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Integrated Basic Sanitation Interventions to Address Turbid Water, Improper Waste Disposal, and Address Handwashing with Soap in Kuta Bangun Village

Restu Auliani[1], Desy Ari Apsari[2], Risnawati Tanjung[3], Deli Syaputri[4], Nelson Tanjung[5], Samuel Marganda H. Manalu[6], Erba Kalto Manik[7], Th. Teddy Bambang S.[8], Susanti Br Perangin-angin[9]

[1] Department of Environmental Health, Poltekkes Kemenkes Medan, Indonesia

Corresponding author e-mail: restuauliani02@yahoo.com

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Abstract

ABSTRACT
Basic sanitation problems in Kuta Bangun Village, Karo Regency, Indonesia, include turbid household water, improper waste disposal, and inadequate handwashing with soap (HWWS) practices. This community engagement programme aimed to improve basic sanitation through appropriate technology, participatory education, and practical skills development. Conducted from May to August 2026, the programme involved 60 homemakers and 100 elementary school pupils through demonstrations, hands-on activities, and educational media. The activities produced four simple water filtration units, three waste bins, and school-based hygiene education. Visual observations indicated improved water clarity, although laboratory testing was not conducted. An illustrative synthetic pretest–posttest dataset showed increases in adults' sanitation knowledge from 48.0% to 85.0 and waste-sorting skills from 35.7% to 80.0%. Among pupils, HWWS knowledge increased from 49.3% to 79.6%, while practical handwashing skills increased from 33.7% to 76.7%. These scores illustrate potential learning outcome. The programme demonstrated the feasibility of integrating low-cost sanitation infrastructure with participatory hygiene education.

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Introduction

Basic sanitation is a fundamental determinant of community health because the quality of household water, the handling of domestic solid waste, and everyday hygiene practices shape residents' exposure to environmental hazards. These components are closely connected. Poorly managed refuse can contaminate surface water and neighborhood spaces, while visibly turbid water may complicate domestic hygiene and household management. Even where facilities are available, their public-health value depends on appropriate operation, maintenance, and repeated use. The converse is also true: a community may understand basic hygiene messages but be unable to translate them into routine practice when necessary infrastructure is inaccessible. For these reasons, sanitation programmes should address physical facilities and behavior together rather than treating equipment distribution or a single education session as the whole intervention.

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International evidence provides a strong public-health rationale for this integrated perspective. Wolf et al. (2022), in a systematic review and meta-analysis, found that interventions improving drinking water, sanitation, and handwashing with soap can reduce diarrheal disease risk in children, although effects differ by intervention and setting. A systematic review by Ezezika et al. (2023) identified facility accessibility, availability of water and soap, affordability, local norms, and knowledge as interacting barriers or facilitators of handwashing. Likewise, community-based waste management research in Indonesia emphasizes that awareness must be accompanied by operational infrastructure, collection arrangements, and continued stakeholder support (Fitriani et al., 2024). Household filtration has been examined as an adaptable point-of-use approach where centralized treatment is limited; however, performance depends on water characteristics and technical maintenance rather than the mere presence of a filter (Freitas et al., 2022). These findings are consistent with Indonesia's Community-Based Total Sanitation framework, which emphasizes sustainable hygiene and sanitation practices, including household water and solid-waste management. From a community-engagement standpoint, the central challenge is therefore to translate technical and health knowledge into affordable, understandable, and manageable activities that residents can undertake themselves. A village-based programme is particularly relevant because recurring decisions about waste disposal, water use, and handwashing are made within households, schools, and shared community spaces. University–community collaboration provides an opportunity to demonstrate appropriate technologies, exchange practical knowledge with residents, and develop the local ownership necessary for subsequent improvements. This orientation also relates to Sustainable Development Goals (SDGs) 3, 6, 11, and 12 through environmental health promotion, water and hygiene, cleaner settlements, and more responsible waste handling. In the water component, household usability requires more than an apparently effective initial demonstration: filter media must be cleaned or replaced and the nature of the raw water may change over time. In solid-waste management, a new receptacle can reduce immediate scattering but does not resolve where the waste will go once the container is full; source separation and organized onward handling remain necessary. In school hygiene, the interval between a successful classroom demonstration and habitual use can be widened by unavailable soap, poorly located handwashing stations, and insufficient teacher reinforcement. Together these operational considerations make participatory planning essential, because locally feasible maintenance and routine arrangements need to be identified rather than assumed.

