For sustainability, the intervention should be embedded into PAWE's routine educational activities rather than remain a single event. Booster sessions can reinforce difficult concepts, and simplified visual materials can remain at the centre for repeated use. PAWE staff or selected older-adult peer champions could potentially support recurring reinforcement, although such roles were not defined in the available programme records. Any future scale-up should therefore document partner ownership, responsible persons, monitoring frequency, and resources required. This would strengthen both the sustainability and replicability of the programme across comparable PAWE settings in Sarawak.

CONCLUSION

The PAWE-based healthy-ageing education programme showed promising immediate descriptive gains in several mental-health-literacy domains among 19 older adults in Miri, particularly knowledge of depression-protective factors (+31.5 percentage points), the burden of mental-health problems (+26.3 points), structured social support (+15.8 points), and PAWE's role (+10.5 points). At the same time, three abstract or exception-based items showed lower posttest accuracy, indicating that a single educational session did not improve all knowledge domains equally. The findings support PAWE as a feasible setting for community mental-health education, but they should not be interpreted as definitive evidence of effectiveness because the programme had no control group and only aggregated pretest-posttest data were available. Future implementation should strengthen pedagogical reinforcement and use paired individual-level data, follow-up assessment, and a comparison group where feasible.

RECOMMENDATIONS

PAWE and the KTP team should provide brief booster sessions supported by age-friendly visual materials. Future evaluations should retain paired pretest-posttest data, include a comparison group when feasible, and conduct follow-up assessments to measure knowledge retention. Before scale-up, programme ownership, local facilitators, monitoring, and replication resources should be clearly defined.

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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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Stress Management Education to Support Psychological Well-Being among Educational Support Staff

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Abstract

Educational support staff play an essential role in maintaining academic and administrative services; however, high workloads, overlapping responsibilities, organizational change, and limited psychological support may contribute to occupational stress. This community service program aimed to strengthen educational support staff's knowledge and practical understanding of occupational stress, psychological well-being, and stress-management strategies. A single-group pretest-posttest evaluation was conducted among 16 staff members at Campus B, Universitas Sunan Gresik, Gresik, Indonesia, on 22 June 2026. The intervention combined interactive psychoeducation, participatory discussion, self-reflection, stress-management simulation, and practical use of a Weekly Planner and Workload Control Sheet. Data were collected through attendance records, direct observation, participant feedback, program documentation, and pretest-posttest knowledge assessments and were analyzed descriptively using category distributions and mean scores. The mean knowledge score increased from 39.5 to 72.0, representing a 32.5-point gain. At pretest, 31.25% of participants were classified as having low knowledge, 31.25% as moderate, and 37.50% as high. At posttest, 93.75% reached the very high category, while 6.25% were classified as high. These findings indicate substantial immediate improvement in measured knowledge. However, the single-group design, small sample size, absence of inferential testing, undocumented instrument validity and reliability, and lack of longer-term follow-up limit causal interpretation and conclusions regarding sustainability. Structured psychoeducation combined with reflection and workload-management tools may offer a feasible capacity-building approach; nevertheless, sustained workplace well-being and service quality also require organizational action addressing workload, communication, and psychosocial risks.

Keywords: occupational stress; psychoeducation; workplace well-being; workload management; educational support staff

Abstrak

Tenaga kependidikan berperan penting dalam keberlanjutan layanan akademik dan administrasi, tetapi beban kerja tinggi, tanggung jawab yang tumpang tindih, perubahan organisasi, dan keterbatasan dukungan psikologis dapat meningkatkan stres kerja. Program pengabdian kepada masyarakat ini bertujuan memperkuat pengetahuan dan pemahaman praktis mengenai stres kerja, kesejahteraan psikologis, dan strategi pengelolaan stres pada tenaga kependidikan. Evaluasi menggunakan desain satu kelompok pretest-posttest dengan 16 tenaga kependidikan Kampus B Universitas Sunan Gresik, Gresik, Indonesia, pada 22 Juni 2026. Intervensi memadukan psikoedukasi interaktif, diskusi partisipatif, refleksi diri, simulasi

pengelolaan stres, serta praktik menggunakan Weekly Planner dan Workload Control Sheet. Data dikumpulkan melalui daftar hadir, observasi, umpan balik peserta, dokumentasi, dan penilaian pengetahuan pretest-posttest, kemudian dianalisis secara deskriptif berdasarkan kategori dan nilai rata-rata. Nilai rata-rata meningkat dari 39,5 sebelum intervensi menjadi 72,0 setelah intervensi, atau bertambah 32,5 poin. Pada pretest, 31,25% peserta berada pada kategori pengetahuan rendah, 31,25% kategori sedang, dan 37,50% kategori tinggi. Pada posttest, 93,75% mencapai kategori sangat tinggi dan 6,25% berada pada kategori tinggi. Hasil tersebut menunjukkan peningkatan segera pada pengetahuan yang diukur setelah program. Namun, desain satu kelompok, jumlah peserta yang kecil, tidak adanya uji inferensial, validitas dan reliabilitas instrumen yang belum terdokumentasi, serta tidak adanya tindak lanjut jangka panjang membatasi kesimpulan kausal dan keberlanjutan. Psikoedukasi terstruktur yang dipadukan dengan refleksi dan alat pengelolaan beban kerja dapat menjadi pendekatan promotif dan preventif yang layak, sedangkan perbaikan organisasi terkait beban kerja, komunikasi, dan risiko psikososial tetap diperlukan untuk mendukung kesejahteraan kerja secara berkelanjutan dan kualitas layanan.

Kata kunci: stres kerja; psikoedukasi; kesejahteraan kerja; pengelolaan beban kerja; tenaga kependidikan

INTRODUCTION

Educational support staff are central to the continuity of higher-education services because they support academic administration, finance, library operations, student services, security, and other essential institutional functions. These roles often involve time pressure, multiple responsibilities, interpersonal demands, system changes, and limited control over work processes. The International Labour Organization identifies excessive workload, low job control, role ambiguity, poor communication, and insufficient support as psychosocial hazards that may contribute to work-related stress (International Labour Organization, 2022). Similarly, the World Health Organization recognizes working conditions, workload, organizational culture, and limited support as important determinants of mental health at work (World Health Organization, 2022a, 2024).

Occupational stress is particularly relevant in higher education because administrative and support personnel are expected to maintain service quality while adapting to institutional change. Recent studies involving educational and university personnel have linked workload, organizational demands, and the work environment to stress, psychological distress, burnout, job satisfaction, and performance (Rahmandani et al., 2021; Manik et al., 2023; Kama et al., 2024; Hakim et al., 2024; Rejoice & Regi S, 2025). A recent qualitative study of administrative staff in public universities likewise identified workload, role demands, institutional pressures, and organizational factors as prominent sources of occupational stress and burnout (Saeed et al., 2024).

Evidence from workplace mental-health interventions suggests that educational and psychosocial strategies can improve knowledge, stress-management capacity, and selected mental-health outcomes, although the magnitude and certainty of these effects vary. An umbrella review of meta-analyses found that workplace psychosocial interventions, including stress management and psychoeducation, may produce beneficial effects across several mental-health and well-being outcomes (Miguel et al., 2023). Similarly, a systematic review of

psychosocial interventions for work-related stress reported benefits from cognitive-behavioral, mindfulness, exercise, technology-based, and stress-management approaches, while also noting substantial heterogeneity in intervention quality and study design (Restrepo & Lemos, 2021).

Higher-education settings warrant particular attention because interventions must be compatible with the practical demands of academic and administrative work. Ohadomere and Ogamba (2021) emphasized the importance of management involvement, routine mental-health assessment, effective communication, and accessible support within higher education. More recent systematic evidence indicates that brief, structured, theoretically grounded, and institutionally supported workplace interventions may improve well-being and coping among university staff; however, sustainable implementation depends on leadership support, workload accommodation, flexible delivery, and appropriate follow-up mechanisms (Hossain et al., 2025). Implementation research further suggests that workplace mental-health programs may be undermined when managers do not prioritize them or when workload and staffing constraints limit participation (Gray et al., 2022).

The needs assessment conducted at Campus B, Universitas Sunan Gresik, identified several context-specific concerns, including high and uneven workloads, multiple roles extending beyond formal job descriptions, additional assignments, incomplete digital administrative systems, limited structured stress-management training, coordination difficulties, unclear task guidance, and limited workplace mental-health literacy. Program documentation also identified psychological burdens among some staff, including work-related stress, mental fatigue, anxiety, reduced motivation, and burnout-like symptoms. These findings supported the use of an intervention that combined psychological education with practical workload-management tools rather than relying solely on a lecture-based format.

The present program integrated psychoeducation on occupational stress with participatory discussion, self-reflection, stress-management simulation, and practical use of the Weekly Planner and Workload Control Sheet. This approach is consistent with current recommendations indicating that worker training can strengthen mental-health literacy and stress-management skills, while organizational interventions should simultaneously address psychosocial hazards within the work environment (World Health Organization, 2022a; World Health Organization & International Labour Organization, 2022b). The program was designed as an initial capacity-building intervention rather than a substitute for institutional action related to workload distribution, communication, role clarity, and support systems. Its objective was to improve educational support staff's knowledge and practical understanding of occupational stress and stress-management strategies. The primary measurable outcome was the change in knowledge scores from pretest to posttest among the 16 participating staff members.

METHODS

This community service program employed a single-group pretest-posttest evaluation design. Sixteen educational support staff completed a baseline knowledge assessment, participated in the stress-management education program, and subsequently completed a

posttest. No control or comparison group was included. Accordingly, the analysis describes within-group change and does not estimate a controlled causal effect.

The program was conducted on 22 June 2026 in the Smart Classroom at Campus B, Universitas Sunan Gresik, Gresik, East Java, Indonesia.

The partner institution was Universitas Sunan Gresik, and the direct beneficiaries were 16 educational support staff members at Campus B. Participants represented academic administration, study-program administration, finance, library services, security, and other support functions. Data on age, sex, educational attainment, length of employment, and other demographic characteristics were not available for analysis and therefore are not reported.

Preparation included coordination with institutional leaders, a partner needs assessment, development of educational materials, and preparation of evaluation instruments. Following the pretest, the intervention addressed occupational stress, workplace stressors, psychological consequences, emotional regulation, adaptive coping, time management, and task prioritization. Participatory activities included group discussion, self-reflection, stress-management simulation, and practical application of the Weekly Planner and Workload Control Sheet. The session concluded with the posttest and recommendations for continued application of stress-management and workload-planning strategies.

The primary outcome was knowledge of occupational stress and stress-management strategies, operationalized through pretest and posttest assessment scores. Program outcomes were summarized using the change in mean score and the distribution of participants across the low, moderate, high, and very high knowledge categories. No a priori numerical threshold for program success was specified.

Data sources included attendance records, direct observation, participant feedback, program documentation, and a pretest-posttest knowledge assessment. The assessment covered occupational stress, psychological well-being, and stress-management strategies; however, information on the number of items, item-development process, scoring rubric, validity evidence, and reliability coefficient was not documented. The Weekly Planner and Workload Control Sheet were used as practical intervention tools rather than validated outcome measures.

Participant and outcome data were analyzed descriptively. Knowledge-category distributions were summarized using frequencies and percentages, while mean pretest and posttest scores were compared using the absolute difference. The mean score increased from 39.5 to 72.0, corresponding to a 32.5-point increase. Participant-level paired scores, inferential test results, effect sizes, confidence intervals, and information on statistical software were unavailable; therefore, inferential analyses were not conducted retrospectively.

A formal ethics-committee approval number and a detailed written informed-consent procedure were not documented in the program records available for this report. The activity was conducted as an institutional community-service and staff-development program. No participant photographs are included in this manuscript, and participant privacy should be maintained in all program records and subsequent reporting.

Sustainability requires both continued individual practice and organizational support. Unit leaders may integrate the Weekly Planner and Workload Control Sheet into routine workload reviews, while the human resources unit can schedule periodic mental-health literacy and stress-management sessions. Individual capacity building should be complemented by organizational measures to manage workload, clarify roles, strengthen communication, and improve access to workplace support.

RESULTS

All 16 educational support staff completed the program and both the pretest and posttest assessments. Additional sociodemographic data were not available; therefore, Table 1 reports only the participant characteristics documented for the program.

Table 1. Partner and participant characteristics

Characteristic	Category	n	%
Participant type	Educational support staff	16	100.00
Work setting	Campus B, Universitas Sunan Gresik	16	100.00
Evaluation completion	Pretest and posttest completed	16	100.00

Before the intervention, 5 participants (31.25%) were classified as having low knowledge, 5 (31.25%) as moderate, and 6 (37.50%) as high; none were classified in the very high category. After the intervention, no participants remained in the low or moderate categories. One participant (6.25%) was classified as having high knowledge, while 15 (93.75%) reached the very high category.

Table 2. Pretest-posttest knowledge distribution

Knowledge level	Pretest n	Pretest %	Posttest n	Posttest %
Low	5	31.25	0	0.00
Moderate	5	31.25	0	0.00
High	6	37.50	1	6.25
Very high	0	0.00	15	93.75
Total	16	100.00	16	100.00

The mean knowledge score increased from 39.5 at pretest to 72.0 at posttest, representing an absolute gain of 32.5 points. This change was accompanied by a clear shift from low-to-high knowledge categories at baseline to predominantly very high knowledge after the intervention. Because participant-level paired scores and inferential statistics were unavailable, these findings are presented as descriptive program outcomes rather than statistically tested causal effects.

DISCUSSION

The principal documented outcome was a 32.5-point increase in the mean knowledge score, accompanied by a marked shift in the distribution of knowledge categories. Before the

intervention, 62.50% of participants were classified in the low or moderate categories. After the intervention, no participants remained in these categories, and 93.75% were classified as having very high knowledge. These findings indicate that the program achieved its immediate educational objective of strengthening participants' knowledge of occupational stress and its management. Nevertheless, the observed change should be interpreted within the methodological constraints of a single-group pretest-posttest design.

The direction of the observed change is consistent with broader evidence on workplace psychosocial interventions. In an umbrella review developed to inform WHO workplace mental-health guidance, Miguel et al. (2023) reported that psychosocial interventions, including stress management, psychoeducation, problem solving, and related approaches, may improve selected mental-health and well-being outcomes, although the certainty of evidence varies. Restrepo and Lemos (2021) likewise reported beneficial findings across several types of interventions for work-related stress. The present program adds a context-specific example involving educational support staff rather than clinical or industrial workers.

The psychoeducational component was complemented by participatory activities rather than being delivered solely as didactic information. Participants discussed workplace stressors, reflected on their own experiences, and practiced strategies for coping and task prioritization. This approach is relevant because implementation studies indicate that workplace mental-health interventions are more acceptable and sustainable when they are responsive to actual working conditions, delivered flexibly, and supported by managers (Gray et al., 2022; Waddell et al., 2023). Accordingly, the intervention sought to connect conceptual knowledge with the day-to-day demands experienced by staff.

The Weekly Planner and Workload Control Sheet served as practical links between psychological education and workload organization. Their inclusion was informed by the partner needs assessment, which identified overlapping tasks, additional assignments, coordination problems, and limitations in administrative systems. These tools may help staff identify priorities and organize competing responsibilities; however, the present evaluation did not assess their continued use, adherence, perceived workload, or effects on work performance. Their contribution should therefore be interpreted as part of the intervention design rather than as a demonstrated behavioral outcome.

The findings should also be considered in relation to the organizational determinants of work-related stress. WHO and ILO guidance emphasizes that worker training alone is insufficient when psychosocial hazards are embedded in job design, workload, role clarity, communication, or organizational culture (World Health Organization, 2022a; World Health Organization & International Labour Organization, 2022b; International Labour Organization, 2022). Recent reviews similarly support multilevel approaches that combine individual-level support with organizational action (Ohadomere & Ogamba, 2021; Greiner et al., 2022; Waddell et al., 2023). In the present setting, institutional improvements in workload distribution, task clarification, communication pathways, and supervisory support remain important complements to individual stress-management skills.

This distinction is particularly important in a higher-education setting with evolving administrative systems and organizational demands. The needs assessment identified multiple roles, limitations in administrative systems, and coordination challenges that cannot be addressed through individual coping strategies alone. Recent evidence among university administrative staff has highlighted workload, institutional pressure, role demands, and organizational conditions as contributors to occupational stress and burnout (Saeed et al., 2024). Indonesian studies have also reported psychological distress and work-related stress among educational or university staff (Rahmandani et al., 2021; Manik et al., 2023; Kama et al., 2024; Wahyono et al., 2025). The intervention should therefore be viewed as one component of a broader institutional strategy for promoting workplace well-being.

Several limitations should be considered when interpreting the findings. First, only 16 staff members participated, which limits the generalizability of the results. Second, the single-group design cannot rule out testing effects, regression to the mean, or other factors that may have influenced the observed change between measurements. Third, participant-level paired scores, inferential analyses, effect sizes, confidence intervals, and psychometric evidence for the knowledge instrument were not available. Fourth, the posttest was administered immediately after the intervention, so longer-term knowledge retention remains unknown. Fifth, the evaluation did not measure perceived stress, burnout, psychological well-being, absenteeism, job performance, or continued use of the workload-management tools.

These limitations are important because an improvement in knowledge does not necessarily indicate a reduction in occupational stress or an improvement in psychological well-being. Recent reviews of workplace interventions distinguish mental-health literacy outcomes from symptom, well-being, and work-performance outcomes and recommend using measures that align with the intended mechanism of change (Tóth et al., 2023; Waddell et al., 2023). Accordingly, the present findings support an immediate gain in knowledge but should not be interpreted as evidence that the intervention reduced stress, prevented burnout, or improved job performance.

Future implementation should adopt a more rigorous evaluation design. At a minimum, individual paired data should be retained, the development and psychometric properties of the assessment instrument should be documented, and knowledge should be reassessed after several weeks or months. Where feasible, a delayed-intervention or non-equivalent comparison group could strengthen causal interpretation. Outcome measurement should extend beyond knowledge to include perceived stress, burnout, psychological well-being, workload organization, help-seeking behavior, and continued use of the planner and workload-control tools. The human resources unit should also document organizational actions taken in response to recurring workload and communication concerns.

Despite these limitations, the program offers a feasible community-service model for a higher-education workplace. It combines mental-health literacy, self-reflection, practical workload-management tools, and organizational recommendations within a single staff-development activity. This approach is consistent with contemporary guidance emphasizing both individual capacity and organizational responsibility for psychosocial risk management.

Its principal value lies in providing an initial platform for more systematic mental-health promotion and organizational improvement rather than implying that a brief educational session alone can resolve occupational stress.

