



Community Empowerment Program for Fishermen Through Technology and Engineering-Based Assistance

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Abstract

Fishermen's communities in many rural coastal areas often face environmental and technological challenges, particularly in managing organic waste and in utilising appropriate technologies to support sustainable community activities. Limited access to simple engineering solutions may lead to environmental pollution and inefficient waste management practices. Therefore, community empowerment initiatives that integrate technological support and participatory engagement are essential to improve environmental management and community capacity. This community service program aims to empower fishing communities through the implementation of engineering-based appropriate technology, combined with active participation from students and residents. The program was conducted using a participatory approach comprising several stages: preliminary assessment and field observation; technology planning and preparation; technology installation and community participation; and evaluation with knowledge transfer. The results show that installing a brick-based combustion technology successfully supported organic waste management in the community. In addition, the program strengthened collaboration between academics, students, and community members while improving environmental awareness and technical understanding of the introduced technology. The novelty of this article lies in integrating engineering technology implementation, participatory community engagement, and student involvement within a single community empowerment framework. This integrated approach contributes to sustainable environmental management and enhances the long-term adoption of appropriate technology within fishermen communities.

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1. Introduction

Coastal communities, particularly fishing communities, play an important role in supporting local economies and food security in many developing countries. However, these communities often face various socio-economic and environmental challenges, including limited access to technology, low productivity, and poor waste management systems [1]-[3]. In many rural coastal areas, traditional practices are still widely used, which may limit the efficiency of fisheries-related activities and reduce the potential economic benefits for fishermen's families [4]. Therefore, community empowerment

programs that integrate technological innovation and community participation have become essential strategies for improving the welfare and sustainability of fishing communities [5].

In recent years, universities have increasingly contributed to community development through community service programs that apply engineering and technological knowledge to solve practical problems faced by local communities. Such programs aim not only to introduce appropriate technology but also to strengthen community capacity through knowledge transfer and participatory engagement [6], [7]. The involvement of academic institutions, students, and community members in collaborative activities can create sustainable development initiatives and improve local problem-solving capabilities [8]. These initiatives also provide students with opportunities to gain practical experience in applying engineering knowledge to real-world challenges [9].

One of the major environmental issues facing coastal communities is the improper management of organic waste generated by daily household activities and fishery-related processes. Accumulated organic waste may cause environmental pollution, unpleasant odours, and potential health risks for residents [9]. Several studies have suggested that implementing simple combustion or biomass-based technologies can significantly improve waste management efficiency in rural communities while minimising environmental impacts [11], [12]. Such technologies are often designed using locally available materials to ensure affordability, sustainability, and ease of maintenance by local users [13].

Appropriate technology development has been widely recognised as an effective approach to support rural and community-based development. Appropriate technologies are typically designed to match local socio-economic conditions, available resources, and community capabilities [14]. In the context of fishing communities, engineering-based technologies can help improve environmental management, increase productivity, and promote sustainable practices [15]. Previous studies have shown that community participation in technology implementation significantly increases the success and sustainability of such initiatives [16].

Furthermore, the success of community empowerment programs depends heavily on stakeholder participation and collaboration. Active participation of students, academics, and local communities can strengthen social cohesion and encourage knowledge exchange between scientific and local knowledge systems [16]. Through participatory approaches, community members become directly involved in the planning, preparation, and implementation of technological interventions, thereby enhancing their sense of ownership and responsibility for the technology introduced [18].

In addition, environmental awareness and community involvement are important elements in ensuring the sustainability of technological interventions in rural areas. Programs that combine technological innovation with environmental management practices can help communities address both socio-economic and ecological challenges simultaneously [19]-[21]. Several studies highlight that community-based environmental management initiatives supported by universities can significantly improve local environmental conditions and community resilience [22]-[24].