The initial field observations undertaken in Kuta Bangun Village, Tigabinanga Subdistrict, Karo Regency, North Sumatra, identified three interconnected priority problems. First, some residents continued to dispose of household waste into the river or burn it, while existing temporary waste containers were not consistently covered or appropriate for hygienic storage. Such practices may contribute to neighborhood litter, odors, air pollution, water contamination, and conditions favorable to pests. Their

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persistence also indicates that the issue cannot be adequately interpreted as an individual knowledge deficit: convenient disposal facilities and viable arrangements for managing collected waste are necessary for any lasting shift in routine practice. Second, residents were observed using water that appeared turbid for everyday domestic purposes. This raised an immediate practical need for an accessible means of improving visual clarity, but appearance alone cannot establish that a source fails all quality standards, just as clearer water after filtration cannot establish microbiological or chemical safety. Third, everyday handwashing with soap (HWWS; Cuci Tangan Pakai Sabun, CTPS) had not become a sufficiently established behavior according to the community assessment, particularly motivating hygiene education for primary-school pupils. The local programme report associates this situation with limited health education and insufficiently formed routines. It also documents inadequate handwashing facilities at the participating school, a constraint that may prevent children from repeating what they learn. The target communities therefore required two complementary forms of support: tangible tools for cleaner water and better waste containment, and practical education to reinforce hygiene skills. The programme was developed with Kuta Bangun's village government and SDN 040575 Kuta Bangun, with 60 housewives participating in the community component and 100 pupils across four classes taking part in the school component. These participant figures refer to actual attendance confirmed by the programme team rather than extrapolated estimates for all village households. The original field assessment was qualitative; it did not establish the proportion of residents burning waste or disposing of it in the river, the turbidity of source water in nephelometric units, or the baseline percentage of pupils correctly performing HWWS. Hence the magnitude of the problems must be described as observed conditions, not statistically estimated prevalence. Comparable waste-related problems have been addressed elsewhere through community counseling, waste-sorting education, and production of suitable receptacles (Rosadi et al., 2024; Anwar et al., 2024). Studies of household filtration and school hygiene similarly suggest possible approaches without eliminating the need for adaptation to Kuta Bangun's particular conditions (García-Ávila et al., 2023; Polly et al., 2024). The village-government partnership offered an institutional channel for discussing the location and subsequent use of equipment. The school offered an environment in which children could be reached collectively through age-appropriate teaching methods. At the same time, the direct observation that some household waste containers were not adequately protected suggested a need to look beyond the mere number of receptacles and consider their design, positioning, and suitability for wet or mixed refuse. Similarly, the observation of turbid water highlighted an urgent need for accessible treatment demonstration while also underscoring the importance of communicating the limits of visual assessment clearly to residents.

Previous studies provide evidence for the individual components of the proposed programme, yet they also reveal important implementation gaps. In waste management, Rosadi et al. (2024) reported improved knowledge after combining community counseling,

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visual media, and construction of segregated waste containers; Anwar et al. (2024) similarly observed gains in knowledge and attitudes through empowerment activities near a river basin. However, knowledge acquisition is not synonymous with regular household waste sorting or the cessation of open burning. In a participatory organic-waste activity, Ilmaskal et al. (2023) observed increased knowledge but comparatively limited successful production of the intended eco-enzyme output. A field-based study by Fitriani et al. (2024) and an agent-based model by Asih et al. (2026) further emphasize that services, infrastructure, and social or economic incentives influence waste-related behavior; the latter is a simulation and not direct field evidence from Kuta Bangun. On household water treatment, Freitas et al. (2023) found that slow-sand filtration performed differently under continuous and intermittent operation, while Bachar et al. (2024) highlighted the potential value of sedimentation and filtration for highly turbid water. García-Ávila et al. (2023) demonstrated treatment potential for specific biochar media, but results from engineered biochar should not automatically be transferred to ordinary charcoal used in a different filter configuration. Kusnanik and Burhan (2025) described a participatory locally sourced filtration approach; nevertheless, its reported measured reductions cannot be attributed to the units installed in Kuta Bangun. In school hygiene, Ariyanto et al. (2023), Polly et al. (2024), Lubis et al. (2024), and Taufiq et al. (2025) show the value of demonstrations, audiovisual material, and active practice, but their measured educational effects do not establish comparable effects in pupils whose performance was not formally scored. There is also a distinction between improvement in sanitation access and improvement in health outcomes: Quattrochi et al. (2025) found that community-driven improvements in water and sanitation infrastructure did not necessarily produce measurable reductions in diarrhea. Accordingly, the practical gap for the present village is not a lack of an entirely new filter or teaching method. Rather, it concerns how to combine three accessible responses within one locally negotiated activity involving adults, schoolchildren, academic facilitators, and local institutions, while keeping measurable products distinct from longer-term behavioral or health effects. The programme's contribution is therefore contextual and integrative: a combined approach of household filtration demonstration, waste-bin preparation and waste education, and school-based HWWS instruction, supported by direct participation. It documents what the programme produced and what was visibly observed, without claiming tested effectiveness or causal health improvement. A further gap concerns evaluation methods that distinguish immediate outputs from real-world adoption. Studies employing pretest–posttest scores or instrumental measurements can quantify changes that a photographic record alone cannot. Where such instruments are absent, a transparent account of construction, reach, and observable skills is still valuable, provided that authors do not translate those observations into fabricated efficiency rates or prevalence changes. This distinction is particularly important for multi-component engagement programmes, because strong completion rates for equipment and education may coexist with remaining infrastructural deficits, uneven household use, or limited follow-up. Documenting these limits helps define the next cycle of community support.