CONCLUSION

The stress-management education program was followed by a substantial immediate improvement in measured knowledge among 16 educational support staff at Campus B, Universitas Sunan Gresik. The mean score increased from 39.5 to 72.0, representing a 32.5-point gain, and 93.75% of participants reached the very high knowledge category after the intervention. Interactive psychoeducation, self-reflection, discussion, simulation, and workload-management tools provided a practical capacity-building format. However, the small sample size, single-group design, absence of inferential testing and instrument-validation data, and lack of long-term follow-up limit causal interpretation and do not demonstrate reductions in occupational stress or improvements in psychological well-being. The program should therefore be regarded as an initial promotive and preventive intervention that may support a broader institutional strategy combining staff education with organizational action on workload, communication, role clarity, and psychosocial support.

RECOMMENDATIONS

Within the next 3-6 months, the university's human resources unit should conduct follow-up stress-management and mental-health literacy sessions and assess knowledge retention, perceived stress, and continued use of the Weekly Planner and Workload Control Sheet. Unit leaders should routinely review workload distribution, overlapping assignments, and role clarity. A structured communication channel should also be established to enable staff to report workload-related concerns and support needs. Future evaluations should retain individual paired data, document instrument validity and reliability, apply appropriate statistical analyses, and, where feasible, include a delayed-intervention or comparison group.

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Empowering Rural Women through Packaging Innovation and Business Training for Coconut Shell Biomass Briquettes

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Abstract

Rural communities often face challenges in increasing the market value of locally produced goods when packaging capabilities and basic business-management skills are limited. Coconut-shell biomass briquettes have potential both as a renewable-energy product and as a means of utilizing locally available biomass residues. This community engagement program aimed to strengthen the capacity of a rural women's group in packaging innovation and basic business-feasibility analysis for coconut-shell biomass briquettes. The program was conducted in Karangcangkring Village, Dukun District, Gresik Regency, East Java, on 23 May 2026 and involved 22 members of a women's community group. A participatory approach combined interactive lectures, demonstrations, hands-on packaging design using Canva, group discussions, and practical exercises in calculating the cost of goods manufactured, setting selling prices, estimating profit, and determining the investment payback period. Program evaluation relied on a post-training questionnaire and facilitator observation. Participant responses were consistently positive: 61.9% strongly agreed that the packaging materials were easy to understand, 71.4% strongly agreed that they understood the importance of packaging, 57.1% strongly agreed that they could design product labels using Canva, 42.9% strongly agreed that they understood basic business-feasibility calculations, and 52.4% strongly agreed that they intended to apply the acquired skills. The financial simulation further showed that the reported production cost was below the proposed selling-price range. Overall, the program was well accepted and practically relevant. However, because no pretest or comparison group was used, causal conclusions regarding effectiveness or knowledge improvement cannot be drawn.

Keywords: biomass briquettes; business feasibility; community empowerment; packaging innovation; rural women

Abstrak

Masyarakat perdesaan dapat menghadapi kendala dalam meningkatkan nilai pasar produk lokal apabila pengetahuan mengenai kemasan dan pengelolaan usaha masih terbatas. Briket biomassa tempurung kelapa memiliki potensi sebagai produk energi terbarukan sekaligus sebagai bentuk pemanfaatan residu biomassa lokal. Kegiatan pengabdian kepada masyarakat ini bertujuan memperkuat kapasitas kelompok perempuan melalui pelatihan inovasi kemasan dan analisis kelayakan usaha dasar untuk briket biomassa tempurung kelapa. Kegiatan dilaksanakan di Desa Karangcangkring, Kecamatan Dukun, Kabupaten Gresik, Jawa Timur, pada 23 Mei 2026 dan melibatkan 22 anggota kelompok perempuan. Pendekatan partisipatif memadukan ceramah interaktif, demonstrasi, praktik desain kemasan menggunakan Canva, diskusi kelompok, serta latihan perhitungan harga pokok produksi, penetapan harga, estimasi keuntungan, dan periode pengembalian investasi. Evaluasi program menggunakan kuesioner pascapelatihan dan observasi fasilitator. Respons yang dilaporkan secara konsisten positif: 61,9% peserta sangat setuju bahwa materi kemasan mudah dipahami, 71,4% sangat setuju

memahami pentingnya kemasan, 57,1% sangat setuju memahami desain label menggunakan Canva, 42,9% sangat setuju memahami perhitungan dasar kelayakan usaha, dan 52,4% sangat setuju berniat menerapkan keterampilan tersebut. Simulasi keuangan juga menunjukkan biaya produksi yang dilaporkan berada di bawah rentang harga jual yang diusulkan. Program dinilai dapat diterima dan relevan secara praktis, tetapi tidak adanya data pretest dan kelompok pembandingan membatasi kesimpulan mengenai efektivitas atau peningkatan pengetahuan.

Kata kunci: briket biomassa; kelayakan usaha; pemberdayaan masyarakat; inovasi kemasan; perempuan perdesaan

INTRODUCTION

The global transition toward renewable energy has increased interest in agricultural biomass as both an alternative fuel and a resource for local value creation. Biomass residues can be converted into useful products that reduce waste while supporting household-scale economic activity. Coconut shells are particularly relevant because their carbon content and fuel characteristics make them suitable for briquette production (Hadiyanto et al., 2023; Yirijor & Bere, 2024; Fardin & Nurjannah, 2024). In rural settings, the value of coconut-shell briquettes extends beyond energy substitution: when technical production is supported by appropriate post-production and business-management capabilities, briquettes can also provide an entry point for microenterprise development.

Product competitiveness, however, depends on more than the ability to manufacture briquettes. Packaging influences product identification, perceived quality, brand recognition, and purchasing decisions, while basic financial management enables producers to determine production costs, set appropriate selling prices, estimate profit margins, and assess the financial feasibility of household-scale enterprises. Studies of micro and small enterprises have shown that packaging innovation and marketing capability can enhance product attractiveness and business performance (Maziriri, 2020; Badri et al., 2022; Pranowo et al., 2024). Financial analysis is equally important for biomass enterprises because production costs and pricing structures determine whether a technically feasible product can be sustained commercially (Bot et al., 2023; Girmay et al., 2025).

The partner community in Karangcangkring Village, Dukun District, Gresik Regency, consisted of women involved in Family Welfare Empowerment activities and local micro-scale enterprises. A preliminary needs assessment conducted through observation and discussion identified an estimated 1.3-1.5 m³ of coconut-shell waste generated daily in the local area, much of which was either used as conventional fuel or discarded. The assessment also identified two major barriers to commercialization: limited skills in packaging, labeling, branding, and digital design, and limited capacity to calculate production costs, selling prices, profit, break-even points, and investment-recovery indicators. These gaps constrained the community's ability to transform an available biomass resource into a differentiated product supported by basic business planning.

Previous community empowerment initiatives involving biomass briquettes have often focused primarily on production techniques, while post-production competencies have received less attention. Yet packaging, branding, financial literacy, and market preparation

become critical when communities move from demonstration-scale production toward microenterprise development. The practical gap addressed by this program was therefore not briquette production itself, but the participants' capacity to present the product professionally and make basic business decisions using accessible financial calculations. By integrating packaging innovation through Canva with simple business-feasibility exercises, the program offered a locally adapted capacity-building model that connected renewable-biomass utilization with women's entrepreneurship and rural economic empowerment.

Accordingly, the program aimed to strengthen participants' practical understanding of packaging development, product branding, digital label design, and basic business-feasibility analysis for coconut-shell biomass briquettes. The immediate outcomes were participants' post-training perceptions of material clarity, self-reported understanding of packaging and financial-analysis concepts, and intention to apply the acquired skills. Because the activity did not include a pretest or control group, the evaluation was designed as a descriptive post-training assessment rather than a test of causal effectiveness.

METHODS

This community engagement program employed a participatory capacity-building approach with a single-group post-training evaluation. The activity did not include a baseline pretest or a control/comparison group. Accordingly, the program was evaluated descriptively using post-training participant responses, facilitator observations, and outputs produced during the training sessions. Claims of effectiveness or measured improvement were avoided because no pre-intervention comparison was available.

The program was implemented on 23 May 2026 in Karangcangkring Village, Dukun District, Gresik Regency, East Java, Indonesia.

The partner was a rural women's community group involved in village empowerment activities. Twenty-two participants, aged approximately 26-56 years, attended the program and were predominantly housewives and micro-scale entrepreneurs. The group was selected because of its active role in household welfare, local entrepreneurship, and community empowerment.

The program consisted of preparation, implementation, and evaluation stages. Preparation included field observation, discussions with community representatives, identification of priority needs, and development of learning materials. The packaging session covered packaging functions, labeling, branding, and digital design using Canva. The business session addressed production-cost calculation, cost of goods manufactured, selling-price determination, profit estimation, and investment payback using a household-scale briquette scenario. Demonstrations, hands-on exercises, and group discussions were incorporated to encourage active participation.

The primary indicators were post-training responses concerning material clarity, perceived understanding of the value of packaging, ability to use Canva for label design, understanding of basic cost and payback calculations, and intention to apply the acquired knowledge. Secondary outputs included completion of practical packaging-design exercises and

participation in the business-feasibility simulation. No a priori numerical threshold for program success was specified in the available program documentation.

Evaluation data were obtained from a post-training questionnaire, facilitator observations, attendance records, and activity outputs. The questionnaire used agreement categories to assess participants' perceptions and self-reported understanding. The available documentation did not specify the total number of response-scale points beyond the categories presented, the instrument-development process, evidence of validity, reliability coefficients, or detailed scoring procedures.

Questionnaire responses were summarized descriptively using the reported percentages. No pretest-posttest comparison, inferential statistical test, effect-size estimate, confidence interval, or statistical software was reported. Twenty-two participants attended the activity; however, the denominator used to calculate the questionnaire percentages was not explicitly documented and was therefore not inferred.

The available program documentation did not report formal ethics-committee approval, written informed consent, privacy procedures, or consent for image use. These details should be verified by the authors and reported where applicable before publication. Sustainability was addressed through recommendations for continued mentoring, application of packaging and financial-analysis skills to community products, and future collaboration with local government, cooperatives, and institutions supporting microenterprises. Longer-term monitoring of product commercialization, sales, and continued use of the introduced tools was not reported.

The training introduced a simple cost of goods manufactured (COGM) calculation: $\text{COGM} = \text{Total Production Cost} / \text{Total Production Output}$. Total production cost comprised raw materials, binder, labor, and operating expenses, whereas total production output was expressed in kilograms.

A simple investment-payback calculation was also introduced: $\text{Payback Period} = \text{Total Investment} / \text{Net Profit per Day}$. These calculations were presented as educational tools for household-scale business planning rather than as audited financial projections.

RESULTS

The program involved 22 members of the rural women's community group. Participants were women aged approximately 26-56 years who were primarily housewives and micro-scale entrepreneurs involved in village empowerment activities. The program focused on two complementary areas of capacity building: packaging and product presentation, and basic business-feasibility analysis.

Table 1. Partner and participant characteristics

Characteristic	Category / summary	n	%
Participant group	Rural women's community group	22	100
Age range	Approximately 26–56 years	22	100
Main roles	Housewives and micro-scale entrepreneurs	22	100

During the packaging session, participants practiced identifying essential packaging elements, including the product name, label information, net weight, usage information,

producer identity, and branding components. Canva was introduced as an accessible digital platform for practical label and packaging design. The business-feasibility session introduced production-cost calculation, cost of goods manufactured, selling-price determination, profit estimation, and investment-payback concepts using a household-scale biomass-briquette scenario.

Table 2. Financial simulation used in the household-scale briquette training

Parameter	Reported value
Coconut-shell feedstock	50 kg/day
Biomass briquette output	27 kg/day
Reported COGM	IDR 9,250/kg
Proposed selling price	IDR 12,000–15,000/kg
Estimated daily revenue	IDR 324,000–405,000
Reported investment payback period	Approximately 17 days

The reported COGM was lower than the proposed selling-price range, indicating a positive margin within the training scenario. The simulation illustrated how production costs and selling prices can be compared in basic business planning. However, because the program documentation did not provide a complete audited cost structure or the exact daily net-profit figure, the simulation should be interpreted as an educational example rather than as a verified estimate of profitability.

Post-training participant evaluation

Table 3. Reported post-training participant responses

Evaluation statement	Disagree (%)	Agree (%)	Strongly agree (%)
Packaging materials were easy to understand	0.0	38.1	61.9
Understood the importance of packaging in increasing product value	0.0	28.6	71.4
Understood how to design product labels using Canva	0.0	42.9	57.1
Understood COGM and investment payback calculation	0.0	57.1	42.9
Intended to apply packaging and feasibility analysis in community products	0.0	47.6	52.4

All reported responses fell within the positive agreement categories. The highest proportion of 'strongly agree' responses was recorded for understanding the importance of packaging in increasing product value (71.4%). Strong agreement was also reported for the clarity of the packaging materials (61.9%), the ability to design product labels using Canva (57.1%), intention to apply the acquired skills (52.4%), and understanding of basic cost and payback calculations (42.9%). These findings indicate high acceptability and positive self-reported understanding immediately after the program. However, they do not demonstrate measured improvement because no baseline assessment was conducted.

DISCUSSION

The program addressed a practical commercialization gap in community-based biomass development. Rather than focusing solely on the production of coconut-shell briquettes as a renewable-energy product, the training introduced post-production competencies needed to support market-oriented use. Packaging, labeling, branding, and financial planning are important at this stage because technical production alone does not ensure product differentiation, disciplined pricing, or market readiness. The consistently positive post-training responses suggest that the selected training topics were relevant to the partner community's immediate needs.

Packaging innovation was a central component of the program because community products often compete in markets where presentation and product information shape consumer perceptions. The high proportion of participants who strongly agreed that they understood the importance of packaging supports the practical relevance of this component. Previous studies have likewise associated packaging innovation with product attractiveness, differentiation, and sales performance among microenterprises (Maziriri, 2020; Badri et al., 2022; Pranowo et al., 2024). The use of Canva may also have lowered the technical barrier to design practice by providing an accessible tool that participants could continue to use without specialized graphic-design software.

The business-feasibility component complemented the packaging session by strengthening awareness of production costs and pricing. Community enterprises may underestimate actual production costs when pricing decisions are based primarily on competitors' prices or informal estimates. Introducing COGM and investment-payback concepts provided participants with a structured framework for considering raw materials, labor, operating expenses, selling prices, and investment recovery. Economic studies of biomass briquettes similarly emphasize that financial viability depends on production efficiency and the relationship between production cost and market price (Bot et al., 2023; Girmay et al., 2025). In the present training scenario, the reported COGM was below the proposed selling-price range, making the simulation useful for illustrating positive-margin business planning. Nevertheless, the figures should not be interpreted as a validated enterprise forecast because a complete audited cost structure and sensitivity analysis were not available.

The integration of packaging and business analysis represents a key strength of the program. Packaging can enhance product visibility and perceived value, whereas cost and pricing analysis supports more informed managerial decision-making. Addressing both areas within a single program reflects the practical sequence faced by rural microenterprises: products need to be presented credibly while also being priced on the basis of production costs and expected returns. This integrated approach is consistent with community-empowerment literature that emphasizes practical, participatory, and entrepreneurship-oriented capacity building rather than one-way knowledge transfer (Pugu et al., 2024).

Although the post-training responses indicate strong acceptability, the evaluation design substantially limits interpretation. The program did not include a pretest, a control group, or

an objective assessment of participant competency. Consequently, the available evidence does not support claims of improved understanding or training effectiveness in a causal sense. A more appropriate interpretation is that participants reported finding the material understandable, perceived that they understood the key concepts after the session, and expressed an intention to apply the skills. Self-reported understanding may overestimate actual competency, particularly for financial calculations and digital-design tasks. Future evaluations should therefore include baseline measurement and direct assessment of completed packaging designs and cost calculations.

A further methodological issue concerns the denominator used for the questionnaire percentages. Although 22 participants attended the program, the reported percentages are not readily reconcilable with a denominator of 22, and the number of valid questionnaire responses was not explicitly documented. This information should be verified before publication. Clear reporting of valid responses is necessary to ensure that percentages can be interpreted accurately and, where appropriate, converted into participant counts.

Sustainability also requires evidence beyond immediate post-training responses. Participants expressed an intention to apply the acquired skills, but no follow-up data were reported regarding adoption of packaging prototypes, commercialization of the briquettes, expansion of online or offline marketing, or continued use of the financial-planning tools in subsequent production cycles. For a community-empowerment program, these downstream indicators are important because sustainability depends on continued practice, partner ownership, market access, and institutional support. Continued mentoring could therefore focus on product standardization, packaging refinement, digital marketing, simple bookkeeping, and market testing.

Overall, the program was well aligned with community-development objectives because it connected local biomass utilization, women's capacity building, renewable-energy awareness, and microenterprise skills. Its principal contribution lies in integrating post-production packaging with basic business planning within a single rural empowerment activity. Future implementation should move beyond immediate participant perceptions toward measurable competency and enterprise outcomes by incorporating pretest-posttest assessment, a comparison group where feasible, objective performance rubrics, and follow-up indicators such as adoption, continuity of production, sales, and market reach.

CONCLUSION

The community engagement program provided 22 rural women in Karangcangkring Village with practical training in packaging innovation and basic business-feasibility analysis for coconut-shell biomass briquettes. Post-training responses indicated high acceptability, with strong agreement regarding the importance of packaging, clarity of the training materials, use of Canva, understanding of basic financial calculations, and intention to apply the acquired skills. The financial simulation also demonstrated how reported production costs could be compared with a proposed selling-price range for household-scale business planning. However, because the program did not include a pretest, a control group, or an objective

competency assessment, the findings support conclusions regarding participant acceptability and self-reported understanding rather than causal effectiveness or measured improvement. The program may therefore be considered an initial capacity-building model that links local biomass utilization with rural women's entrepreneurship.

RECOMMENDATIONS

Village partners and the university team should continue mentoring activities focused on packaging refinement, digital marketing, simple bookkeeping, and market testing. Future evaluations should include baseline and post-training assessments, objective competency rubrics, verification of valid questionnaire-response counts, and follow-up measurement of product adoption, sales, and continued use of business-planning tools.