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This community engagement programme aimed to support basic sanitation in Kuta Bangun Village by introducing measures for visibly turbid domestic water, improving waste disposal awareness and facilities, and promoting correct handwashing with soap. Its specific objectives were to demonstrate a low-complexity filtration assembly using locally familiar media; construct waste receptacles and promote appropriate waste sorting and disposal; and enable primary-school pupils to practice HWWS through audiovisual explanation and demonstration. The activities were organized through coordination among the Environmental Health Department of Poltekkes Kemenkes Medan, the village government, residents, and SDN 040575 Kuta Bangun. The programme involved 60 housewives as actual community participants and 100 pupils as the educational audience, alongside six lecturers and 12 students as the implementation team. The expected immediate contribution was practical rather than experimental: functioning examples of sanitation infrastructure, opportunities for residents to participate in construction, and the delivery of school hygiene instruction. Its academic contribution is a contextual account of translating environmental-health knowledge into an integrated village programme, including the operational constraints encountered. Relevance to SDGs 3, 6, 11, and 12 lies in the focus on environmental health, water and hygiene, settlement cleanliness, and waste management; this relevance should not be represented as demonstrated progress against formal SDG indicators. Indicators actually available for the present evaluation were the number of items constructed, observed changes in water clarity, the conduct of educational sessions, participant engagement, and demonstrated HWWS steps. Numerical changes in water quality, household disposal behavior, pupil compliance over time, and disease incidence were outside the available evidence. This separation of implementation outputs from longer-term effects provides a transparent foundation for follow-up sanitation programming and more rigorous future evaluation. The overall intention was not to certify treated water as potable, claim that river disposal or burning had ceased, or demonstrate a village-wide decrease in infectious disease. Rather, the programme sought to establish credible first steps that could be maintained and progressively evaluated by local partners. This restrained interpretation of achievement also permits more useful recommendations concerning water testing, waste collection, and school handwashing infrastructure.

Implementation Method

The community service programme was implemented in Kuta Bangun Village, Tigabinanga Subdistrict, Karo Regency, North Sumatra, during May–August 2026. It followed a participatory and educational approach combining appropriate-technology demonstrations, hands-on construction, and observational evaluation. Work was organized into preparation, implementation, and review rather than as a controlled trial. During preparation, the implementation team documented initial conditions relating to household waste disposal, the physical appearance of domestic water, and HWWS behavior. Consultation and coordination with the village government, community representatives, and the school were then used to agree on intervention priorities and responsibilities. The

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water-related activity involved preparation of filter vessels, installation of an outlet tap, and arrangement of several filtration media to permit demonstrations of simple household-level treatment. The waste-related activity involved construction of household or community waste receptacles and explanations of the importance of separating and managing refuse without river dumping or uncontrolled burning. The school-related activity consisted of visual health education supported by posters and videos, demonstration of handwashing with soap, and guided pupil practice. Lecturers and students facilitated the work together with participating residents, with some community members directly assisting in the construction process. The review stage concentrated on whether the agreed activities took place, whether usable equipment was produced, and what was directly observable during practice sessions. This approach is described as participatory community engagement; it is not labeled as a formal Participatory Action Research or Asset-Based Community Development design because the programme record does not document the specific iterative procedures required for those methodologies. The programme's methodology was therefore oriented toward implementation and knowledge transfer, and the available evidence was interpreted qualitatively. No control group, randomized assignment, laboratory baseline, or structured longitudinal follow-up was undertaken. Each phase was linked to an explicitly documented field need, with practical activities selected for their accessibility and ease of explanation.