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Mindfulness Psychoeducation to Strengthen Burnout and Emotion-Regulation Literacy among University Lecturers

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Abstract

University lecturers face overlapping academic, administrative, research, and community-service demands that may contribute to work-related stress and increase the need for burnout-prevention literacy. This community service program aimed to strengthen lecturers' knowledge of burnout, emotion regulation, mindfulness, and simple mindfulness practices. A one-group pretest-posttest design was used with active lecturers at Campus B, Universitas Sunan Gresik. The intervention combined psychoeducation, interactive discussion, the STOP Technique (Stop, Take a Breath, Observe, Proceed), and approximately three minutes of mindful breathing. The same evaluation instrument was administered immediately before and after the session, and mean scores were summarized descriptively. Posttest means were higher than pretest means across all six reported knowledge indicators: 4.63 to 4.84, 4.05 to 4.79, 4.18 to 4.68, 3.89 to 4.74, 3.47 to 4.79, and 3.47 to 4.63, corresponding to descriptive gains of 0.21–1.32 points. Facilitators also observed active participation during discussion and guided practice. These findings suggest immediate gains in measured knowledge following the program; however, they do not demonstrate improved emotion-regulation ability or reduced burnout because those psychological outcomes were not assessed directly. The absence of a control group, participant-level statistical analysis, and longer-term follow-up further limits causal interpretation. Workplace-based mindfulness psychoeducation may therefore serve as an initial promotive learning activity, while future programs should incorporate validated outcome measures and stronger evaluation designs.

Keywords: burnout literacy; emotion regulation; mindfulness; psychoeducation; university lecturers

Abstrak

Dosen menghadapi tuntutan akademik, administrasi, penelitian, dan pengabdian kepada masyarakat yang dapat berkontribusi terhadap stres kerja sehingga literasi mengenai pencegahan burnout menjadi penting. Kegiatan pengabdian kepada masyarakat ini bertujuan memperkuat pengetahuan dosen mengenai burnout, regulasi emosi, mindfulness, dan praktik mindfulness sederhana. Evaluasi menggunakan desain satu kelompok pretest-posttest pada dosen aktif Kampus B Universitas Sunan Gresik. Intervensi memadukan psikoedukasi, diskusi interaktif, praktik STOP Technique (Stop, Take a Breath, Observe, Proceed), dan mindful breathing selama kurang lebih tiga menit. Instrumen evaluasi yang sama diberikan sebelum dan segera setelah kegiatan, kemudian skor rata-rata dianalisis secara deskriptif. Skor posttest lebih tinggi dibandingkan pretest pada keenam indikator pengetahuan yang dilaporkan, yaitu

4,63 menjadi 4,84; 4,05 menjadi 4,79; 4,18 menjadi 4,68; 3,89 menjadi 4,74; 3,47 menjadi 4,79; dan 3,47 menjadi 4,63, dengan peningkatan deskriptif sebesar 0,21–1,32 poin. Fasilitator juga mengamati partisipasi aktif selama diskusi dan praktik. Hasil mendukung adanya peningkatan pengetahuan segera setelah program, tetapi tidak membuktikan peningkatan kemampuan regulasi emosi atau penurunan burnout karena kedua outcome psikologis tersebut tidak diukur secara langsung. Ketidadaan kelompok kontrol, analisis statistik berbasis data individu, dan tindak lanjut jangka panjang juga membatasi interpretasi kausal. Psikoedukasi mindfulness di tempat kerja dapat digunakan sebagai kegiatan promotif awal, dengan evaluasi mendatang menggunakan instrumen tervalidasi dan desain yang lebih kuat.

Kata kunci: burnout; dosen; literasi kesehatan mental; mindfulness; regulasi emosi

INTRODUCTION

University lecturers work in a professional environment characterized by simultaneous demands in teaching, research, community service, student supervision, institutional administration, and performance reporting. These responsibilities are central to the Tri Dharma of Higher Education, yet their accumulation may generate sustained work pressure when job demands exceed available time, resources, or coping capacity. Work-related stress can affect not only lecturers' well-being but also professional functioning and institutional performance. Kusnadi (2014) reported an association between workload, self-efficacy, and work stress among university lecturers, illustrating the relevance of both psychological resources and job demands in academic work. For universities, early promotive initiatives that strengthen lecturers' understanding of occupational stress and adaptive self-management are therefore relevant to human-resource development.

When chronic workplace stress is not managed effectively, it may contribute to burnout. Maslach and Jackson (1981) conceptualized burnout in terms of emotional exhaustion, depersonalization, and reduced personal accomplishment, while the World Health Organization (2019) recognizes burnout as an occupational phenomenon resulting from chronic workplace stress that has not been successfully managed. Burnout should therefore not be reduced to low motivation or temporary fatigue. For lecturers, persistent emotional and cognitive demands may be particularly relevant because academic work involves repeated interpersonal contact, deadline pressure, evaluation, and multiple role expectations. The present community-service program did not diagnose burnout or estimate its prevalence among lecturers at Campus B; rather, burnout was addressed as an educational topic within a promotive and preventive psychoeducation program.

Emotion regulation provides a useful framework for understanding how individuals respond to demanding situations. Gross et al. (1998) described emotion regulation as the processes through which individuals influence which emotions they experience, when they experience them, and how those emotions are expressed. A stronger conceptual understanding of emotion regulation may help lecturers recognize emotional reactions and consider more deliberate responses when facing academic or interpersonal stressors. Mindfulness is commonly associated with present-moment awareness and reduced automatic

responding. Kabat-Zinn (2003) described mindfulness as intentionally paying attention to present-moment experience in a nonjudgmental manner, while Bishop et al. (2004) proposed an operational framework emphasizing self-regulation of attention and an open orientation toward experience.

Recent evidence provides a rationale for introducing mindfulness in occupational settings. In a systematic review of standardized mindfulness programs and burnout outcomes, Shoker et al. (2024) reported that mindfulness-based interventions may reduce burnout-related outcomes under appropriate intervention conditions. However, the intensity, duration, and measurement procedures used in formal mindfulness interventions differ substantially from those of a brief community-service psychoeducation session. A short activity of this kind should therefore not be expected to produce the same psychological effects as a structured clinical or workplace mindfulness program. Its more defensible immediate purpose is to improve knowledge, introduce simple techniques, and help participants recognize when and how mindfulness-based strategies can be practiced.

The program was implemented for lecturers at Campus B, Universitas Sunan Gresik, through psychoeducation, participatory discussion, and guided practice. The intervention integrated burnout literacy, emotion-regulation concepts, mindfulness education, the STOP Technique (Stop, Take a Breath, Observe, Proceed), and brief mindful breathing within a single workplace-based activity. The STOP Technique and mindful breathing were selected because they can be demonstrated in a short session and practiced without specialized equipment. This combination extended the activity beyond lecture-based socialization by providing participants with both conceptual information and an initial experiential exercise. Formal baseline needs-assessment data on burnout prevalence or emotion-regulation difficulties at Campus B were not available, which limits the extent to which the local problem can be quantified.

Against this background, the program aimed to strengthen lecturers' knowledge of burnout, emotion regulation, mindfulness, the STOP Technique, and the application of simple mindfulness practices in daily work. The primary measurable outcome was the immediate change in mean scores across six knowledge indicators from pretest to posttest. Participant engagement during discussion and guided practice was treated as a supporting process observation. Because the program used a one-group pretest-posttest design without a control group and did not directly measure burnout severity or emotion-regulation ability, the findings are interpreted as short-term educational changes rather than evidence of reduced burnout or improved emotion regulation.

METHOD

This community-service activity used a one-group pretest-posttest design. Participants completed the same knowledge assessment immediately before and after the psychoeducational intervention. No control or comparison group was included. The design

therefore allowed descriptive assessment of immediate within-group change but did not permit causal attribution of the observed differences to the intervention alone.

The program was conducted at Campus B, Universitas Sunan Gresik, Gresik, East Java, Indonesia. The available program records did not specify the exact implementation date or total program duration; these details were therefore not included in the present report.

Campus B, Universitas Sunan Gresik, served as the institutional partner. The beneficiaries were active lecturers responsible for teaching, research, community service, and institutional duties. The available program records did not document the exact number of participants, the number of valid paired pretest-posttest responses, recruitment procedures, age, sex, faculty distribution, or years of service. Consequently, these characteristics could not be reported quantitatively.

Preparation involved institutional coordination, development of psychoeducational materials and presentation media, and preparation of the pretest-posttest instrument. The activity began with the pretest, followed by educational content on the concept, signs, and consequences of burnout; distinctions between burnout and work-related stress; emotion-regulation concepts; mindfulness; and the application of mindfulness in daily work. Interactive discussion encouraged participants to relate the material to academic and interpersonal demands. Guided practice then introduced the STOP Technique (Stop, Take a Breath, Observe, Proceed) and approximately three minutes of mindful breathing. The same evaluation instrument was administered immediately after the session as the posttest.

The primary outcome was the immediate change in mean knowledge scores from pretest to posttest across six indicators in the evaluation instrument. The indicators addressed burnout, emotion regulation, mindfulness, the STOP Technique, and the workplace application of mindfulness; however, the exact wording and mapping of the six indicators were not available in the program records. Participant engagement during discussion and guided practice was treated as a secondary process observation rather than as a psychological outcome.

The same evaluation instrument was administered before and after the program. Documentation did not include the number of items underlying each indicator, the response-scale range, scoring instructions, instrument-development procedures, content-validity assessment, construct validity, or reliability coefficients. These omissions limit full appraisal of the instrument's measurement properties. Burnout severity and emotion-regulation ability were not assessed using dedicated validated psychological scales.

Mean pretest and posttest scores were summarized descriptively for each of the six knowledge indicators. Absolute change was calculated as the posttest mean minus the pretest mean. Because participant-level paired scores, standard deviations, and the exact sample size were unavailable, paired t-tests, Wilcoxon signed-rank tests, effect-size estimates, confidence intervals, and other inferential analyses were not performed. The available program documentation did not include an ethics-approval number, a formal institutional-permission statement, details of the informed-consent procedure, privacy-protection procedures, or

consent for publication of participant photographs. These aspects should be documented in future program reporting in accordance with institutional and journal requirements.

Sustainability can be supported through periodic mindfulness-literacy sessions and more intensive guided practice facilitated by the Psychology Study Program in collaboration with Campus B. Future monitoring should assess continued use of the techniques and directly measure relevant outcomes such as burnout, emotion-regulation ability, work-related stress, or psychological well-being using validated instruments. Follow-up plans should also specify the responsible unit, implementation schedule, monitoring frequency, and required resources.

RESULTS

The program was delivered to active lecturers at Campus B, Universitas Sunan Gresik. Participants completed the pretest, received psychoeducation, joined an interactive discussion, practiced the STOP Technique and mindful breathing, and then completed the posttest. Facilitators observed active participation during discussion and guided practice. Because the program records did not include the exact participant number or demographic characteristics, these data could not be presented quantitatively.

Table 1. Pretest-posttest knowledge indicator scores / Skor indikator pengetahuan pretest-posttest

Knowledge indicator	Pretest mean	Posttest mean	Change (Δ)
Indicator 1*	4.63	4.84	+0.21
Indicator 2*	4.05	4.79	+0.74
Indicator 3*	4.18	4.68	+0.50
Indicator 4*	3.89	4.74	+0.85
Indicator 5*	3.47	4.79	+1.32
Indicator 6*	3.47	4.63	+1.16

Posttest means were descriptively higher than pretest means across all six reported indicators. The increases were +0.21 for Indicator 1, +0.74 for Indicator 2, +0.50 for Indicator 3, +0.85 for Indicator 4, +1.32 for Indicator 5, and +1.16 for Indicator 6. The largest descriptive gains occurred for Indicators 5 and 6, whereas Indicator 1 showed the smallest change. Because the response-scale range, exact indicator wording, sample size, standard deviations, and participant-level paired data were unavailable, neither the statistical significance nor the practical magnitude of these differences could be determined.

Program records also noted positive participant responses to the STOP Technique and mindful breathing, together with active participation during discussion. These observations support the feasibility and acceptability of the activity as a workplace-based psychoeducational session. They should not be interpreted as direct evidence of improved emotion-regulation ability or reduced burnout, because neither outcome was assessed with a dedicated validated psychological measure.

DISCUSSION

The principal finding was that posttest mean scores exceeded pretest means across all six knowledge indicators, with descriptive gains ranging from 0.21 to 1.32 points. Indicators 5 and 6 showed the largest numerical increases, whereas Indicator 1 changed only slightly. Interpretation of this pattern remains limited because the exact construct represented by each indicator and the response-scale range were not available. If Indicator 1 began close to the upper limit of the scale, the smaller increase may partly reflect limited room for improvement; however, this possibility cannot be evaluated without complete instrument information.

The findings are best interpreted as changes in knowledge or understanding rather than changes in psychological functioning. The program provided information on burnout, emotion regulation, mindfulness, the STOP Technique, and the workplace application of mindfulness. Higher posttest means therefore suggest greater immediate understanding of the material presented. This distinction is important because knowledge of emotion regulation is not equivalent to actual emotion-regulation ability, and knowledge of burnout prevention does not demonstrate a reduction in burnout symptoms. Accordingly, the results support an educational interpretation rather than a claim of psychological improvement.

Burnout literacy is a relevant component of workplace mental-health promotion because lecturers face overlapping academic, administrative, research, and service demands. Maslach and Jackson (1981) conceptualized burnout through emotional exhaustion, depersonalization, and reduced personal accomplishment, while the World Health Organization (2019) identifies burnout as an occupational phenomenon associated with chronic workplace stress that has not been successfully managed. In this program, these concepts served as educational content rather than diagnostic outcomes. The activity may therefore help lecturers recognize burnout-related concepts and distinguish them from ordinary tiredness or temporary work dissatisfaction, but it cannot determine whether participants were experiencing burnout or whether their burnout risk changed.

The emotion-regulation component provided a conceptual link between work demands and deliberate responses to emotional experiences. Gross et al. (1998) emphasized that emotion regulation involves processes that influence the experience and expression of emotion. For lecturers, understanding these processes may be useful when responding to student interactions, deadlines, evaluation demands, or competing institutional responsibilities. However, the evaluation did not use a validated emotion-regulation scale. The observed pretest-posttest differences should therefore be interpreted as changes in understanding of emotion-regulation concepts rather than evidence that participants became more effective at regulating their emotions.

The mindfulness component added an experiential dimension to the psychoeducation. Kabat-Zinn (2003) and Bishop et al. (2004) describe mindfulness in terms of present-moment attention, awareness, and a less automatic orientation toward internal experience. The STOP Technique and mindful breathing translated these concepts into brief practices that participants could experience during the session. Facilitators reported positive responses and

active engagement during the exercises. These observations support the acceptability of brief mindfulness practices in a lecturer workplace setting; however, acceptability should not be equated with psychological effectiveness, particularly because the practice was brief and longer-term adherence was not assessed.

The findings are broadly consistent with the rationale underlying more intensive mindfulness interventions, but direct comparison should be made cautiously. Shoker et al. (2024) reviewed standardized mindfulness programs and reported beneficial effects on burnout-related outcomes in controlled studies. Such programs typically involve more structured intervention doses and more rigorous outcome measurement than a single psychoeducational session. The present activity is therefore more appropriately positioned as an introductory program that may encourage continued practice, rather than as an intervention proven to reduce burnout. This conservative interpretation is consistent with the design and the outcomes that were actually measured.

The descriptive pattern also suggests directions for future educational design. The relatively small change in one indicator, compared with the larger gains in Indicators 5 and 6, suggests that learning gains may have varied across content domains. Once the exact indicator labels are documented, future analyses should examine why particular topics show larger or smaller changes. Content that is already familiar at baseline may show limited improvement, whereas practical material introduced through guided exercises may yield larger immediate gains. Such domain-specific interpretation would be more informative than treating all knowledge indicators as equally responsive.

Several methodological limitations constrain interpretation. First, the exact participant number and the number of valid paired responses were not available, limiting assessment of sample size and attrition. Second, the instrument was incompletely described: the wording of the six indicators, number of items, response scale, scoring procedure, validity, and reliability were not documented. Third, only mean scores were available; participant-level paired data, standard deviations, and distributional information were absent, preventing inferential testing, confidence-interval estimation, and effect-size calculation. Fourth, the one-group pretest-posttest design lacked a control group and remained vulnerable to testing effects and other alternative explanations. Finally, measurement occurred immediately after the session, so knowledge retention and behavioral transfer remain unknown.

Future evaluations should retain individual paired responses and use a clearly described instrument with documented content validity and reliability. If knowledge remains the primary outcome, the choice of paired statistical analysis should reflect the scale and distribution of the data. If the program aims to evaluate burnout or emotion regulation directly, validated psychological measures should also be included. A non-equivalent comparison group or delayed-intervention design would strengthen causal interpretation, while follow-up assessments could examine knowledge retention, frequency of mindfulness practice, and psychological outcomes over time.

From a community-development perspective, the program offers practical value as a feasible workplace-based learning model that combines mental-health literacy with simple experiential practice. Its contribution lies in presenting psychological concepts in an accessible format within lecturers' institutional environment. Sustainability, however, requires continuation beyond a single psychoeducational session. The Psychology Study Program and Campus B could establish periodic reinforcement sessions, designate facilitators, provide protected time for practice, and monitor participation. Future program reports should document partner ownership, implementation frequency, resource requirements, and measurable follow-up outcomes to support replication and more rigorous evaluation.

CONCLUSION

The workplace-based mindfulness psychoeducation program was followed by higher immediate posttest knowledge scores across all six reported indicators among participating lecturers at Campus B, Universitas Sunan Gresik. Descriptive increases ranged from 0.21 to 1.32 points, indicating short-term gains in measured understanding of the program content. Guided practice of the STOP Technique and mindful breathing was feasible within the session and accompanied by active participant engagement. However, the program did not directly assess burnout severity or emotion-regulation ability, and the absence of a control group, complete instrument information, participant-level analysis, and follow-up limits causal and psychological-outcome conclusions. The program is therefore best regarded as an initial promotive psychoeducational activity rather than evidence that burnout was reduced or emotion regulation improved.

RECOMMENDATIONS

The Psychology Study Program and Campus B should conduct periodic follow-up mindfulness sessions and retain paired participant-level evaluation data. Future evaluations should report complete instrument properties, use validated measures when burnout or emotion-regulation outcomes are assessed, include a comparison or delayed-intervention group where feasible, and conduct follow-up assessments to examine knowledge retention, practice adherence, and psychological outcomes.