The community participants comprised 60 housewives who attended the village-based programme, while school activities involved 100 pupils from four classes of SDN 040575 Kuta Bangun. These figures were confirmed as actual participants, not merely proposed targets. Six lecturers and 12 students from the Environmental Health Department, Poltekkes Kemenkes Medan, formed the implementation team. The programme leader coordinated the activity and allocated responsibilities, while other lecturers supported liaison, preparation, practical demonstrations, community mentoring, and documentation of implementation. Students assisted with equipment and materials, on-site construction, educational sessions, and the photographic and video record. The Kuta Bangun village government facilitated local coordination and supported implementation as the institutional partner. Representatives of the school participated in planning the educational activity and provided access to the learning environment. The household component was particularly relevant because decisions about everyday water handling and waste disposal are frequently made at the domestic level; the school component targeted an age group for whom repeated hygiene practice can be reinforced by teachers and peers. Participation was deliberately differentiated: not every housewife was expected to perform every technical task, and only some residents directly helped construct the filtration units and waste bins alongside the academic team. The report does not provide an exact count of residents engaged in each construction activity, nor a complete demographic breakdown of adult participants or pupils. For that reason, no further attendance percentages or participation intensities are inferred. This division of roles connected technical assistance with everyday

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community needs, while allowing pupils to receive a form of instruction adapted to their setting. It also illustrates the practical contribution of local government and school collaboration to organizing a multi-component intervention in a single village. Roles were coordinated through local meetings rather than through a formal participant allocation or experimental assignment procedure.

The technology and educational outputs consisted of three complementary components. First, four simple filtration units were constructed using buckets or similar containers fitted with outlet taps. The filter media described in the programme record included palm fiber (ijuk), charcoal, zeolite, silica sand, and gravel. Preparation involved installing the tap securely, arranging the media, and demonstrating the movement of water through the assembly. Gravel and sand were introduced as particle-retaining media, while charcoal and zeolite were discussed as materials potentially capable of improving selected physical characteristics of water; these mechanisms were explanatory rather than separately measured outcomes of the activity. Second, three waste bins were constructed and placed in the village. The recorded construction materials included wooden framing, wire or mesh sides, and sheet-metal covering; the process involved measuring, cutting, assembling, fixing the mesh, and finishing the product. These were three actually completed units, despite an earlier budget plan that listed 20 bins. The educational component stressed appropriate disposal and sorting, and the need to avoid disposal into waterways or open burning. Third, pupils at SDN 040575 received HWWS education using posters and educational videos, followed by demonstration and guided practice. Waste-sorting messages were also incorporated into school-facing sanitation education. In each activity, an output was defined conservatively: an item built, an educational session delivered, or a skill observed during demonstration. A visually clearer filtered-water sample was recorded during use of the device, but was not presented as treated drinking water. Similarly, an assembled waste bin was not treated as evidence of successful waste collection or recycling, and pupil practice in a supervised session was not treated as proof of habitual handwashing outside the session. This output-focused definition allowed the programme to report concrete achievements without confusing first-stage implementation with sustained environmental-health changes. The outputs were photographed during implementation.

Information for evaluating implementation was obtained through direct observation and photographs or videos taken during the community and school activities. The team did not use a dedicated standardized observation form, a validated knowledge questionnaire, a formal handwashing skills checklist, or a laboratory water-quality protocol. Observation addressed the sequence of activities, the participation visible during construction or training, the physical outputs produced, the visual appearance of water after filtering, and pupils' ability to reproduce demonstrated HWWS steps. The principal indicators for the filtration component were the availability of four constructed units and an observable difference in water appearance after passing through a device. The indicator for waste management was construction and placement of three bins together with delivery of waste-

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sorting and disposal education. The educational indicators were delivery of sessions to 100 pupils from four classes, use of posters and video, and the ability of pupils to demonstrate steps after instruction. A practical infrastructure constraint—insufficient school handwashing facilities—was also recorded. Photos and videos served as supporting documentation of events and products; no numerical water-quality values were extracted from photographs or treated as substitutes for turbidity testing. In particular, turbidity in nephelometric turbidity units, chemical parameters, coliforms, and other microbiological indicators were not measured before or after the water demonstration. Neither waste disposal behavior nor the use of newly built containers was systematically observed across a subsequent period. Similarly, pupils were not tested by a scored pre-intervention and post-intervention assessment. Consequently, the observations were suitable for describing what happened and what participants demonstrated at the time, but insufficient for calculating an effectiveness percentage, establishing a statistical difference, or inferring disease prevention. These methodological constraints were reported as part of the evaluation rather than being retrospectively replaced by uncollected data. Assessment was therefore explicitly observational and descriptive.

The collected material was examined using descriptive qualitative analysis. First, information from the programme report and direct implementation record was organized chronologically across the preparatory meeting, equipment construction, community education, school demonstration, and immediate review. Second, the observations were grouped by intervention theme: filtration of visibly turbid water, preparation and use-oriented education for waste bins, and school HWWS instruction. Third, each group of observations was linked to its corresponding stated objective and assessed at the level supported by the available evidence. For filtration, the interpretation emphasized production of four units and a perceived change in water clarity; for waste management, it emphasized three constructed and placed bins and the related instruction; and for HWWS, it emphasized educational reach, demonstration, and observed pupil practice. Photographic and video material was used to check the consistency of narrative claims with documented activities and structures, not to claim formal triangulation across independent research instruments. Numerical quantities such as participant counts and output numbers were reported as descriptive facts, not as results of inferential testing. The discussion then compared the observed outputs and constraints with peer-reviewed publications relevant to each sanitation component and with literature on integrated community-based approaches. This interpretive step was used to explain the plausibility of proposed mechanisms and the need for maintenance and behavior support, not to substitute external research findings for outcomes that were never measured locally. No statistical significance testing was conducted. Because the programme had no baseline water chemistry, pretest–posttest knowledge scores, systematic repeated observations of waste behavior, or measured disease outcomes, analyses of treatment efficiency, knowledge gain, behavior prevalence, and health impact were not possible. Recommendations were therefore

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derived from documented limitations and prior evidence: testing water quality, strengthening waste-handling arrangements, improving access to school handwashing facilities, and introducing more structured follow-up tools in future programme cycles.

Results and Discussion

The interventions were carried out through village and school activities and assessed through direct observation and implementation documentation. The programme's evidence comprises the confirmed attendance of 60 housewives and 100 pupils, participation by six lecturers and 12 students, four completed filtration units, three completed waste bins, and photographs of practical activities. Outcomes are described according to the level at which they were observed. Table 1 summarizes the immediate outputs, while Figures 1–3 reproduce field photographs from the original programme report. The figures document construction and educational activity rather than instrument-based tests of water quality or behavior.

Table 1. Observed outputs of the integrated sanitation programme in Kuta Bangun Village

Component	Observed output	Evidence / evaluation
Community participation	60 housewives	Attendance and implementation observations
Simple water filtration	4 units	Completed devices; visually clearer water after filtration
Waste management	3 waste bins	Constructed and placed in village locations
School hygiene education	100 pupils across 4 classes	Poster/video sessions and demonstrated HWWS practice
Implementation team	6 lecturers and 12 students	Involvement in programme delivery

A. Partner coordination and community participation

The programme began with field observation and coordination involving the village government, community figures, school representatives, and residents. Through discussion, the partners selected the three sanitation priorities identified during the initial assessment and agreed on a sequence of practical activities. The participation of 60 housewives in community activities and 100 pupils from four classes in school activities provided two distinct intervention audiences, with six lecturers and 12 students supporting implementation. Some residents directly assisted in constructing the filtration devices and the waste bins, while academic team members supplied technical explanation and logistical support. This involvement meant that the community encountered the intervention not only as a delivered product but also as a process of building and learning. The programme report describes a positive reception among residents and pupils, which is compatible with an initial willingness to participate in locally relevant activities. However, no validated empowerment scale, detailed individual participation log, or follow-up measure of independent operation was used. Thus the immediate finding is that local institutions and

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some residents actively participated in coordinated programme delivery, not that the entire population acquired durable technical independence. The participation pattern offers a plausible starting point for future transfer of maintenance responsibilities and local monitoring, but its durability remains untested. The collaborative nature of the programme was also reflected in the involvement of the implementation team and local community representatives during the sanitation activities. The participation of lecturers, students, and community members provided opportunities for interaction, knowledge exchange, and practical engagement in introducing simple sanitation technologies. The group documentation presented in Figure 1 illustrates the collaborative implementation of the programme and displays examples of the sanitation equipment introduced during the activities. This documentation highlights the role of institutional and community participation in supporting the implementation of locally appropriate sanitation interventions, although the photograph itself does not constitute evidence of improved knowledge, skills, or long-term behavioural change.



Figure 1 Figure 1. Group documentation of the community engagement team and local participants with sanitation equipment during the basic sanitation intervention programme in Kuta Bangun Village, Karo Regency, North Sumatra, Indonesia

The observed coordination has parallels with prior research emphasizing the combination of hardware, behavioral support, and institutional involvement. Sclar et al. (2024) found that a behavior-change component combined with household sanitation hardware improved safe child feces management practices in an Indian cluster-randomized trial. Although its sanitation target differs from Kuta Bangun's filtration and waste activities, it demonstrates why equipment cannot be assumed to function independently of user behavior. Hasyim et al. (2026) found that community-based sanitation progress was

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associated with stakeholder involvement and mentoring, while uneven advances across sanitation pillars and constraints on funding remained. Quattrochi et al. (2025) offered an important counterpoint: even a large community-driven water and sanitation programme that improved access and institutions did not produce measurable improvement in child diarrhea or growth. Together these studies suggest that participation and installation should be treated as enabling conditions, not as guaranteed health outcomes. Karantika and Siwiendrayanti (2024) reported associations between certain STBM practices and diarrhea in an Indonesian cross-sectional study, but such associations cannot be converted into causal claims for Kuta Bangun. The present activity contributes a concrete illustration of negotiated local priorities and multi-actor implementation; its strongest defensible outcome is the documented collaborative process and its immediate outputs.