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Smart-Bandeng: Internet of Things-Based Water-Quality Monitoring for Community Milkfish Aquaculture in Ujungpangkah

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Abstract

Milkfish farmers in Pangkahwetan, Ujungpangkah, Gresik, commonly rely on visual observations and reactive responses to assess pond-water conditions, underscoring the need for accessible real-time monitoring. This community service programme introduced and demonstrated the Smart-Bandeng System, an Internet of Things (IoT)-based platform that integrates temperature, pH, and turbidity sensors with a web-based monitoring interface and a K-Nearest Neighbors (KNN) classification component. The programme involved the Pangkahwetan Pond Farmers Association, comprising 30 farmers who manage approximately three hectares of ponds. Activities included socialisation, operator training, device installation, field demonstration, mentoring, and follow-up planning. During a documented two-hour field test, sensor readings were transmitted at five-second intervals. The available dataset recorded temperatures of approximately 28.00–28.19 °C and turbidity values of 29–30 NTU. pH was initially 7.03, rose abruptly to 12.68–13.08, and subsequently returned to 7.00. Because this rapid fluctuation was not verified using a calibrated reference instrument, it is interpreted cautiously as a possible sensor, calibration, electrical, or local sampling artefact rather than a confirmed pond-wide change. Programme documentation did not report sensor models, calibration accuracy, participant pretest-posttest outcomes, harvest effects, or validated KNN performance metrics. The primary documented achievement was therefore the successful deployment and real-time demonstration of a community-oriented monitoring prototype, rather than evidence of reduced harvest failure or improved production. Future implementation should prioritise sensor validation, verification of water-quality thresholds, model-performance assessment, operator competency evaluation, and longitudinal monitoring of technology adoption, pond management, and production outcomes before wider operational deployment.

Keywords: aquaculture monitoring; Internet of Things; milkfish; water quality; community technology

Abstrak

Petambak bandeng di Pangkahwetan, Ujungpangkah, Gresik, masih banyak mengandalkan pengamatan visual dan respons reaktif terhadap kondisi air tambak sehingga membutuhkan sistem pemantauan waktu nyata yang mudah digunakan. Program pengabdian kepada masyarakat ini bertujuan memperkenalkan dan mendemonstrasikan Smart-Bandeng System, yaitu platform berbasis Internet of Things yang mengintegrasikan sensor suhu, pH, dan kekeruhan dengan pemantauan berbasis web serta komponen klasifikasi K-Nearest Neighbors. Mitra program adalah Persatuan Tani Tambak Pangkahwetan yang terdiri atas 30 petambak dan mengelola sekitar tiga hektare tambak. Pelaksanaan mencakup sosialisasi, pelatihan operasional, pemasangan perangkat, demonstrasi lapangan, pendampingan, dan rencana evaluasi lanjutan. Pada uji lapangan selama dua jam, data sensor dikirim setiap lima detik. Data yang terdokumentasi menunjukkan suhu sekitar 28,0–28,19 derajat Celsius dan kekeruhan 29–

30 NTU, sedangkan pH awal 7,03 kemudian meningkat sangat cepat menjadi 12,68-13,08 sebelum kembali menjadi 7,00. Karena perubahan pH tersebut tidak divalidasi dengan instrumen acuan terkalibrasi, hasil ini ditafsirkan secara hati-hati sebagai kemungkinan artefak sensor, kalibrasi, gangguan listrik, atau sampling, bukan perubahan kondisi tambak yang telah terkonfirmasi. Laporan sumber belum menyediakan model sensor, akurasi kalibrasi, hasil pretest-posttest peserta, dampak panen, maupun metrik validasi model K-Nearest Neighbors. Dengan demikian, capaian yang dapat dipastikan adalah keberhasilan penerapan dan demonstrasi prototipe pemantauan waktu nyata. Implementasi berikutnya perlu memprioritaskan validasi sensor, verifikasi ambang mutu air, validasi model, kompetensi operator, adopsi teknologi, dan luaran produksi jangka panjang.

Kata kunci: budidaya bandeng; Internet of Things; kualitas air; monitoring; teknologi komunitas

INTRODUCTION

Gresik Regency is one of East Java's major brackish-water aquaculture areas, with milkfish (*Chanos chanos*) among its leading commodities. Programme background documentation, citing the Directorate General of Aquaculture (2022), reports approximately 28,000 hectares of ponds, annual milkfish production of about 87,000 tonnes, and an estimated economic value of IDR 1.4 trillion. These figures underscore the local importance of pond aquaculture and the need to protect production from environmental instability. Water quality is a critical determinant of aquaculture performance because temperature, dissolved oxygen, pH, salinity, turbidity, nitrogen compounds, and other physicochemical parameters influence fish physiology, feeding, growth, and susceptibility to disease (Prapti et al., 2022; Zhao et al., 2021).

Pangkahwetan Village, Ujungpangkah District, is a coastal aquaculture area where many farmers continue to assess pond-water conditions primarily through visual cues such as colour, odour, and surface appearance. The programme partner, the Pangkahwetan Pond Farmers Association, comprises 30 farmers managing approximately three hectares of ponds. The needs assessment identified four priority concerns: the absence of quantified real-time water-quality information, limited familiarity with digital production-management tools, predominantly reactive decision-making, and the risk of delayed detection of abnormal pond conditions. These constraints are particularly relevant in ponds affected by tidal exchange, rainfall, river inflow, and anthropogenic pollution.

Real-time sensing has become an important component of smart aquaculture. A review of IoT-based aquaculture systems found that temperature, dissolved oxygen, and pH were among the most frequently monitored parameters and that real-time monitoring was the dominant application (Prapti et al., 2022). More recent reviews have further documented the rapid expansion of IoT sensor applications in aquaculture and highlighted their potential for early anomaly detection, remote access, and data-informed management. At the same time, these studies emphasise persistent practical challenges, including sensor fouling, corrosion, calibration drift, communication reliability, and maintenance under rural field conditions (Abdullah et al., 2024; Flores-Iwasaki et al., 2025).

Machine learning can extend sensor-based systems beyond data visualisation to classification, prediction, and decision support. Zhao et al. (2021) reviewed machine-learning

applications in fish aquaculture, including water-quality prediction and intelligent management. However, predictive performance cannot be evaluated meaningfully without transparent reporting of the training data, class labels, preprocessing procedures, hyperparameters, validation strategy, and performance metrics. Systematic reviews of smart aquaculture and aquaponics likewise indicate that monitoring prototypes are common, whereas rigorous stakeholder-centred evaluation and long-term performance validation remain comparatively limited (Anila & Daramola, 2025; Chandramenon et al., 2024).

The Smart-Bandeng System was introduced as an appropriate-technology intervention for community-based pond aquaculture. The prototype integrates an ESP32 microcontroller; temperature, pH, and turbidity sensors; wireless data transmission; a web-based monitoring dashboard; and a K-Nearest Neighbors component intended to classify water conditions. Its community-service contribution lies in combining field deployment with farmer training and mentoring rather than treating the system solely as an engineering prototype. Available programme records, however, provide substantially more information on the technical demonstration than on community-level outcomes. The present article therefore distinguishes between system functions that were demonstrated in the field and outcomes that were not measured or validated.

Accordingly, this community service programme aimed to deploy and demonstrate the Smart-Bandeng prototype with the Pangkahwetan Pond Farmers Association and to establish a practical pathway for real-time water-quality monitoring. The documented outputs included device deployment, real-time data acquisition, dashboard visualisation, and field use of the monitoring interface. Because programme records do not provide validated pretest-posttest measures of farmer competency, technology adoption, harvest performance, mortality, economic outcomes, or machine-learning accuracy, the programme is not interpreted as evidence that harvest failure was reduced, yield increased, or predictive accuracy was achieved.

METHODS

The programme employed a participatory technology-deployment and mentoring approach rather than a controlled effectiveness design. Activities comprised socialisation, operator training, field installation, technology demonstration, mentoring, evaluation planning, and sustainability planning. No independent control group or participant-level pretest-posttest dataset was available; consequently, the programme is evaluated as a field implementation and feasibility activity rather than a quasi-experimental effectiveness study.

The programme was implemented in the aquaculture area of Pangkahwetan Village, Ujungpangkah District, Gresik Regency, East Java, Indonesia. Programme records document a two-hour field data-collection session dated 07/06/2026; however, the date format is ambiguous, and the complete programme start and end dates were not consistently recorded. Mentoring was planned to continue for approximately two to three months following deployment.

The community partner was the Pangkahwetan Pond Farmers Association, consisting of 30 farmers who collectively manage approximately three hectares of pond area. Farmers

participated as beneficiaries and field operators, provided the installation site, attended operational training, and were expected to contribute to routine sensor maintenance, data observation, and pond-management decisions. Detailed participant characteristics, recruitment criteria, session-specific attendance, and baseline digital-literacy measures were not available in the programme records.

The Smart-Bandeng prototype used an ESP32 microcontroller connected to temperature, pH, and turbidity sensors. Sensor readings were transmitted wirelessly to a database and displayed through a web-based interface. Implementation included an explanation of the monitoring concept, operator training, field installation and demonstration, real-time observation, troubleshooting, and planned mentoring. Technical documentation did not specify the sensor manufacturers or models, measurement ranges, stated precision, calibration procedures, deployment depth, number of deployed devices, or maintenance schedule. These details should be documented in subsequent technical evaluations to support reproducibility and performance assessment.

The documented technical outputs comprised real-time data acquisition, data transmission at five-second intervals, database storage, web-dashboard visualisation, and operation of a K-Nearest Neighbors classification component. The programme plan also proposed evaluating partner understanding, operational skills, application use, sensor functionality, and harvest productivity through observation, interviews, questionnaires, and yield analysis. However, corresponding quantitative community-outcome data were not available. These indicators are therefore treated as intended evaluation targets rather than achieved outcomes.

Programme documentation used reference ranges of 28-32 °C for temperature, pH 7.0-8.5, and 20-30 NTU for turbidity and attributed them to SNI 01-6148-1999. The cited BSN reference identifies SNI 01-6148-1999 as a standard for milkfish parent stock rather than a general pond-water monitoring guideline. The present article therefore retains these thresholds as programme reference values but does not present them as independently verified universal SNI limits for pond-water quality. The applicable standard and parameter definitions should be verified before final operational use.

The K-Nearest Neighbors component was intended to classify whether observed water conditions fell within predefined reference ranges. Programme records did not include the training-dataset size, class distribution, feature scaling, selected k value, distance metric, train-test split, cross-validation procedure, confusion matrix, accuracy, precision, recall, F1 score, or external validation. Accordingly, KNN is reported as an implemented analytical component of the prototype, not as a validated predictive model.

The available technical dataset was analysed descriptively. The field sample consisted of measurements recorded at five-second intervals. Inferential statistical analysis was not undertaken because the programme did not include repeated independent experimental units, participant-level outcome data, or validated model-performance outputs.

Programme documentation did not include a formal ethics-committee approval number, an institutional-permission identifier, or a written participant-consent procedure. No

identifiable participant photographs are included in this publication-ready version. The authors should ensure that all applicable institutional permission and consent requirements are documented in accordance with journal policy before publication.

Sustainability planning included farmer operator training, provision of a Smart-Bandeng guidebook, routine maintenance, continued mentoring, and potential collaboration with local government and neighbouring pond communities. Long-term sustainability should be evaluated using measurable indicators such as device uptime, calibration frequency, independent farmer operation, response to alerts, maintenance costs, and changes in pond-management practices.

RESULTS

The Smart-Bandeng prototype was assembled and deployed in the field with the Pangkahwetan Pond Farmers Association. During the documented test, the system acquired temperature, pH, and turbidity readings, transmitted data at five-second intervals, stored the measurements in a database, and displayed current values through a web-based dashboard. These findings demonstrate the feasibility of real-time field data acquisition under the observed test conditions; however, they do not establish sensor accuracy, improved farmer competency, or effects on aquaculture production.

Table 1. Partner profile and Smart-Bandeng implementation characteristics

Characteristic	Description	Reported value/status
Community partner	Pangkahwetan Pond Farmers Association	30 farmers
Managed pond area	Approximate partner-managed pond area	3 hectares
Measured parameters	Temperature, pH, turbidity	3 parameters
Controller	ESP32 microcontroller	ESP32-based prototype
Transmission interval	Real-time sensor upload	Every 5 seconds
Field-test duration	Continuous field data collection	2 hours
Dashboard	Web-based monitoring interface	Operational demonstration
Machine-learning component	K-Nearest Neighbors	Implemented; validation metrics not reported

Table 2. Five-second field readings recorded during the field test

Time	Temperature (°C)	Turbidity (NTU)	pH
08:53:20	28.00	29	7.03
08:53:25	28.00	29	7.03
08:53:30	28.00	29	7.03
08:53:35	28.00	29	7.03
08:53:40	28.00	29	7.03
08:53:45	28.00	29	7.03

Time	Temperature (°C)	Turbidity (NTU)	pH
08:53:50	28.00	29	7.03
08:53:55	28.00	29	7.03
08:54:00	28.19	30	12.68
08:54:05	28.19	30	12.68
08:54:10	28.19	30	12.68
08:54:15	28.19	29	13.08
08:54:20	28.19	29	13.01
08:54:25	28.00	29	13.04
08:54:30	28.00	29	7.00

Across the displayed 70-second interval, temperature and turbidity remained relatively stable, whereas pH changed abruptly from 7.03 to 12.68-13.08 before returning to 7.00. Programme documentation interpreted this sequence as an actual pond-water event followed by rapid correction after the addition of peat and fresh water. This interpretation requires caution because a pond-wide pH shift of this magnitude within seconds would need independent confirmation. In the absence of simultaneous measurements from a calibrated reference instrument, documented calibration data, and information on sensor placement and water mixing, the observed fluctuation may reflect sensor drift, electrical interference, probe fouling, a transient local sampling condition, or another measurement artefact.

An interface example in the programme documentation displayed pH 13.3, temperature 24.6 °C, turbidity 55 NTU, and an overall classification of unsuitable water. These values are reported only to describe the prototype interface and should not be interpreted as validated field measurements because no calibration or reference-instrument confirmation was provided for that display.

Table 3. Water-quality reference ranges applied in the programme

Parameter	Programme reference range	Interpretive note
Temperature	28-32 °C	Used as an SNI-linked reference in the programme; the applicable standard should be verified
pH	7.0-8.5	Used as an SNI-linked reference in the programme; the applicable standard should be verified
Turbidity	20-30 NTU	Used in the programme; the appropriate turbidity/clarity definition and standard should be verified

The K-Nearest Neighbors component was used to generate a water-suitability classification based on the programmed reference ranges. Because no model-development or

validation results were reported, the available evidence does not support claims of predictive accuracy. The defensible technical conclusion is limited to successful integration of the KNN component into the prototype workflow and its use in displaying a classification output.

DISCUSSION

The Smart-Bandeng programme addresses a practical community need for timely information when pond conditions change. IoT-based water-quality monitoring is increasingly used in aquaculture because continuous sensing can shorten the interval between environmental change and management response. Prapti et al. (2022) identified real-time monitoring as one of the most common functions of IoT-based aquaculture systems, while Abdullah et al. (2024) and Flores-Iwasaki et al. (2025) highlighted the value of remote monitoring alongside persistent challenges in sensor durability, maintenance, calibration, and data reliability. The present field demonstration is therefore consistent with current smart-aquaculture development, particularly as a community-oriented prototype.

An ESP32-based architecture is potentially suitable for low-cost community deployment, but technical reporting must be sufficiently detailed to support reproducibility and safe operational use. Sensor model, measurement range, stated precision, calibration frequency, deployment depth, fouling protection, power supply, network reliability, and replacement cost are all relevant to field adoption. Reviews of smart aquaculture consistently identify calibration drift, biofouling, corrosion, and environmental exposure as major limitations of long-term sensing (Abdullah et al., 2024; Flores-Iwasaki et al., 2025). In the absence of these specifications, Smart-Bandeng can be described as operationally demonstrated but not yet technically validated.

The abrupt pH sequence is the most important technical issue in the available field dataset. A rise from approximately pH 7 to above pH 12, followed by a return to pH 7 within seconds, is sufficiently extreme that measurement error should be excluded before biological or management interpretations are made. pH probes can be affected by calibration error, electrical noise, contamination, local chemical gradients, fouling, or inadequate stabilisation time. Although programme notes associate the decline with the addition of peat and fresh water, the short interval and absence of an independent reference measurement prevent a causal conclusion. The sequence is therefore best treated as an anomalous signal requiring investigation rather than evidence of an immediate pond-wide chemical correction.

The three monitored parameters provide useful information but do not constitute a complete aquaculture water-quality profile. Reviews identify temperature, pH, and dissolved oxygen as particularly important in aquaculture monitoring, with ammonia, salinity, conductivity, nitrite, nitrate, and turbidity also relevant depending on the culture system (Prapti et al., 2022; Anila & Daramola, 2025; Chandramenon et al., 2024). Dissolved oxygen and salinity were not documented in the present prototype, although both may be important in brackish-water milkfish ponds. Any future expansion should therefore be guided by local management needs, affordability, maintenance capacity, and the specific decisions that each additional sensor is intended to support.

The machine-learning component also requires substantially stronger validation. Machine learning is increasingly applied to aquaculture water-quality prediction and decision support (Zhao et al., 2021), but a KNN classifier cannot be described as accurate without transparent performance evaluation. At minimum, future reporting should specify the training-set size, input features, class labels, selected *k* value, distance metric, preprocessing procedures, train-test partition, confusion matrix, accuracy, precision, recall, F1 score, and preferably cross-validation results. If classification is primarily determined by fixed water-quality thresholds, the added value of KNN relative to a direct rule-based system should also be explained.

From a community-development perspective, technical deployment represents only one dimension of empowerment. The programme plan included observation, interviews, questionnaires, skills assessment, and harvest-yield analysis, yet quantitative results for these outcomes were not reported. Claims of improved empowerment, technology adoption, or reduced harvest risk therefore remain unsupported by the available evidence. A stronger community evaluation should measure baseline and follow-up operator competency, independent dashboard use, correct responses to alerts, sensor-maintenance ability, perceived usefulness, frequency of adoption, and whether farmers changed pond-management decisions in response to system information.

The water-quality reference ranges embedded in the dashboard also require verification. Programme documentation attributes temperature 28–32 °C, pH 7.0–8.5, and turbidity 20–30 NTU to SNI 01-6148-1999. The cited BSN reference identifies SNI 01-6148-1999 as a parent-stock standard for milkfish, so the authors should confirm whether these thresholds are derived from the appropriate clause, another production standard, or a different aquaculture guideline. This is particularly important for turbidity because water clarity, total suspended solids, and turbidity may be reported in different units and have different management implications. Until verified, these values should be regarded as programme reference ranges rather than universal operational thresholds.

The long-term value of Smart-Bandeng will depend on whether the prototype remains functional and useful after the service team withdraws. Reviews of smart aquaculture note that many systems are evaluated only as short-term prototypes, while stakeholder-centred assessment, maintenance planning, and long-term field validation remain less common (Anila & Daramola, 2025; Flores-Iwasaki et al., 2025). For Pangkahwetan, sustainability should therefore be monitored through device uptime, calibration and maintenance records, farmer-led troubleshooting, connectivity and data costs, frequency of independent system use, and the pond-management actions taken in response to alerts.

This community service programme has two clear strengths: it responds to a locally identified monitoring need and places a functioning digital prototype directly within a farmer-operated aquaculture setting. Its limitations are equally important: the absence of a control group and farmer pretest-posttest outcomes, incomplete sensor specifications and calibration records, unvalidated KNN performance, uncertainty surrounding the extreme pH sequence, and the absence of documented harvest or economic outcomes. These limitations do not negate the value of the field demonstration; rather, they define the evidence required before

stronger claims can be made regarding technical accuracy, farmer empowerment, operational effectiveness, or production benefits.

CONCLUSION

The Smart-Bandeng programme demonstrated real-time acquisition and web-based visualisation of temperature, pH, and turbidity data for the Pangkahwetan Pond Farmers Association. The prototype transmitted readings at five-second intervals and incorporated a K-Nearest Neighbors classification component. At this stage, however, the available evidence does not establish sensor accuracy, validated machine-learning performance, improved farmer competency, reduced harvest failure, or increased production. The abrupt pH sequence from approximately 7 to above 12 and back to 7 requires calibration and confirmation with a reference instrument before it can be interpreted as a genuine pond-water event. Smart-Bandeng should therefore be regarded as a promising technical and community-deployment pilot. Further implementation should verify applicable water-quality standards, document sensor calibration and KNN validation, assess farmer adoption and competency, and evaluate longer-term pond-management and production outcomes.

RECOMMENDATIONS

Within the next 1-3 months, the service team and farmer operators should calibrate all sensors against appropriate reference instruments, document sensor specifications and maintenance procedures, and verify the applicable water-quality standards for milkfish aquaculture. The KNN component should be evaluated using a clearly described labelled dataset and transparent performance metrics. Over the subsequent 3-6 months, follow-up should assess farmer competency, independent system use, responses to alerts, device uptime, maintenance costs, changes in pond-management practices, mortality, harvest yield, and production economics. Dissolved oxygen and salinity should be considered for future integration where local management needs and maintenance capacity justify their inclusion.

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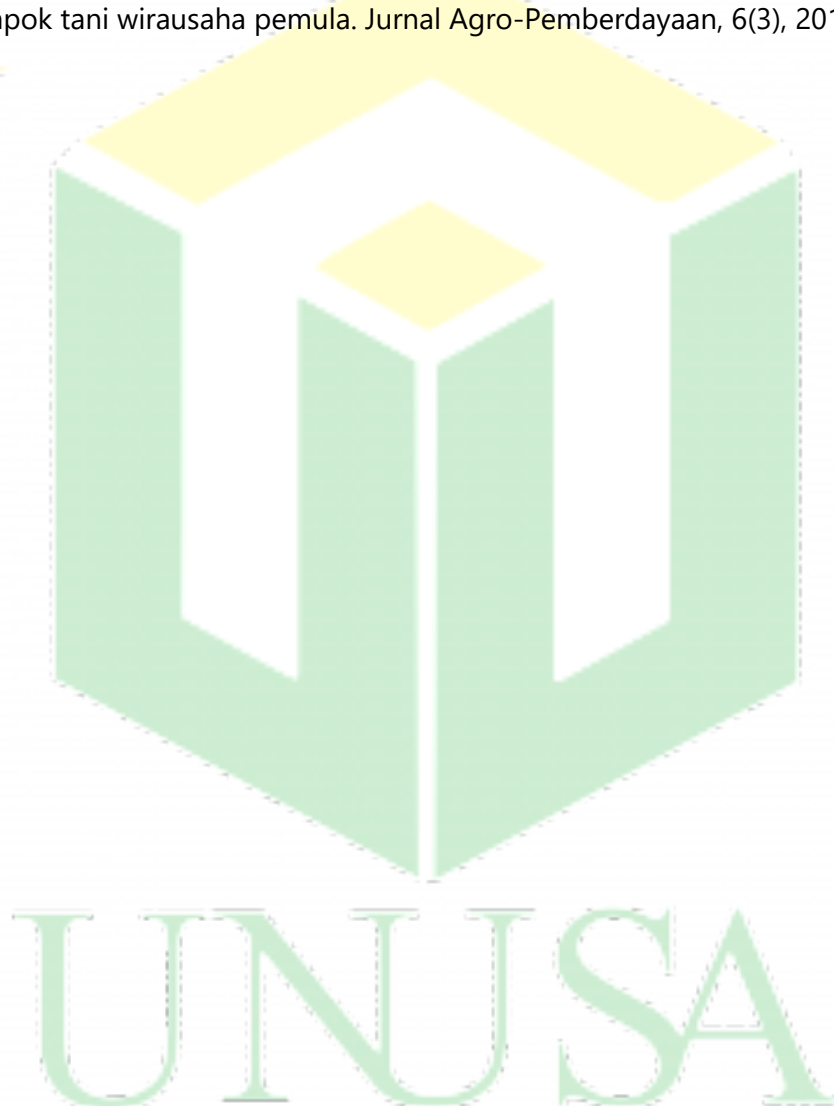
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Empowering pesantren fish-processing MSMEs through packaging, management, and business-legality mentoring

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Abstract

Islamic boarding schools (pesantren) can strengthen local economic resilience through productive micro, small, and medium enterprises (MSMEs); however, their sustainability depends on product quality, sound management, legal compliance, and market readiness. This community service program aimed to identify priority constraints and provide practical mentoring for an alumni-managed fish-processing business unit at MBI Mambaul Falah Islamic Boarding School, Bawean Island, Indonesia. The program adopted a Participatory Action Research (PAR)-oriented approach involving collaborative problem identification, action planning, mentoring, observation, and reflection. The documented beneficiary was one alumni-managed business unit producing bonggolan and fish balls; the available program records did not specify the exact number of individual participants or implementation dates. Baseline observations and partner interviews identified the use of simple, unlabeled airtight packaging, reported spoilage during some off-island shipments, limited formal business-management practices, and incomplete business-legality readiness. The mentoring activities focused on problem mapping, business-management guidance, packaging and labeling recommendations, and preparation for Business Identification Number registration. The available documentation did not confirm issuance of the Business Identification Number, completion of food-production certification, halal certification, quantified packaging performance, sales growth, or pretest-posttest competency outcomes. Accordingly, the results are presented as documented service outputs rather than as evidence of causal improvement in economic independence. The mentoring clarified priority actions related to safer packaging, formal record keeping, business legality, and future digital marketing, while also highlighting the pesantren's alumni-based business-management model. The program provides a feasible foundation for MSME strengthening; however, measurable follow-up indicators are required to determine subsequent changes in product loss, market reach, revenue, legal status, and institutional economic contribution.

Keywords: pesantren MSME; fish processing; packaging; business legality; community empowerment

Abstrak

Pondok pesantren dapat memperkuat ketahanan ekonomi lokal melalui pengembangan usaha mikro, kecil, dan menengah produktif, namun keberlanjutan usaha sangat dipengaruhi oleh mutu produk, tata kelola, legalitas, dan kesiapan pasar. Program pengabdian kepada masyarakat ini bertujuan mengidentifikasi kendala prioritas serta memberikan pendampingan

praktis pada satu unit usaha pengolahan ikan yang dikelola alumni Pondok Pesantren MBI Mambaul Falah, Pulau Bawean, Indonesia. Kegiatan menggunakan pendekatan berorientasi Participatory Action Research melalui identifikasi masalah bersama, perencanaan tindakan, pendampingan, observasi, dan refleksi. Penerima manfaat yang terdokumentasi adalah satu unit usaha alumni yang memproduksi bonggolan dan bakso ikan; jumlah peserta individu dan tanggal pelaksanaan tidak tercantum dalam laporan sumber. Observasi awal dan wawancara mitra menemukan penggunaan kemasan plastik kedap udara sederhana tanpa label, laporan pembusukan pada sebagian pengiriman luar pulau, praktik manajemen usaha yang belum formal, serta kesiapan legalitas yang belum lengkap. Pendampingan yang terdokumentasi berfokus pada pemetaan masalah, penguatan manajemen usaha, rekomendasi kemasan dan pelabelan, serta persiapan pengurusan Nomor Induk Berusaha. Laporan sumber tidak mendokumentasikan penerbitan NIB, penyelesaian sertifikasi pangan rumah tangga, sertifikasi halal, kinerja kemasan terukur, pertumbuhan penjualan, maupun hasil kompetensi pretest-posttest. Oleh karena itu, hasil dilaporkan sebagai luaran layanan yang terdokumentasi, bukan sebagai bukti kausal peningkatan kemandirian ekonomi. Pendampingan menghasilkan prioritas tindak lanjut pada pengemasan, pencatatan usaha, legalitas, dan pemasaran digital, serta menegaskan potensi model pengelolaan usaha berbasis alumni. Evaluasi lanjutan diperlukan dengan indikator kerusakan produk, jangkauan pasar, pendapatan, status legalitas, dan kontribusi ekonomi kelembagaan.

Kata kunci: UMKM pesantren; pengolahan ikan; kemasan; legalitas usaha; pemberdayaan masyarakat

INTRODUCTION

Pesantren increasingly function not only as religious education institutions but also as local economic actors through cooperatives, production units, entrepreneurship programs, and alumni-based enterprises. Recent Indonesian studies indicate that leadership, institutional business units, entrepreneurship, and community integration are important determinants of pesantren economic resilience and self-reliance (Adamin et al., 2025; Hakim et al., 2025; Kusuma Wisudawan et al., 2025; Muiz et al., 2025). These findings are particularly relevant to community-service initiatives because the sustainability of pesantren enterprises depends on the ability to convert social capital, alumni networks, and local resources into professionally managed and market-ready businesses.

MBI Mambaul Falah Islamic Boarding School on Bawean Island has developed an alumni-entrepreneurship model in which graduates are encouraged to manage business activities aligned with their educational backgrounds. Program documentation identifies a fish-processing enterprise managed by fisheries alumni and also notes broiler and greenhouse activities associated with alumni from animal-husbandry and agricultural fields. For the fish-processing unit, the available baseline information is primarily qualitative rather than financial. The business produces bonggolan and fish balls, uses simple airtight plastic packaging without visual product labels, and, according to the business manager, has experienced spoilage during some off-island shipments. Production volume, shipment frequency, spoilage rates, sales, profit, and monetary losses were not documented; therefore, these indicators are not estimated in this article.

Packaging and business management are important priorities for food MSMEs because packaging affects product protection, information provision, brand identity, logistics, and market presentation. Community-service studies in Indonesia have shown that packaging and labeling mentoring can strengthen MSME readiness for wider marketing, particularly when combined with digital branding and sustained assistance (Relawati et al., 2021; Sukmasetya et al., 2021; Nasrulloh et al., 2022). Similarly, business-management mentoring that combines simple bookkeeping with digital promotion can strengthen MSME operational capacity (Farida et al., 2022; Yuliani et al., 2022). Collectively, these studies also suggest that one-off training is rarely sufficient because effective implementation requires continued mentoring and routine application.

Business legality is another important enabling factor for food MSMEs. In Indonesia, a Business Identification Number (Nomor Induk Berusaha, NIB) provides a basic legal identity for business actors under the risk-based licensing system, while food-production and halal requirements vary according to product category and applicable regulations. Recent studies indicate that halal-certification assistance can help MSMEs navigate administrative procedures and that certification may be associated with improved operational or market performance; however, certification alone does not establish economic independence (Fatchurrohman & Nuha, 2022; Giyanti & Indriastiningsih, 2019; Sadiyah & Erawati, 2024; Akbar & Rohman, 2023; Nur Azizah et al., 2025). Legal readiness should therefore be viewed as one component of a broader business-development pathway.

Digital marketing represents a further opportunity once the foundations of product quality, packaging, management, and legality have been sufficiently strengthened. Indonesian community-empowerment programs have reported improvements in MSME digital-marketing knowledge, social-media use, branding, marketplace access, and promotional reach following structured training and mentoring (Widiyanto et al., 2022; Yuliani et al., 2022; Mirani et al., 2022; Himarosa et al., 2022; Saragih & Ulum, 2022). In the present program, however, digital marketing was documented primarily as a recommended next step rather than as a completed intervention outcome.

Based on the documented needs assessment, the priority problem was defined as limited business readiness in packaging, formal management, and legal preparation within the alumni-managed fish-processing MSME. The program therefore aimed to identify these priority constraints and provide practical mentoring to support subsequent standardization and market development. The program did not measure sales, profit, market expansion, institutional income, or reduced dependence on external financing; consequently, it does not claim to have increased economic independence.

METHODS

The program employed a Participatory Action Research (PAR)-oriented community-service approach. The documented process comprised partner engagement, collaborative problem identification, action planning, mentoring, observation, and reflection. Because the available

records do not specify the number or dates of complete PAR cycles, no cycle count is reconstructed. The method therefore reports only intervention components that were explicitly documented.

The program was conducted with the MBI Mambaul Falah Islamic Boarding School community on Bawean Island, Gresik Regency, East Java, Indonesia. The directly documented beneficiary was one alumni-managed fish-processing business unit producing bonggolan and fish balls. Pesantren administrators and alumni were also involved as partners within the broader business ecosystem. The available records did not document the total number, age, sex, or other detailed characteristics of individual participants.

Baseline information was obtained through field observation and discussions with the business manager and pesantren representatives. The assessment focused on product type, packaging practices, distribution experience, business management, and legal readiness. Documented concerns included the use of simple airtight plastic packaging without product labels, reported spoilage during some off-island shipments, informal or insufficiently formalized business-management practices, and the need to strengthen business legality. Production volume, the frequency of spoiled shipments, financial losses, market-reach indicators, and baseline sales data were not available.

The documented intervention included discussions of product-processing and packaging problems, guidance on packaging and labeling improvement, recommendations for business management and governance, and assistance related to NIB registration through the Online Single Submission system. The program also identified PIRT or equivalent food-production licensing, halal certification, digital marketing, and product standardization as subsequent development priorities. Because completion of these processes was not documented, they are reported as follow-up priorities rather than completed outputs.

The primary documented outputs were completion of the partner needs assessment, identification of priority business constraints, delivery of business-management and packaging guidance, and initiation or preparation of business-legality assistance. The available documentation did not include predefined quantitative success targets, pretest-posttest scores, objective packaging-performance tests, sales or profit changes, product shelf-life testing, organoleptic testing, or confirmation of NIB issuance. These missing indicators are treated as evaluation limitations rather than estimated retrospectively.

Qualitative findings were summarized descriptively across five domains: product and packaging, business management, legality, marketing, and institutional governance. No inferential statistical analysis was performed because participant-level quantitative data were not available. Reports of product spoilage are therefore presented as partner-reported observations rather than quantified rates.

Program documentation indicates institutional collaboration with the pesantren but does not provide a formal ethics-approval number, an institutional-permission identifier, or a documented participant-consent procedure. No identifiable participant photographs are included in this copy. Before final publication, the authors should ensure that all applicable

journal requirements regarding institutional permission and consent have been fulfilled and appropriately reported.

Program sustainability depends on partner ownership of subsequent development steps, including formal bookkeeping, packaging standardization, completion of business-legality requirements, food-safety compliance, halal certification where applicable, and gradual adoption of digital marketing. The alumni-based governance model offers a potential mechanism for continuity because the business units are managed by graduates whose educational backgrounds are aligned with the relevant business sectors.

RESULTS

The results summarize documented observations and completed mentoring outputs while distinguishing them from recommended follow-up actions. The available evidence is qualitative and reflects one alumni-managed business unit rather than a quantitative pretest-posttest evaluation.

Table 1. Documented baseline findings, program status, and follow-up priorities

Domain	Documented finding/output	Operational follow-up
Product	Bonggolan and fish balls were produced by the alumni-managed unit.	Maintain product focus while strengthening process and quality documentation.
Packaging	Simple airtight plastic packaging was used without a visual product label.	Improve protective packaging, labeling, and product-information completeness.
Distribution	The manager reported that some products spoiled during shipments outside the region; frequency and financial loss were not recorded.	Document shipment duration, damage rate, temperature/handling conditions, and product loss.
Business management	The business was managed separately from the pesantren's academic/spiritual administration and operated by alumni; detailed bookkeeping indicators were not reported.	Formalize roles, routine records, cost calculation, and performance monitoring.
Business legality	Guidance/preparation for NIB registration was documented; actual issuance was not confirmed in the source report.	Complete NIB status and proceed with applicable food-production and halal requirements.
Digital marketing	Digital marketing was discussed as a development need, not as a completed measurable program outcome.	Implement after core product, packaging, and legality readiness is strengthened.

Domain	Documented finding/output	Operational follow-up
Institutional model	Pesantren support for alumni entrepreneurship was documented across fisheries, broiler, and greenhouse activities.	Use alumni expertise as local champions for enterprise continuity and cross-unit learning.

Packaging was the most immediate problem identified in the fish-processing unit. Products were packed in simple airtight plastic without visual labels. The business manager reported that products shipped outside the region did not always arrive in acceptable condition and that spoilage occurred in some shipments. Because no shipment logs, destination-specific failure rates, transport-duration records, or financial-loss data were available, these observations are not converted into percentages or monetary estimates.

Business-legality mentoring was another documented program output. The team provided guidance on obtaining an NIB through the Online Single Submission system and explained the relevance of subsequent food-production and halal requirements. However, the available records do not confirm issuance of an NIB, PIRT or equivalent food-production authorization, or a halal certificate during the program. The result is therefore reported as guidance and preparatory assistance rather than as completed legalization.

The program documentation also describes an alumni-based governance model. The fish-processing business is managed by fisheries alumni, while other pesantren enterprises include broiler activities associated with animal-husbandry alumni and greenhouse activities associated with agricultural graduates. This arrangement suggests an existing mechanism for aligning alumni expertise with productive activities, although comparative performance data across business units were not available.

DISCUSSION

The principal contribution of this community-service program lies in clarifying a practical development pathway for an alumni-managed pesantren food MSME. Rather than demonstrating economic independence, the documented findings identify foundational constraints that should be addressed before stronger market and financial outcomes can reasonably be expected. This interpretation is consistent with recent pesantren literature indicating that business units, leadership, entrepreneurship, community participation, and institutional governance contribute to economic resilience, while self-reliance remains a multidimensional outcome that requires sustained organizational capacity (Adamin et al., 2025; Hakim et al., 2025; Kusuma Wisudawan et al., 2025; Muiz et al., 2025).