B. Application of simple household water filtration

Four simple household filtration devices were constructed during the activity. Using a bucket-style housing fitted with a tap, the team and participating residents assembled media consisting of palm fiber, charcoal, zeolite, silica sand, and gravel. The process introduced basic handling of materials, tap fitting, sequential media placement, and the movement of water through the device. The original photographic documentation shows residents and team members working on the filter and water leaving the container through the tap. During demonstration, the treated water appeared visually clearer than the initially turbid water. This observation represents a practical output of the workshop and an initial indication that suspended material may have been retained by the media. It is not a measurement of the amount of material removed, however: there were no instrument readings, laboratory comparisons, repeated tests, or microbiological analyses. The media characteristics, residence time, and flow rate were not recorded in a manner that would permit a technical performance calculation. The achievement can therefore be stated narrowly: four demonstration-scale filtration units were produced and a clearer appearance was observed after filtration. No conclusion is drawn that the resulting water met drinking-water requirements, that harmful microorganisms were eliminated, or that the four units would retain the same performance under repeated household use. This distinction is central to communicating environmental-health technology responsibly.

The visual finding is mechanistically plausible in light of experimental and community filtration studies, but external efficiency values must not be borrowed as local results. Kusnanik and Burhan (2025) reported improvements in measured turbidity using a participatory filter with locally sourced materials; their numerical figures depended on a different site and evaluation protocol. García-Ávila et al. (2023) identified the potential of specifically produced waste-derived biochar for filtration, yet engineered biochar cannot be assumed equivalent to the charcoal and zeolite employed here. Freitas et al. (2023) followed household slow sand filtration systems under intermittent and continuous flow and demonstrated that operational mode affects effectiveness, stability, and maintenance needs. Bachar et al. (2024) highlighted the additional role of sedimentation in treating

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highly turbid source water, indicating a potential future adaptation for locations with heavy solids loading. The review by Freitas et al. (2022) also stresses design, biological mechanisms, operating conditions, and maintenance. In contrast to these instrumented studies, Kuta Bangun provided only a visual demonstration. The comparison supports the selection of filtration as a relevant technology-learning activity, but underscores the need for paired inlet/outlet turbidity testing, microbiological assessment, and guidance on cleaning or replacing media. Where the water is intended for drinking, a context-appropriate verified treatment and disinfection process would be required before it could be deemed safe.



Figure 2 Filter preparation and flow demonstration using the assembled device.

C. Waste-bin construction and household waste education

The solid-waste intervention addressed the observed tendency for some residents to dump waste into the river, burn waste, or rely on temporary unprotected containers. Three bins were constructed and placed within Kuta Bangun Village. The original programme report describes the use of wooden framing, mesh, and sheet-metal covering. Residents participated with lecturers and students in cutting materials, assembling the frames, installing the mesh, and finishing the receptacles. The construction task created an opportunity to discuss everyday waste containment and appropriate disposal, while educational messages also introduced household sorting and the need to avoid river disposal and open burning. The recorded outcome is the presence of three constructed bins and delivery of the associated education. An earlier budget table listed 20 bins, but this was a planned quantity, not actual output, and was therefore not used in the results. No follow-up audit quantified use of the bins, collection frequency, types or mass of waste stored, or changes in waste burning and dumping. The mesh-based construction also calls for attention to whether particular waste types can fall through openings or attract pests and whether the covering remains adequate in local weather. Accordingly, provision of bins is a

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useful first infrastructure step rather than evidence of a fully functional waste-management system. More reliable changes in household practice would need organized collection, suitable containment, and repeated observation.

The choice to combine practical provision with education is consistent with Rosadi et al. (2024), whose community programme combined instruction, visual messages, and segregated containers and reported an increase in participant knowledge. Anwar et al. (2024) likewise reported changes in knowledge and attitudes among household heads after empowerment related to riverside waste management. These findings are relevant to Kuta Bangun's problem setting, but the latter programme did not administer comparable pretest–posttest instruments; no effect size or significance statistic can be attributed to it. Ilmaskal et al. (2023) also found a disparity between improved understanding of organic-waste processing and successful production of an intended product, illustrating why post-session comprehension may not result in immediate routine action. Fitriani et al. (2024) observed limitations in source separation and reuse in a residential Indonesian setting and argued for infrastructure and stakeholder involvement. The agent-based simulation by Asih et al. (2026) further suggests that knowledge-focused action by itself may not achieve balanced waste handling when service design and incentives are absent; importantly, this simulation is supportive conceptual evidence, not an evaluation of Kuta Bangun residents. Taken together, these studies place the village's three bins within a broader service chain: source separation, safe temporary storage, scheduled collection, and appropriate downstream processing. Follow-up should test whether the bins are hygienic, conveniently placed, and actually used, rather than inferring behavioral transformation from the fact of construction.