Packaging emerged as the clearest product-level constraint. In food MSMEs, packaging performs protective, informational, and marketing functions simultaneously. Community-service programs in Indonesia have reported that packaging and labeling assistance can strengthen product presentation and readiness for digital marketing, although implementation often requires continued support and access to suitable suppliers (Relawati et al., 2021; Sukmasetya et al., 2021; Nasrulloh et al., 2022). For the MBI Mambaul Falah business unit, the

reported spoilage during some off-island shipments indicates that packaging should be evaluated not only for visual presentation but also for logistics performance and product stability. Future mentoring should therefore document product shelf life, transport conditions, packaging integrity, damage frequency, and handling procedures.

Improving business management is equally important because market expansion without basic records can obscure whether growth actually improves financial performance. Farida et al. (2022) showed that mentoring in simple bookkeeping and social-media marketing can generate concrete operational outputs in a food MSME, while Yuliani et al. (2022) reported that branding, marketplace access, and financial-reporting awareness can be developed through structured socialization, training, and mentoring. In the present program, management weaknesses were identified but were not measured using a baseline-postintervention rubric. The next practical step is therefore to introduce a minimal management dashboard covering production costs, sales, product losses, inventory, cash flow, and monthly profit.

Business legality should be interpreted as an enabling condition rather than as a direct indicator of economic independence. NIB registration provides a basic legal identity, while applicable food-production and halal requirements may strengthen regulatory readiness and consumer confidence. Studies of Indonesian MSMEs suggest that halal-certification assistance can reduce administrative barriers and that certification may be associated with operational or financial performance (Fatchurrohman & Nuha, 2022; Giyanti & Indriastiningsih, 2019; Akbar & Rohman, 2023; Sadiyah & Erawati, 2024; Nur Azizah et al., 2025). Nevertheless, because the present program did not document completed certification or subsequent sales changes, legality is discussed as a strategic preparation pathway rather than as evidence of increased income.

Digital marketing is likewise more appropriately positioned as a subsequent development phase than as a completed result. Several Indonesian empowerment programs report that targeted mentoring can improve digital-marketing knowledge, establish social-media or marketplace accounts, and expand promotional activities (Widiyanto et al., 2022; Mirani et al., 2022; Himarosa et al., 2022; Saragih & Ulum, 2022). Those programs, however, generally report specific implementation outputs. Because digital marketing appears mainly as a recommendation in the present documentation, this article does not claim that digital-market adoption occurred.

The alumni-based governance model represents a notable institutional asset. Aligning business activities with alumni educational backgrounds may strengthen ownership, technical relevance, and continuity. This observation is consistent with recent work emphasizing entrepreneurship incubation, santri empowerment, and community integration as mechanisms for pesantren economic development (Hakim et al., 2025; Kusuma Wisudawan et al., 2025). Nevertheless, the contribution of this model should be evaluated using measurable indicators such as business survival, employment, revenue contribution, reinvestment, and the number of alumni enterprises sustained over time.

The principal limitation of the program report is the absence of quantitative baseline and follow-up indicators. The number of individual participants, implementation dates, shipment-loss records, sales and profit data, NIB completion status, packaging performance, and formal competency outcomes were not documented. Consequently, the strongest defensible conclusion is that the program identified priority business constraints and delivered preparatory mentoring. Future implementation cycles should establish measurable targets in advance, including reductions in spoilage, packaging compliance, completion of legality milestones, bookkeeping adoption, digital-marketing activity, market reach, revenue, and institutional contribution.

From a sustainability perspective, a staged development strategy appears most feasible. The first stage should stabilize product quality, packaging, and business records; the second should complete legal and food-safety requirements; the third should strengthen branding and digital marketing; and the fourth should evaluate financial and institutional contributions. This sequence would enable the pesantren to translate its existing alumni network and sector-specific expertise into a more accountable business-development system while avoiding unsupported claims of economic independence.

CONCLUSION

The program identified packaging, business management, and legal readiness as the principal documented constraints of the alumni-managed fish-processing MSME at MBI Mambaul Falah Islamic Boarding School. The business produced bonggolan and fish balls using simple unlabeled airtight packaging, and the manager reported spoilage during some off-island shipments. The community-service team conducted problem mapping, provided management and packaging guidance, and supported preparation for NIB registration, while food-production licensing, halal certification, packaging standardization, and digital marketing remained follow-up priorities. Because participant-level outcomes, confirmed legal-compliance milestones, sales growth, product-loss rates, and institutional revenue data were not available, the program cannot yet be interpreted as evidence of increased economic independence. Its main contribution is the establishment of a practical strengthening pathway that should be evaluated using measurable operational and financial indicators in subsequent mentoring cycles.

RECOMMENDATIONS

Within the next 1-3 months, the business manager and pesantren should document the status of NIB registration, establish routine production and financial records, and create a shipment-loss log. Within 3-6 months, the partner should test and standardize packaging, complete applicable food-production and halal requirements, and develop compliant product labels. Digital marketing should be introduced once these foundations are in place. The university community-service team should then conduct follow-up evaluation using measurable indicators of spoilage, packaging compliance, bookkeeping adoption, market reach, sales, profit, and institutional contribution.

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Strengthening Sharia financial literacy and budgeting skills among dormitory students to address online loan risks

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Abstract

The rapid expansion of digital lending has increased financial risks for university students who are beginning to manage their finances independently. This community service program aimed to strengthen Sharia financial literacy and provide practical budgeting experience to help dormitory students make more informed decisions about online borrowing. A single-group repeated-measures pretest-posttest design was implemented with 30 students residing at the Universitas Sunan Gresik dormitory, Gresik, East Java, on 8 July 2026. The intervention integrated Sharia financial literacy education, discussion of online-loan risks, case-based learning, and guided budgeting using the Sharia Student Budget Template. Knowledge was assessed using a 10-item questionnaire, with composite scores reported on a 0-100 scale. A subgroup of 15 participants completed a second assessment before the intervention, providing an internal repeated pre-intervention comparison. Among all 30 participants, the mean score increased from 55.10 (SD 7.92) to 85.00 (SD 5.72), representing a 29.90-point gain, $t(29)=64.54$, $p<0.001$, 95% CI [28.95, 30.85], with an N-Gain of 0.67. In the 15-participant subgroup, the mean score increased by 2.60 points before the intervention and by a further 28.00 points after training. All ten questionnaire items showed higher proportions of correct responses at posttest, and participants completed a structured personal-budget exercise. The program was associated with substantial immediate knowledge gains and demonstrated the feasibility of guided budgeting practice. However, the absence of an independent control group and long-term behavioral follow-up limits causal interpretation and conclusions regarding sustained financial behavior.

Keywords: Sharia financial literacy; budgeting practice; online loan risk; dormitory students; financial empowerment

Abstrak

Meningkatnya akses terhadap layanan pinjaman digital meningkatkan risiko keuangan bagi mahasiswa yang mulai mengelola keuangan pribadi secara mandiri. Kegiatan pengabdian kepada masyarakat ini bertujuan memperkuat literasi keuangan syariah dan memberikan pengalaman praktik penyusunan anggaran bagi mahasiswa asrama sebagai upaya preventif terhadap risiko pinjaman online. Evaluasi menggunakan desain satu kelompok repeated-measures pretest-posttest pada 30 mahasiswa penghuni Asrama Universitas Sunan Gresik, Gresik, Jawa Timur, pada 8 Juli 2026. Intervensi memadukan edukasi literasi keuangan syariah, pembahasan risiko pinjaman online, pembelajaran berbasis kasus, dan praktik penganggaran menggunakan Sharia Student Budget Template. Pengetahuan diukur dengan kuesioner 10 butir dan dilaporkan sebagai skor komposit 0-100. Sebanyak 15 peserta juga mengikuti

pengukuran kedua sebelum pelatihan sebagai pembandingan internal pra-intervensi. Pada seluruh peserta, skor rata-rata meningkat dari 55,10 (SD 7,92) menjadi 85,00 (SD 5,72), meningkat 29,90 poin, $t(29)=64,54$, $p<0,001$, 95% CI [28,95; 30,85], dengan N-Gain=0,67. Pada subkelompok 15 peserta, skor rata-rata meningkat 2,60 poin sebelum intervensi dan 28,00 poin setelah pelatihan. Seluruh sepuluh butir menunjukkan proporsi jawaban benar yang lebih tinggi pada posttest. Peserta juga menyelesaikan latihan penyusunan anggaran pribadi terstruktur. Program berkaitan dengan peningkatan pengetahuan segera dan praktik penganggaran yang layak diterapkan, namun ketiadaan kelompok kontrol independen dan tindak lanjut perilaku jangka panjang membatasi kesimpulan kausal dan perilaku.

Kata kunci: literasi keuangan syariah; praktik penganggaran; risiko pinjaman online; mahasiswa asrama; pemberdayaan keuangan

INTRODUCTION

The expansion of digital finance has substantially changed the ways in which young adults access payments, credit, savings, and other financial services. Although these developments can improve convenience and financial inclusion, they also require users to understand borrowing costs, repayment obligations, digital security, and the consequences of inappropriate financial decisions. The OECD/INFE framework conceptualizes financial literacy as an integrated combination of knowledge, behavior, and attitudes and increasingly emphasizes the digital dimension of financial decision-making (OECD, 2023, 2024a). In Indonesia, the 2025 National Survey of Financial Literacy and Inclusion reported a national financial literacy index of 66.46% and a financial inclusion index of 80.51%. The corresponding indices for Islamic finance were 43.42% and 13.41%, respectively, indicating considerable scope to strengthen both understanding and responsible use of Sharia-compliant financial services (OJK & BPS, 2025).

University students are an important target for financial empowerment because many are transitioning from family-managed finances to increasingly independent day-to-day financial decisions. For students living in dormitories, this transition occurs within a residential setting where food, transportation, communication, academic expenses, and discretionary spending must be balanced against limited financial resources. International and Indonesian studies have consistently linked financial literacy with student debt, financial behavior, saving, and credit decisions (Artavanis & Karra, 2020; Johan et al., 2021; Liu & Zhang, 2021; Mudzingiri et al., 2018). Financial education can improve knowledge and subsequent financial behavior, although the magnitude and persistence of these effects depend on intervention design, opportunities for practice, and follow-up (Kaiser et al., 2022).

Digital credit presents a particular challenge because ease of access can reduce the psychological and procedural barriers that traditionally constrained borrowing. Young adults with limited digital financial literacy may underestimate repayment burdens, platform-related risks, or the cumulative consequences of repeated borrowing (Wan Nawang & Abdul Shukor, 2023). Recent Indonesian evidence also links financial literacy and financial attitudes with online-loan decisions among Generation Z, reinforcing the need to combine general financial education with awareness of digital borrowing risks. In the student context, practical financial-

management strategies, including prioritizing essential needs, limiting discretionary expenditure, maintaining simple records, and reviewing repayment capacity, may reduce vulnerability to problematic digital borrowing (Zulfikar et al., 2025).

From an Islamic perspective, financial literacy also encompasses ethical and Sharia-based principles. Islamic financial decision-making emphasizes responsibility, trustworthiness (*amanah*), proportional consumption, avoidance of waste (*israf*), and avoidance of prohibited elements such as *riba* and *gharar*. Studies involving Indonesian students have associated Islamic financial literacy with financial behavior, saving, and investment decision-making (Firdausi & Kasri, 2022; Mustofa, 2022; Rahman & Arsyianti, 2021; Sabastio, 2024). Parhan et al. (2022) similarly present Islamic financial planning as a practical framework for students, while Nurzianti (2022) demonstrates the relevance of Islamic financial literacy to consumptive behavior. Together, these findings support an intervention that goes beyond warning students about online loans by offering a constructive framework for financial planning, prioritization, and responsible use of available funds.

Community-based financial literacy initiatives have increasingly addressed digital lending and related financial risks. Primasari et al. (2024) used web-based literacy activities to raise awareness of online-loan risks, Roekhudin et al. (2025) integrated ethical digital-lending education with an Islamic perspective, and Joesyiana et al. (2026) reported improvements in young people's understanding of Islamic finance and illegal investment risks. These programs suggest that brief educational interventions can increase awareness, but many continue to emphasize information transfer more strongly than repeated application of personal financial-planning skills. Evidence from financial-education research indicates that practical exercises, contextual examples, and reinforcement are important when the goal is to translate knowledge into financial behavior (Johan et al., 2021; Kaiser et al., 2022).

The present program addressed this practical gap by integrating three components within a dormitory-based intervention: Sharia financial literacy, education on online-loan risks, and guided personal budgeting using the Sharia Student Budget Template. The dormitory setting also provided a defined community partner that could support continued use of the budgeting tool after the activity. The program aimed to strengthen students' Sharia financial knowledge and provide structured practice in identifying income, prioritizing expenditure, and preparing a personal budget. Immediate change in financial knowledge was the primary measurable outcome, whereas budgeting was treated as a practical application output because no standardized pre-post competency rubric was used. A repeated pre-intervention assessment in a 15-participant subgroup was included to document score movement before training and to support a more cautious interpretation of the post-intervention change.

METHODS

This community service program employed a single-group repeated-measures pretest-posttest design. All 30 participants completed a baseline assessment and a final posttest. A subgroup of 15 participants also completed a second assessment before the intervention, resulting in three measurement points for that subgroup: baseline, repeated pre-intervention

assessment, and posttest. Because all participants ultimately received the intervention, there was no independent untreated control group; accordingly, the design is not presented as a controlled quasi-experiment. The repeated pre-intervention assessment was used to document possible score movement before training and to contextualize the larger change observed after the intervention. The exact interval between the two pre-intervention assessments was unavailable in the program records and is acknowledged as a reporting limitation.

The program was implemented as a one-day community service activity on 8 July 2026 at the Universitas Sunan Gresik Dormitory in Gresik Regency, East Java, Indonesia. Activities were coordinated with the Dormitory Management, which served as the community partner and facilitated participant recruitment, venue access, activity coordination, and follow-up use of the budgeting tool.

The beneficiaries were 30 students residing in the university dormitory who had begun managing their daily personal expenses independently. Participants were recruited purposively in coordination with the Dormitory Management based on resident status and willingness to complete the training and evaluation process. All 30 participants completed the baseline pretest and final posttest, and 15 also completed the additional pre-intervention assessment. Detailed demographic characteristics, including age, sex, semester, academic program, and source of financial support, were unavailable in the program evaluation records and were therefore not reconstructed retrospectively.

The program consisted of five linked stages. First, participants received an orientation and completed the baseline knowledge assessment. Second, the team delivered interactive Sharia financial literacy material covering responsible financial management, needs versus wants, expenditure prioritization, amanah, balanced consumption, and avoidance of riba, gharar, and israf. Third, participants analyzed online-loan scenarios and discussed financial need, repayment capacity, borrowing costs, associated risks, and alternative responses. Fourth, participants used the Sharia Student Budget Template to record income, classify expenditures, establish priorities, allocate available funds, and prepare a simple personal budget. Finally, participants completed the posttest and reflected on how the budgeting tool could be incorporated into routine financial management.

The primary outcome was financial knowledge related to Sharia financial principles, personal financial management, and awareness of online-loan risks. The program evaluation reported a composite score on a 0-100 scale, with higher scores indicating greater knowledge. The secondary program output was completion of a structured personal-budget exercise. Because budgeting competence was not assessed using a standardized pre-post rubric, no quantified improvement in budgeting skill is claimed; instead, completion of the exercise is reported as evidence that participants practiced applying the concepts introduced during the training.

Financial knowledge was assessed using a 10-item multiple-choice questionnaire covering Sharia financial budgeting, Sharia financial-management principles, the Islamic perspective on debt, needs versus wants, online-loan risks, borrowing decisions, financial decision-making,

initial steps in budgeting, budget allocation, and monthly financial-behavior evaluation. The evaluation data included participant-level composite scores and item-level proportions of correct responses. The original item-weighting and scoring key were not available in the reporting records; therefore, composite scores and item-level percentages are presented as separate evaluation outputs and were not algebraically reconstructed from one another. Formal evidence of instrument validity and reliability was also not documented. The Sharia Student Budget Template was used as a practical learning tool rather than as a validated competency measure.

Descriptive statistics included frequencies, percentages, means, standard deviations, minimum and maximum scores, and absolute changes. For the 30 participants with baseline and posttest scores, a paired-samples t-test was used to examine the pretest-posttest difference, with the mean difference, 95% confidence interval, p-value, Cohen's *d*_z, and normalized gain (N-Gain) reported. Cohen's *d*_z was calculated as the mean paired difference divided by the standard deviation of the paired differences. N-Gain represented the observed gain relative to the maximum possible remaining gain. For the 15-participant subgroup, pairwise comparisons were reported across the repeated pre-intervention and post-intervention measurements. Because the available reporting records did not include the Shapiro-Wilk statistic or a complete set of assumption diagnostics, additional diagnostic checks and a full repeated-measures model could not be reconstructed for this manuscript. Statistical significance was set at $p < 0.05$.

Participation was voluntary, and participants were informed about the purpose of the activity, its procedures, and the use of evaluation data for program reporting. Participant identities were not disclosed, and no participant photographs are included in this manuscript. A formal ethics-committee approval or exemption number was not available in the program documentation; therefore, no approval number is reported. Institutional permission was obtained operationally through collaboration with the Dormitory Management.

The Sharia Student Budget Template was designed for continued use beyond the one-day program. The Dormitory Management can incorporate monthly budget reviews into routine student-development activities, while the university community service team can provide periodic reinforcement on financial decision-making, debt management, and digital financial risks. Longer-term monitoring should assess not only knowledge retention but also budgeting behavior, borrowing decisions, saving practices, and actual use of online credit.

RESULTS

Thirty dormitory students completed the community service program. All participants completed the baseline knowledge assessment, integrated training, budgeting exercise, and final posttest, while 15 also completed the repeated pre-intervention assessment. No attrition was reported between the baseline and final assessments. Because detailed demographic variables were unavailable in the evaluation records, participant reporting focuses on measurement completion and exposure to the intervention.

Table 1. Participant flow and measurement completion (N=30)

Program characteristic	n	%
Dormitory residents enrolled in program	30	100.0
Completed baseline pretest	30	100.0
Completed repeated pre-intervention assessment	15	50.0
Completed intervention	30	100.0
Completed final posttest	30	100.0

The mean composite knowledge score increased from 55.10 (SD 7.92) at baseline to 85.00 (SD 5.72) after the intervention, representing a 29.90-point increase. The reported minimum and maximum scores also shifted upward. All participants achieved higher final scores than at baseline, with individual gains ranging from 25 to 36 points.

Table 2. Pretest and posttest composite knowledge scores

Indicator	Pretest	Posttest	Change
N	30	30	-
Mean	55.10	85.00	+29.90
SD	7.92	5.72	-
Minimum	40	75	-
Maximum	70	95	-

The paired-samples analysis identified a statistically significant pretest-posttest difference, $t(29)=64.54$, $p<0.001$. The 95% confidence interval for the mean difference was 28.95-30.85 points. Cohen's d_z was 11.78, and the N-Gain was 0.67, categorized as moderate. The exceptionally large standardized effect reflects both the magnitude of the mean increase and the low variability of the paired differences. It should therefore be interpreted cautiously and in conjunction with the single-group design and the evidence of pre-intervention retest change described below.

Table 3. Statistical summary of the primary knowledge outcome (N=30)

Statistic	Result
Mean pretest	55.10
Mean posttest	85.00
Mean difference	29.90
95% CI	28.95-30.85
Paired t-test	$t(29)=64.54$
p-value	<0.001
Cohen's d_z	11.78
N-Gain	0.67

Statistic	Result
N-Gain category	Moderate

Among the 15 participants with three measurements, the mean score increased from 54.73 (SD 8.80) at baseline to 57.33 (SD 8.31) at the repeated pre-intervention assessment and then to 85.33 (SD 6.01) after training. Thus, the mean increased by 2.60 points before the intervention and by a further 28.00 points after training. The pre-intervention change was itself statistically significant, $t(14)=8.98$, $p<0.001$, Cohen's $d_z=2.32$, indicating measurable score movement before the intervention rather than a completely stable baseline. The second-pretest-to-posttest comparison was substantially larger, $t(14)=40.99$, $p<0.001$, Cohen's $d_z=10.58$.

Table 4. Repeated knowledge measurements in the 15-participant subgroup

Measurement	n	Mean	SD	Change	Reported paired comparison
Baseline pretest	15	54.73	8.80	-	-
Repeated pre-intervention	15	57.33	8.31	+2.60	$t(14)=8.98$; $p<0.001$; $d_z=2.32$
Final posttest	15	85.33	6.01	+28.00	$t(14)=40.99$; $p<0.001$; $d_z=10.58$

At the item level, the proportion of correct responses increased for all ten assessment domains. The largest increase was observed for Sharia financial-management principles (+56.7 percentage points). Five domains increased by 50.0 percentage points: the purpose of Sharia budgeting, the Islamic perspective on debt, distinguishing needs from wants, financial decision-making, and monthly financial-behavior evaluation. The lowest posttest accuracy was 73.3% for monthly financial-behavior evaluation, suggesting that application-oriented content remained more challenging than several conceptual domains.

Table 5. Percentage of correct responses by questionnaire item

Assessment aspect	Pretest (%)	Posttest (%)	Change (pp)
Purpose of Sharia financial budgeting	43.3	93.3	+50.0
Principles of Sharia financial management	33.3	90.0	+56.7
Islamic perspective on debt	46.7	96.7	+50.0
Distinguishing needs and wants	30.0	80.0	+50.0
Risks of irresponsible online loans	53.3	93.3	+40.0

Assessment aspect	Pretest (%)	Posttest (%)	Change (pp)
Appropriate decision before using online loans	40.0	86.7	+46.7
Financial decision-making	26.7	76.7	+50.0
First step in preparing a personal budget	50.0	96.7	+46.7
Budget allocation	36.7	83.3	+46.6
Evaluating monthly financial behavior	23.3	73.3	+50.0

The budgeting component complemented the knowledge assessment by requiring participants to prepare a personal financial plan using the Sharia Student Budget Template. Participants identified available income, categorized expenditures by priority, allocated funds, and considered whether potential borrowing could be accommodated within available resources. Because no baseline budgeting rubric was used, this component is interpreted as evidence of practical application during the session rather than as proof of a quantified improvement in budgeting competence.

DISCUSSION

The principal finding was a substantial immediate increase in the reported composite knowledge score following the program. The mean rose by 29.90 points, and the proportion of correct responses increased across all ten questionnaire domains. This pattern is consistent with broader evidence on financial education. In a synthesis of randomized experiments, Kaiser et al. (2022) concluded that financial education can improve financial knowledge and downstream behavior. In Indonesia, Johan et al. (2021) similarly showed that personal-finance education can influence university students' knowledge, attitudes, and behavior. The present program extends this evidence to a Sharia-oriented, dormitory-based setting by combining general financial-management concepts with online-loan risk education and ethical considerations relevant to Muslim students. Nevertheless, the single-group design requires the observed changes to be interpreted as program-associated rather than definitively causal.

The findings also highlight the importance of situating financial literacy within the realities of digital finance. OECD frameworks increasingly define digital financial literacy in terms of the knowledge, skills, attitudes, and behaviors required to use digital financial services safely and support financial well-being (OECD, 2023, 2024a). This is particularly relevant for young adults because borrowing can be initiated rapidly through digital platforms. Wan Nawang and Abdul Shukor (2023) identified meaningful gaps in digital financial literacy among young adults, while recent Indonesian evidence continues to link financial literacy with online-loan and digital-credit decisions. The program's case-based discussion of online borrowing therefore addressed a practical decision environment in which students must evaluate financial need, borrowing costs, repayment capacity, and available alternatives.

The Sharia component added an ethical framework to financial decision-making. Firdausi and Kasri (2022) describe Islamic financial literacy as multidimensional, extending beyond knowledge of financial products to include Sharia principles and financial conduct. Rahman and Arsyianti (2021) similarly reported relationships between Islamic financial literacy, financial behavior, and investment decisions, while Mustofa (2022) documented continuing gaps in Islamic financial literacy and saving behavior among students. In the present program, substantial item-level gains in Sharia financial-management principles and the Islamic perspective on debt suggest that participants responded positively to the ethical framing of financial responsibility. These immediate knowledge gains, however, should not be interpreted as evidence of sustained adherence to Sharia financial behavior.

The practical budgeting exercise was an important component because it connected abstract financial concepts with everyday allocation decisions. Financial capability requires more than factual knowledge; it also involves planning, prioritization, and repeated application. European Union/OECD youth competency frameworks emphasize planning and managing finances, understanding risk and reward, and navigating the broader financial landscape as interrelated competence domains (European Union/OECD, 2023). The Sharia Student Budget Template translated these concepts into a simple exercise suited to dormitory students. However, because no validated baseline and post-intervention competency rubric was used, the evidence supports completion and practical application of the exercise rather than a statistically demonstrated improvement in budgeting skill.

The repeated pre-intervention assessment provides useful but cautionary evidence. In the 15-participant subgroup, the mean score increased by 2.60 points before training, and this difference was statistically significant with a large reported standardized effect. The baseline was therefore not completely stable. The change may reflect retest familiarity, spontaneous learning, measurement reactivity, or other influences unrelated to the intervention. Although the subsequent 28.00-point increase after training was considerably larger, the absence of an independent untreated control group prevents definitive causal attribution. The study is therefore more appropriately interpreted as a single-group repeated-measures evaluation with an internal pre-intervention comparison rather than as a controlled quasi-experiment.

The very large reported Cohen's d values also warrant careful interpretation. An effect size of 11.78 is unusual in educational research and can occur mathematically when a large mean difference is combined with very low variability in paired change scores. The reported confidence interval and t statistic are consistent with this pattern. Nevertheless, such an extreme standardized estimate should not be interpreted in isolation as evidence of exceptional intervention effectiveness. Repeated exposure to the same assessment, the relative homogeneity of the sample, and immediate posttesting may all contribute to highly consistent score changes. The N-Gain of 0.67, categorized as moderate, provides a complementary and more conservative description of the observed learning gain relative to the remaining possible score range.

Item-level findings further suggest that conceptual learning and analytical application did not progress uniformly. Posttest accuracy exceeded 90% in several conceptual domains, whereas monthly financial-behavior evaluation remained lower at 73.3%. This pattern is consistent with the distinction between knowing a financial principle and applying it to real decisions. OECD (2024b) emphasizes that student financial literacy includes the ability to apply knowledge in real-life situations rather than merely recall concepts. Similarly, Ajayi et al. (2022) and community-based financial interventions indicate that practice-oriented coaching can be useful when the intended outcome extends beyond knowledge acquisition. Continued exercises should therefore require students to review actual budgets, identify spending trade-offs, and evaluate borrowing scenarios over time.

The intervention is also consistent with recent Indonesian community-service initiatives. Primasari et al. (2024) demonstrated the usefulness of web-based digital financial literacy in raising awareness of online-loan risks. Roekhudin et al. (2025) integrated ethical digital-lending education with an Islamic perspective, while Joesyiana et al. (2026) reported improved youth understanding of Sharia finance and illegal investment risks. The present program extends these approaches by embedding guided budgeting practice within a residential student community. The dormitory setting may also support sustainability because the partner institution can reinforce the material through recurring student-development activities rather than treating the intervention as a one-time seminar.

Several limitations should be considered. First, the sample was small and drawn from a single dormitory, which limits generalizability. Second, detailed demographic characteristics were unavailable in the evaluation records. Third, the composite knowledge-scoring key and psychometric evidence for the 10-item instrument were not documented, preventing independent reconstruction of the composite score from the item-level percentages. Fourth, the repeated pre-intervention subgroup showed a statistically significant retest change, confirming that repeated measurement itself may have influenced scores. Fifth, the posttest was administered immediately after the intervention, so knowledge retention remains unknown. Finally, actual budgeting behavior, saving, debt use, and online-loan uptake were not assessed longitudinally. Accordingly, the strongest defensible conclusion concerns immediate knowledge change and the feasibility of guided budgeting practice.

To strengthen sustainability, the Dormitory Management should integrate monthly budget reviews into routine student-development activities, while the university team can provide periodic case-based reinforcement. Future evaluations should use a clearly documented and validated knowledge instrument and a budgeting-competency rubric, collect relevant demographic and financial-context variables, and assess outcomes after several months. Where feasible, a delayed-intervention or independent comparison group should be included to strengthen causal interpretation. Monitoring should also extend to actual financial behaviors, including budget adherence, saving frequency, borrowing decisions, and use of online lending. These improvements would move the initiative beyond short-term educational

evaluation toward a stronger community-empowerment model linking knowledge, practical skills, and sustained financial behavior.

CONCLUSION

The dormitory-based program was associated with substantial immediate gains in Sharia financial knowledge among 30 students. The mean composite score increased from 55.10 to 85.00, a 29.90-point change, while all ten questionnaire domains showed higher posttest accuracy and the reported N-Gain was 0.67. In the repeated-measurement subgroup, a 2.60-point increase before the intervention was followed by a substantially larger 28.00-point increase after training, indicating the presence of a retest effect alongside the larger post-intervention change. The Sharia Student Budget Template also provided structured practice in personal financial planning. However, because the evaluation lacked an independent control group, long-term behavioral follow-up, and a standardized pre-post budgeting rubric, the findings support immediate knowledge improvement and the practical feasibility of guided budgeting rather than definitive causal or behavioral effectiveness.

RECOMMENDATIONS

The Dormitory Management should incorporate monthly use of the Sharia Student Budget Template into routine student-development activities within the next 1-3 months. The university community service team should provide reinforcement sessions every 3-6 months, focusing on case-based borrowing decisions, budget review, saving practices, and digital financial risks. Future evaluations should retain the original scoring key, report evidence of instrument validity and reliability, use a standardized budgeting-competency rubric, and include follow-up measures of financial behavior. Where feasible, a delayed-intervention or independent comparison group should be included to strengthen causal interpretation.

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Digital Education for Lake Water-Quality Monitoring Using Saprobiic Indicators and a Socio-Psychological Approach

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Abstract

Telaga Ngipik is an urban freshwater ecosystem in Gresik, East Java, with considerable ecological and community value; however, translating environmental information into sustained public monitoring remains challenging. This community service program developed and implemented a digital education platform that integrated phytoplankton-based saprobic indicators with socio-psychological assessment and community mentoring. The program was conducted from 12 May to 20 July 2026 with two non-equivalent community groups (100 participants enrolled: 50 intervention and 50 comparison). The intervention combined participatory needs assessment, application co-design, environmental education, technical training, field mentoring, and digital monitoring practice. Detailed outcome summaries were available for the 50 intervention participants, while complete-case psychometric analyses were available for 42 respondents. The application translated saprobic information into accessible visual categories and achieved a System Usability Scale score of 84.2. Program records also indicated a 42.5% increase in technical competence, an environmental-stewardship intention indicator of 88%, and a 65% increase in self-initiated monitoring activity. Psychometric analyses showed inter-item correlations of .55 for Being Away, .36-.62 for Coherence, .47-.90 for Compatibility, .03-.68 for Fascination, and .19-.91 for the separately defined Health item set; all five summary variables were non-normally distributed. Because complete comparison-group outcome estimates and raw denominators for several aggregate indicators were unavailable, these outcomes are interpreted descriptively rather than as definitive controlled effects. Overall, the program demonstrates the feasibility of integrating digital bioindicator communication, environmental education, and community participation in lake monitoring, although stronger comparative evaluation is required before causal effectiveness can be established.

Keywords: citizen monitoring; digital environmental education; lake water quality; saprobic indicator; socio-psychological assessment

Abstrak

Telaga Ngipik merupakan ekosistem air tawar perkotaan di Gresik, Jawa Timur, yang memiliki nilai ekologis dan sosial, tetapi informasi lingkungan belum selalu mudah diterjemahkan menjadi pemantauan masyarakat yang berkelanjutan. Program pengabdian kepada masyarakat ini mengembangkan dan menerapkan platform edukasi digital yang mengintegrasikan indikator saprobik berbasis fitoplankton dengan asesmen sosial-psikologis dan pendampingan masyarakat. Program dilaksanakan pada 12 Mei-20 Juli 2026 pada dua kelompok komunitas non-ekuivalen (100 peserta terdaftar: 50 intervensi dan 50 pembandingan).

Intervensi mencakup identifikasi kebutuhan partisipatif, co-design aplikasi, edukasi lingkungan, pelatihan teknis, pendampingan lapangan, dan praktik pemantauan digital. Dokumen program yang diserahkan memuat ringkasan hasil terperinci untuk 50 peserta intervensi; analisis psikometrik complete-case tersedia untuk 42 responden. Aplikasi mengubah informasi saprobik menjadi kategori visual yang mudah dipahami dan memperoleh skor System Usability Scale 84,2. Catatan program juga melaporkan peningkatan kompetensi teknis 42,5%, indikator niat kepedulian lingkungan sebesar 88%, dan peningkatan aktivitas pemantauan mandiri 65%. Analisis psikometrik menunjukkan korelasi antarbutir sebesar 0,55 untuk Being Away, 0,36-0,62 untuk Coherence, 0,47-0,90 untuk Compatibility, 0,03-0,68 untuk Fascination, dan 0,19-0,91 untuk kumpulan butir Health yang diperlakukan terpisah; seluruh variabel ringkasan tidak berdistribusi normal. Karena estimasi hasil lengkap kelompok pembanding dan denominator mentah untuk beberapa indikator agregat tidak tersedia dalam catatan analitik yang diserahkan, hasil tersebut ditafsirkan secara deskriptif dan bukan sebagai efek terkontrol yang definitif. Program menunjukkan kelayakan integrasi komunikasi bioindikator digital, edukasi lingkungan, dan partisipasi masyarakat untuk pemantauan danau, namun evaluasi komparatif yang lebih kuat masih diperlukan sebelum efektivitas kausal dapat disimpulkan.

Kata kunci: edukasi lingkungan digital; indikator saprobik; kualitas air danau; pemantauan warga; asesmen sosial-psikologis

INTRODUCTION

Telaga Ngipik, located in Gresik Regency, East Java, is an urban freshwater ecosystem used by surrounding communities for fisheries, recreation, local economic activities, and other environmental services. Freshwater systems in rapidly urbanizing and industrial areas are particularly vulnerable to nutrient enrichment, organic loading, land-use change, and declining ecological quality. Contemporary water-management literature increasingly emphasizes the integration of scientific evidence with sustained community participation because citizen-generated observations can complement formal monitoring networks and strengthen local stewardship when adequate training, feedback, and institutional support are provided (Njue et al., 2019; Capdevila et al., 2020; Dominguez-Rendón et al., 2024). At Telaga Ngipik, water-quality deterioration, environmental pressure, and limited public capacity to interpret ecological information were identified as the central partner concerns. However, a verified recent numerical dataset describing local water quality was not available for this report; therefore, no additional local figures are presented.

The practical challenge extends beyond generating water-quality information to ensuring that biological indicators are understandable and usable by non-specialists. Phytoplankton and other aquatic biota can provide ecologically meaningful information about water conditions, while citizen-science approaches can broaden the spatial and temporal coverage of observation and increase public engagement (Aura et al., 2021; Malthus et al., 2020). Smartphone- and web-based monitoring tools can translate environmental observations into accessible records and visual outputs; nevertheless, usability, training, data quality, and sustained motivation remain important determinants of continued use (Carrion et al., 2020; Lewis, 2018; Capdevila et al., 2020). These considerations were directly relevant to Telaga

Ngipik, where the program sought to translate saprobic information into a practical digital interface for community monitoring.

Environmental education can improve knowledge, attitudes, intentions, and behavior, but cognitive gains do not automatically result in sustained pro-environmental action. Systematic reviews indicate that local relevance, active participation, partnerships, practical tasks, feedback, and repeated engagement are important for translating environmental learning into action (Ardoin et al., 2020; Grilli & Curtis, 2021; van de Wetering et al., 2022; Rau et al., 2022). Citizen-science initiatives may also strengthen environmental citizenship when participants move beyond passive data collection toward collaborative interpretation and local decision-making (Hadjichambis et al., 2021; Dominguez-Rendón et al., 2024). Accordingly, this program combined technical monitoring with participatory education rather than relying solely on a stand-alone application.

The socio-psychological component was designed to explore how participants perceived and emotionally related to the lake environment. Contemporary research on perceived restorativeness highlights dimensions such as Being Away, Coherence, Compatibility, and Fascination, while also recognizing that scale structure, item wording, and context influence interpretation (Pasanen et al., 2018; Jang & Son, 2020; Menardo et al., 2021; Ríos-Rodríguez et al., 2021). Connection with natural environments is also positively associated with pro-environmental behavior, although behavioral outcomes are shaped by multiple contextual and psychological determinants (Whitburn et al., 2020; Okumah et al., 2020; Panno et al., 2020). A separate Health item set was also analyzed in the program dataset. Because this item set was not one of the four PRS dimensions specified in the study framework, it is treated as a distinct construct rather than as a PRS subscale.