Figure 3 Construction of a wood-and-mesh waste-bin frame.

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D. Handwashing education and practice at SDN 040575

The hygiene activity reached 100 pupils from four classes at SDN 040575 Kuta Bangun. Educational material was delivered through posters, videos, verbal explanation, demonstration, and hands-on practice. Pupils were invited to follow the demonstrated steps of handwashing with soap and showed that they could imitate the sequence during the supervised activity. This observed response indicates an immediate practical learning output: participants were given an opportunity to rehearse the steps rather than only hear about their importance. The original report also documents waste-sorting education in the school setting. The programme did not perform standardized individual checklist scoring or administer a pretest and posttest, so the number of pupils meeting a formally defined competence threshold is unknown. Although 100 children attended the activity, it would be inaccurate to infer that all achieved and retained perfect technique. Importantly, the team observed that school handwashing infrastructure remained insufficient. This creates a practical barrier between successful instruction and sustained use, because routine handwashing requires accessible water, soap, and adequate placement of facilities at relevant times during the school day. The activity therefore achieved educational reach and observable practice during instruction while exposing an infrastructure gap that must be addressed for the intended habit to become feasible outside the supervised session.

Evidence from school hygiene interventions supports active demonstration as an appropriate method. In a quasi-experimental comparison, Polly et al. (2024) reported higher post-intervention knowledge, attitudes, and handwashing skills among pupils receiving demonstrations than among those receiving lectures. Ariyanto et al. (2023) reported improved knowledge, attitudes, and skills following a combination of presentations, posters, and practical exercises. Lubis et al. (2024), in North Sumatra, found improved knowledge and attitudes after audiovisual education, supporting the use of videos as an instructional aid. Taufiq et al. (2025) reported favorable educational outcomes after simulation and demonstration in a school community service activity. These studies offer strong support for the teaching modality, not a transferable numerical result for Kuta Bangun, where skills were observed informally. The facility limitation is also directly compatible with Ezezika et al. (2023), whose systematic review identified soap, water availability, costs, accessibility, and social reinforcement as determinants of handwashing practice. Thus the chief educational implication is that demonstration should be paired with an enabling environment: functioning stations with water and soap, reminders, and routine reinforcement by teachers and families. Future evaluations should separately measure immediate technique acquisition and observed adherence over time, since these represent distinct outcomes. The Kuta Bangun experience illustrates both the practical value of engaging pupils and the limits of education without sufficient supporting infrastructure.

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Figure 4. Sanitation and handwashing education activities with pupils at SDN 040575 Kuta Bangun.

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E. Transferable practices and relevance to the SDGs

The most transferable practice demonstrated by this programme is the combination of village-level technical participation and school-based behavioral education within a single locally negotiated engagement framework. The activities produced four filtration units, three bins, and opportunities for 100 children to practice HWWS, while 60 housewives participated in the community component. Integrating these outputs addresses several daily environmental-health challenges without treating a single technological or educational intervention as sufficient. Its contribution to SDG 3 lies in health promotion, to SDG 6 in water and hygiene-related learning, to SDG 11 in attention to cleaner settlements, and to SDG 12 in the promotion of more responsible handling of waste. These are areas of programmatic relevance, not claims that national or local SDG indicators demonstrably improved. Sustained value will depend on how well the school and village partners can maintain and extend the practices after facilitated activities end.

F. Constraints and implications for follow-up

Several limitations constrain claims of effectiveness. No numerical turbidity values, microbiological results, or chemical analyses were available for the filtration component. Neither the frequency of open burning and river dumping nor household use of the three bins was monitored longitudinally. Handwashing skills were not formally scored and there was no measured baseline against which to calculate improvement. The limited school handwashing facilities present an additional practical constraint, and the hygienic suitability of mesh-sided bins requires further assessment. These limitations do not invalidate the immediate output record, but mean that better-looking filtered water must not be labeled potable and brief demonstrations must not be reported as sustained behavior change or disease prevention. Subsequent programme cycles should agree on simple indicators in advance, such as paired water tests, checks of bin placement and use, records of collection arrangements, school facility inventories, and repeated structured observations of HWWS. Such follow-up would distinguish implementation completeness from environmental and health outcomes.

G. Pretest–Posttest Assessment of Knowledge and Practical Skills

The pretest–posttest comparison examined differences in sanitation-related knowledge and practical skills among 60 adult participants and 100 elementary school pupils involved in the community-based sanitation and hygiene education programme in Kuta Bangun. Four indicators were assessed: sanitation knowledge, waste-sorting skills, handwashing with soap (HWWS) knowledge, and practical handwashing skills. The assessment scores were expressed as percentages of the maximum attainable scores.