The program's distinctive contribution lies in integrating three elements within a single community-empowerment model: phytoplankton-based saprobic communication, a mobile/web monitoring interface, and socio-psychological reflection supported by field mentoring. This design responds to evidence that effective community water monitoring depends not only on technical capacity but also on the quality of interaction among citizens, institutions, and scientific facilitators (Capdevila et al., 2020; Njue et al., 2019). The program also sought to establish a pathway toward local ownership through the involvement of Pokmaswas, community representatives, student facilitators, and a local monitoring cadre.

The program therefore aimed to develop and implement an accessible digital platform for saprobic-based lake monitoring while strengthening community capacity to understand, use, and sustain environmental monitoring at Telaga Ngipik. The measurable outputs available for reporting were application usability, reported changes in technical competence, environmental-stewardship intention, self-initiated monitoring activity, and psychometric characteristics of the socio-psychological item sets. Because complete intervention-versus-comparison outcome estimates were unavailable, the findings are reported descriptively and are not interpreted as definitive between-group effects.

METHODS

This community service activity implemented the research-based program entitled “Development of an Environmental Quality Assessment Application for Telaga Ngipik Based on the Saprobic Index and a Socio-Psychological Approach.” The implementation plan followed a non-equivalent two-group pretest-posttest framework. A total of 100 community participants were enrolled and allocated to an intervention group (n=50) and a comparison group (n=50). The intervention group received environmental education, application training, field mentoring, and socio-psychological activities, whereas the comparison group continued routine community activities during the primary implementation period. Group allocation was non-random and followed existing community-group participation. Detailed allocation records and complete baseline-comparability statistics were unavailable; accordingly, these characteristics are acknowledged as limitations rather than reconstructed retrospectively.

The program was conducted at Telaga Ngipik and in the surrounding community in Gresik, East Java, Indonesia, from 12 May to 20 July 2026. Field activities were carried out at the lake, while training, demonstrations, discussions, and evaluation were delivered through face-to-face and field-based sessions. The site was reported to be approximately 12 km, or about 25 minutes' travel, from the university campus.

The partner groups were the Telaga Ngipik Environmental Watch Group (Pokmaswas) and the Telaga Ngipik Village Community Group. Participants included fish farmers, PKK cadres, youth representatives, and other residents involved in or living near the lake ecosystem. Eligibility was based on involvement in community or lake-related activities, willingness to participate, and the ability to take part in environmental-monitoring and application activities. Four undergraduate students served as field facilitators and community liaisons, while lecturers acted as technical facilitators and evaluators.

Three denominators corresponded to different stages of the program: 100 participants were enrolled in the two-group design; outcome summaries were available for 50 intervention participants; and 42 complete responses were available for the psychometric and Shapiro-Wilk analyses. A complete attrition or exclusion log was not available for the eight intervention participants without complete psychometric records, and complete post-intervention outcome estimates for the comparison group were also unavailable. The analyses therefore distinguish clearly among enrolled participants, intervention-outcome records, and complete-case psychometric data.

The intervention comprised preparation, participatory needs assessment, application co-design, environmental education, technical workshops, field mentoring, evaluation, handover, and follow-up. Participants learned water-sample collection, phytoplankton bioindicator identification, interpretation of saprobic information, environmental data recording, and use of the mobile/web interface. Weekly field assistance supported independent sampling and application use. Following evaluation, application procedures and supporting educational materials were handed over to designated local representatives. Although eco-branding was

mentioned during program planning, no corresponding measurable outcome was available; it was therefore not included in the interpretation of intervention outcomes.

The application functioned as both an educational and a data-recording tool. It translated phytoplankton-based saprobic information into color-coded visual categories of water quality, supported data entry, and was designed to operate under conditions of limited connectivity. Perceived usability was assessed using the System Usability Scale (SUS), a widely used standardized measure of usability (Lewis, 2018).

The evaluation focused on technical competence in digital water-quality assessment, environmental-stewardship intention, self-initiated monitoring activity, application usability, and socio-psychological item responses. Aggregate program indicators were reported as a 42.5% increase in technical competence, an environmental-stewardship intention indicator of 88%, a 65% increase in self-initiated monitoring activity, and a SUS score of 84.2. Because the underlying pretest and posttest values, raw denominators, comparison-group estimates, confidence intervals, and effect-size calculations were unavailable for these aggregate indicators, they are presented as descriptive program measures rather than inferential treatment effects.

The socio-psychological assessment included items grouped under Being Away, Coherence, Compatibility, and Fascination, consistent with constructs commonly used in perceived-restorativeness research. A separate 12-item Health set (IK1–IK12) was also analyzed. A formal adaptation protocol, complete item wording, content-validity index, Cronbach's alpha, McDonald's omega, and validated scoring interpretation were not available. Consequently, the available inter-item correlations are presented as preliminary psychometric information, and the instrument is not described as locally validated. Inter-item Pearson correlations were available for Being Away and as ranges for the other item sets. Shapiro-Wilk tests were available for 42 complete cases and indicated non-normal distributions for all five summary variables. Descriptive means and rankings were also available. Because complete comparison-group outcomes and final software details were unavailable, no additional inferential comparisons, effect sizes, or confidence intervals were generated. Future analyses should consider non-parametric or robust procedures when distributional assumptions are not satisfied.

The service team coordinated with relevant institutional and community authorities, informed participants about program procedures and data use, obtained informed consent, and protected participant confidentiality. Separate consent was reported for identifiable photographs, although photographs are not included in this publication-ready version. An ethics-approval or institutional-permission identifier was not available and therefore is not reported. Sustainability was supported through the planned local monitoring cadre, Komunitas Peduli Telaga Ngipik, and designated local champions from Pokmaswas and the village community. The application, monitoring procedures, and educational materials were intended for continued use after the formal program period. Student facilitators were integrated into

campus experiential-learning activities, while local representatives were expected to coordinate periodic monitoring and communication with the service team.

RESULTS

The results are presented according to the analytical denominator available at each stage of the program. A total of 100 participants were enrolled and divided equally between intervention and comparison groups. Program-outcome summaries were available for 50 intervention participants, while psychometric analyses were based on 42 complete intervention records. Complete post-intervention outcome estimates for the comparison group were unavailable; consequently, no between-group effectiveness estimate is reported.

Table 1. Participant flow and available analytical denominators

Stage	Intervention	Comparison	Total / analytic n
Enrolled in two-group program	50	50	100
Program-outcome summaries available	50	Not reported	50
Complete psychometric records	42	Not reported	42

Note. A complete attrition/exclusion log and complete comparison-group posttest outcomes were unavailable. Denominators are therefore reported separately for each analytical stage rather than combined into a single sample size.

The digital application translated phytoplankton-based saprobic information into real-time, user-friendly visual categories. Four aggregate program indicators were available for the intervention group. These values are retained as reported; however, the corresponding raw pretest and posttest values, comparison-group estimates, denominators for each percentage, confidence intervals, and effect sizes were unavailable. The indicators should therefore be interpreted descriptively rather than as evidence of a controlled intervention effect.

Table 2. Reported program summary indicators for the intervention group

Indicator	Reported result	Interpretive note
Technical competence in digital water-quality assessment	42.5% increase	Descriptive aggregate change; raw denominator and comparison estimate unavailable
Environmental-stewardship intention	88%	Reported program indicator; exact baseline and comparison denominators unavailable
Self-initiated community water monitoring	65% increase	Descriptive aggregate change; raw activity counts unavailable
System Usability Scale	84.2	High perceived usability based on the reported SUS score

Preliminary inter-item analyses were available for the socio-psychological item sets. The two Being Away items showed a positive correlation of $r=.55$ ($p<.001$). Coherence correlations

ranged from .36 to .62, whereas Compatibility correlations ranged from .47 to .90; the PRS14-PRS15 pair showed the highest Compatibility correlation ($r=.90$), which may indicate content overlap. Fascination showed the widest range (.03-.68), including weak associations for PRS3-PRS6 ($r=.03$) and PRS3-PRS5 ($r=.24$). The separate Health item set showed correlations ranging from .19 to .91, with the strongest association between IK3 and IK6 ($r=.91$) and the weakest between IK5 and IK12 ($r=.19$).

Table 3. Inter-item correlation summary for socio-psychological item sets

Item set	Number of items	Correlation information	Significance / notable pairs
Being Away	2	$r = .55$	$p < .001$
Coherence	4	$r = .36-.62$	Reported $p < .05$ to $p < .001$
Compatibility	5	$r = .47-.90$	All reported $p < .001$; PRS14-PRS15 $r = .90$
Fascination	6	$r = .03-.68$	PRS3-PRS6 $r = .03$; PRS3-PRS5 $r = .24$
Health (separate item set)	12	$r = .19-.91$	IK3-IK6 $r = .91$; IK5-IK12 $r = .19$; majority $p < .05$

Shapiro-Wilk tests for the 42 complete psychometric records indicated statistically significant departures from normality for all five summary variables. These findings support cautious use of rank-based or otherwise robust procedures in future association analyses and underscore the importance of reporting assumption checks in subsequent group comparisons.

Table 4. Shapiro-Wilk normality tests for complete psychometric records (n=42)

Variable	W	p	Interpretation
Being Away	0.848	$< .001$	Non-normal
Coherence	0.940	.028	Non-normal
Compatibility	0.846	$< .001$	Non-normal
Fascination	0.921	.006	Non-normal
Health	0.792	$< .001$	Non-normal

Descriptive rankings showed the highest mean for Being Away ($M=4.308$), followed by Compatibility ($M=4.208$), Fascination ($M=3.821$), and Coherence ($M=2.481$). The Health item set had a mean of 0.528 and was treated separately because it was not defined as a PRS dimension. A previously reported Health percentage of 17.60% was inconsistent with the stated maximum score of 5. Using the reported mean and maximum, the percentage of maximum is 10.56% ($0.528/5 \times 100$). This recalculation preserves the reported mean while restoring mathematical consistency; the underlying Health scoring framework should nevertheless be confirmed.

Table 5. Descriptive ranking of reported socio-psychological summary scores

Variable	Mean	Stated maximum	Percentage of maximum	Rank
Being Away	4.308	5	86.15%	1
Compatibility	4.208	5	84.15%	2
Fascination	3.821	5	76.41%	3
Coherence	2.481	5	49.61%	4
Health (separate item set)	0.528	5	10.56%*	5

*Note. *The Health percentage was recalculated from the reported mean and stated maximum: $0.528/5 \times 100 = 10.56\%$. The previously reported value was 17.60%. The underlying scoring framework should be confirmed before final publication.*

DISCUSSION

This community service program demonstrates the practical feasibility of combining environmental science, digital communication, and community participation in lake monitoring. Because complete comparison-group outcomes were unavailable, the strongest supported conclusion concerns operational feasibility rather than a controlled treatment effect. This distinction is methodologically important: citizen-science and community-monitoring initiatives can generate meaningful capacity-building and governance benefits, but evaluation should clearly distinguish participation outputs from causal effectiveness claims (Capdevila et al., 2020; Dominguez-Rendón et al., 2024).

The application component is consistent with contemporary approaches to community water-quality monitoring. Malthus et al. (2020) found that smartphone applications can support inland water-quality assessment while also highlighting variability in data type, usability, and scientific reliability across platforms. Carrion et al. (2020) similarly described a lake-monitoring application that integrates citizen observations with broader environmental-monitoring systems. These studies support the rationale for a Telaga Ngipik application that simplifies biological information into visual categories. The reported SUS score of 84.2 further suggests favorable perceived usability. Lewis (2018) identifies SUS as a robust standardized usability measure, although interpretation is strongest when sampling, administration, and scoring procedures are fully documented.

The reported 42.5% increase in technical competence and 65% increase in self-initiated monitoring activity are directionally consistent with literature indicating that citizen-monitoring programs can strengthen community knowledge and engagement. Capdevila et al. (2020) identified participant knowledge, motivation, institutional support, communication, and feedback as key success factors in water-quality citizen science, while Njue et al. (2019) emphasized that citizens can contribute useful hydrological information when appropriate protocols and support are provided. A more recent synthesis by Dominguez-Rendón et al. (2024) suggests that community monitoring can contribute to organizational strengthening and local decision-making when participants are connected to institutions and collaborative

arrangements. In this program, however, raw denominators and comparison-group values for the 42.5% and 65% indicators were unavailable; these figures should therefore be interpreted as program-monitoring summaries rather than statistically verified effect estimates.

The environmental-stewardship indicator warrants similar caution. Environmental education can improve knowledge, attitudes, intentions, and behavior, but these outcomes are conceptually distinct and should not be treated as interchangeable. Ardoin et al. (2020) found that successful conservation education often depends on local relevance, partnership, and opportunities for action, while van de Wetering et al. (2022) reported positive average effects of environmental education on knowledge, attitudes, intentions, and predominantly self-reported behavior. Grilli and Curtis (2021) and Rau et al. (2022) likewise show substantial variation in the magnitude and sustainability of behavioral effects. The reported 88% stewardship-intention indicator therefore suggests strong immediate motivational engagement but does not establish sustained conservation behavior without follow-up observation.

The socio-psychological findings provide useful preliminary insight into how participants perceived the lake environment, although they are more appropriately interpreted as measurement-development findings than as intervention outcomes. Being Away and Compatibility had the highest reported mean scores. This pattern is conceptually consistent with restorative-environment research, in which natural settings may provide psychological distance from routine demands and support activities that fit individual goals and preferences (Menardo et al., 2021; Jang & Son, 2020). Panno et al. (2020) further linked the Being Away dimension with eco-friendly behavior through cognitive reappraisal, while Ríos-Rodríguez et al. (2021) showed that perceived environmental quality can influence perceived restorativeness in public spaces. Nevertheless, because a full local validation process was not documented, these constructs should not yet be described as locally validated scales.

The inter-item findings also identify specific priorities for instrument refinement. Within Compatibility, the correlation of .90 between PRS14 and PRS15 may indicate redundancy or substantial content overlap. Fascination included very weak relationships for several item pairs, suggesting that some items may capture distinct aspects of attention or may not function uniformly in this community. Reviews of restorative-environment scales emphasize the importance of psychometric testing, contextual adaptation, and construct clarity before scores are used to support strong substantive conclusions (Pasanen et al., 2018). Future evaluations should report complete item wording, adaptation procedures, content-validity indices, internal-consistency coefficients such as alpha or omega, and factor-analytic evidence when sample size permits.

The Health item set requires additional caution because it was analyzed in the program data but was not defined as one of the PRS dimensions. Treating it as a separate construct resolves this conceptual inconsistency without discarding the available correlation information. Its correlation range of .19-.91 suggests heterogeneous item relationships, potentially reflecting multiple health-related components, redundancy, or both. The inconsistency in the

previously reported percentage further illustrates the need for explicit scale definitions and scoring formulas. In this version, the reported mean of 0.528 and stated maximum of 5 are retained, while the percentage of maximum is reported transparently as 10.56%.

All five summary variables departed significantly from normality in the $n=42$ complete-case dataset. Non-normality does not necessarily indicate poor data quality, particularly for bounded Likert-type measures that may display skewness or ceiling effects. It does, however, influence analytical choice. Rank-based methods such as Spearman correlation or non-parametric group comparisons may be appropriate when consistent with the research question, whereas regression-based models require assessment of model residuals rather than simple normality tests of each observed variable. Because complete comparison-group data were unavailable, no additional inferential model was introduced.

The principal methodological limitation is the incomplete alignment between the planned two-group design and the outcome data available for analysis. Although 100 participants were enrolled, program summaries were available for 50 intervention participants and psychometric analyses for 42 complete cases. Reporting denominators separately resolves the apparent inconsistency but cannot recover missing comparison-group outcomes or explain the eight incomplete psychometric records. Consequently, the study cannot determine whether the intervention produced greater improvement than routine community activity. Future evaluations should document allocation, baseline comparability, attrition, pretest and posttest values by group, change scores, confidence intervals, effect sizes, and the statistical software used.

Despite these limitations, the community-empowerment structure represents an important practical strength of the program. The involvement of Pokmaswas, village-community representatives, student facilitators, and a locally embedded monitoring cadre creates a multi-actor governance structure that may support continuity beyond the formal intervention period. Rather than positioning community members merely as recipients of environmental information, this arrangement provides opportunities for them to participate in data collection, interpretation, communication, and potentially local environmental decision-making. Such participation is particularly important in citizen-science initiatives, where long-term sustainability depends not only on technical competence but also on continued communication, feedback, institutional recognition, perceived relevance, and opportunities for participants to see how the information they generate contributes to tangible environmental-management processes (Capdevila et al., 2020; Hadjichambis et al., 2021; Dominguez-Rendón et al., 2024). From a community-development perspective, this shift from passive participation toward shared responsibility may strengthen local ownership, environmental stewardship, and collective capacity for lake governance. However, these potential benefits should not be assumed solely from the existence of a participatory structure. Their sustainability will depend on whether monitoring activities are institutionalized, responsibilities are clearly distributed, community-generated data are periodically reviewed, and feedback mechanisms connect local observations with village authorities and relevant environmental agencies. For Telaga Ngipik,

the next stage should therefore move beyond maintaining the digital application as a technical product and toward establishing an integrated community-monitoring system. This would involve routine monitoring schedules, standardized data-collection protocols, periodic refresher training, transparent data validation, and formal mechanisms for communicating findings to local decision-makers. Strengthening these institutional linkages would increase the likelihood that the application becomes not merely an educational tool, but a locally owned platform for evidence-informed environmental stewardship and adaptive lake management..

CONCLUSION

The Telaga Ngipik program established a feasible community-based model integrating saprobic water-quality communication, digital application use, environmental education, and socio-psychological reflection. The available records indicate a SUS score of 84.2, a 42.5% increase in technical competence, an environmental-stewardship intention indicator of 88%, and a 65% increase in self-initiated monitoring activity, while complete-case psychometric analyses included 42 respondents. These findings support the practical feasibility of the model and indicate substantial participant engagement. However, complete comparison-group outcome estimates were unavailable; therefore, causal effectiveness cannot be established. Future implementation should retain complete participant-flow data, validate the socio-psychological measures, document raw pretest and posttest outcomes by group, and examine whether monitoring practices and pro-environmental behaviors are sustained over time.

RECOMMENDATIONS

Pokmaswas and the local monitoring cadre should conduct and document periodic water-quality and phytoplankton monitoring, with findings shared with village authorities and relevant environmental agencies. The service team should maintain the application, provide refresher training, and conduct structured follow-up at 3-6-month intervals. Future evaluations should use clearly documented instruments, complete intervention and comparison datasets, standardized participant-flow reporting, and repeated behavioral indicators so that program impact can be assessed beyond immediate self-report outcomes.

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