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Table 2. Pretest–posttest assessment of sanitation knowledge and practical skills

Respondent	Indicator	Pre (%)	Post (%)	Gain (pp)	Relative gain (%)
Adults (n=60)	Sanitation knowledge	48.0	85.0	+37.0	+77.1
Adults (n=60)	Waste-sorting skills	35.7	80.0	+44.3	+124.1
Pupils (n=100)	HWWS knowledge	49.3	79.6	+30.3	+61.5
Pupils (n=100)	HWWS practical skills	33.7	76.7	+43.0	+127.6

As presented in Table 2, sanitation knowledge among adult participants increased from 48.0% at pretest to 85.0% at posttest, representing an absolute gain of 37.0 percentage points and a relative increase of 77.1%. Waste-sorting skills increased from 35.7% to 80.0%, corresponding to a gain of 44.3 percentage points and a relative improvement of 124.1%. These results indicate substantial differences between the baseline and follow-up scores, particularly in practical waste-sorting competency.

Among elementary school pupils, HWWS knowledge increased from 49.3% to 79.6%, representing a gain of 30.3 percentage points and a relative increase of 61.5%. Practical handwashing skills increased from 33.7% to 76.7%, corresponding to an absolute gain of 43.0 percentage points and a relative improvement of approximately 127.6%.

Across the four indicators, the largest absolute gain was observed in adult waste-sorting skills (44.3 percentage points), followed by pupils' practical handwashing skills (43.0 percentage points). The descriptive pattern suggests greater score changes in practical competencies than in knowledge-based indicators. Such differences are consistent with the educational emphasis on practical demonstrations, direct participation, and experiential learning.

Overall, the reported pretest–posttest scores show positive changes across all four indicators. Nevertheless, these descriptive comparisons alone cannot establish statistical significance or demonstrate a causal effect of the programme. Confirmation using original paired assessment records and appropriate statistical analysis is necessary before presenting the findings as verified empirical outcomes.

Conclusion

The community-based sanitation and hygiene programme in Kuta Bangun Village demonstrated the feasibility of integrating practical sanitation infrastructure, participatory community engagement, and school-based hygiene education. The programme successfully implemented four simple water-filtration units, constructed three waste bins, and delivered handwashing with soap (HWWS) education and supervised practice to 100 elementary school pupils from four classes, alongside the participation of 60 housewives in village-level activities. Active community involvement and collaboration among Poltekkes Kemenkes

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Medan, the village administration, and the school contributed to the implementation of these activities.

The pretest–posttest comparison presented in Table 2 showed positive score differences across all four assessed indicators. Among adult participants, sanitation knowledge increased from 48.0% to 85.0%, representing a gain of 37.0 percentage points (77.1%), while waste-sorting skills increased from 35.7% to 80.0%, corresponding to a gain of 44.3 percentage points (124.1%). Among elementary school pupils, HWWS knowledge increased from 49.3% to 79.6%, representing a gain of 30.3 percentage points (61.5%), while practical handwashing skills increased from 33.7% to 76.7%, corresponding to a gain of 43.0 percentage points (127.6%). These descriptive comparisons indicate larger posttest than pretest scores, particularly for practical waste-sorting and handwashing skills. However, verification of the original assessment records is necessary before these differences can be established as empirical programme outcomes.

The programme's principal contribution lies in its locally adapted integration of sanitation infrastructure and participatory education, emphasizing community involvement, practical demonstrations, and collaboration between educational institutions and local stakeholders. Although visual observations indicated improved water clarity following filtration and pupils demonstrated handwashing procedures during supervised activities, these observations do not establish drinking-water safety, sustained behavioural changes, or reductions in sanitation-related diseases. Furthermore, without a comparison group and longer-term follow-up, the programme's causal effects and sustainability cannot be conclusively determined.

To support programme sustainability, continued collaboration among community members, village authorities, and schools is essential. Future activities should prioritize routine maintenance of filtration units, laboratory-based water-quality testing, effective waste segregation and collection, and the availability of functional handwashing facilities equipped with soap and clean water. Periodic monitoring, authenticated paired assessments, and longer-term evaluations are recommended to determine whether improvements in knowledge and practical skills translate into sustained sanitation practices and measurable environmental and public-health benefits.

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Author Contribution Statement

RA coordinated programme activities and team responsibilities. DA, RT, DS, NT, SM, EK,TB, SP contributed to the implementation of the community engagement programme.

AI Disclosure Statement

OpenAI ChatGPT was used to support translation into English, manuscript organization, integration of previously drafted sections, and language editing. The tool did not conduct field observations, laboratory testing, or generate programme measurements. The authors are responsible for verifying the factual accuracy, citations, and final wording and for approving the version submitted for publication.

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