The specific objective of this community service program is to empower fisher communities through the implementation of engineering-based appropriate technology and participatory community engagement. The program focuses on introducing a simple combustion technology to effectively manage organic waste while strengthening community participation and environmental awareness. The novelty of this article lies in integrating engineering technology development, student participation, and community empowerment activities within a single collaborative framework. Unlike previous studies that focus primarily on technological development or community training separately, this program combines technology implementation, environmental management practices, and participatory community engagement to ensure the sustainability and long-term adoption of the introduced technology within the fishermen communities.

2. Methodology

The community service program titled “Community Empowerment Program for Fishermen Through Technology and Engineering-Based Assistance” was carried out using a participatory and practical implementation approach involving academics, university students, and local community members.

This approach was designed to ensure that the technology introduced could be easily understood, adopted, and sustainably utilised by the fishing community. The activities were conducted in several stages, including preliminary assessment, preparation, technology implementation, and evaluation.

The first stage was the preliminary assessment and field observation, which aimed to identify the main challenges faced by the local fishermen community related to environmental management and technological limitations. During this stage, discussions and informal interviews were conducted with community members to understand their needs and existing practices. The information gathered during this process served as the basis for designing an appropriate engineering-based technological solution that could support community activities while remaining simple, affordable, and constructed with locally available materials.

The second stage involved planning and preparation of the technology implementation. The academic team and students designed a simple combustion-based technology constructed using brick materials and metal components. This equipment was intended to assist the community in managing organic waste and to support environmentally friendly practices in the fishermen's settlement area. Before installation, the team prepared the working area by cleaning and organising the site to ensure safe and efficient operation of the equipment.

The third stage consisted of technology installation and community participation activities. During this phase, students and community members collaborated to construct and install the technology unit. Participants were actively involved in the process, including site preparation, material arrangement, and equipment assembly. After the installation process was completed, the team conducted a demonstration and provided explanations of the technology's function, operating procedures, and maintenance.

The final stage was evaluation and knowledge transfer, where the academic team observed the operational performance of the installed technology and gathered feedback from community members. Discussions were conducted to ensure that the community fully understood how to operate and maintain the equipment independently. This stage aimed to strengthen community capacity to utilise engineering-based technologies and to ensure the sustainability of the empowerment program in supporting the productivity and environmental management of the fishing community.

Figure 1 presents the methodological framework used in the Community Empowerment Program for Fishermen Through Technology and Engineering-Based Assistance. The framework illustrates the systematic stages of the community service program, beginning with the preliminary assessment and field observation. At this stage, the academic team conducted direct observations and discussions with community members to identify the main challenges faced by the fishermen community. This initial assessment was important to understand local conditions, community needs, and environmental issues related to waste management and technological limitations. The information gathered during this stage served as the foundation for designing an appropriate technological solution that could be effectively implemented and accepted by the local community.

The second, third, and fourth stages describe the planning, implementation, and evaluation processes of the technology-based empowerment program. In the planning stage, the team designed a simple brick-based combustion technology using locally available materials to ensure affordability and ease of maintenance. The implementation stage involved installing the technology and the active participation of students and community members during construction and demonstration activities. Finally, the evaluation and knowledge transfer stage focused on providing guidance, training, and feedback to ensure the community could operate and maintain the technology independently. Overall, this methodological framework emphasises a participatory and collaborative approach, integrating engineering knowledge with community engagement to support sustainable development and improve environmental and socio-economic conditions for fishing communities.



Figure 1. Methodological Framework of the Community Empowerment Program for Fishermen Through Technology and Engineering-Based Assistance.

3. Result & Discussion

The results of the Community Empowerment Program for Fishermen Through Technology and Engineering-Based Assistance demonstrate the successful implementation of collaborative activities between the academic team, students, and the local community. This program focused on introducing appropriate engineering technology while simultaneously strengthening community participation in supporting sustainable local development. The activities included site preparation, technology installation, operational demonstrations, and the direct involvement of community members in the implementation process. Throughout these stages, the program not only provided technological solutions to support fisheries-related activities and environmental management but also encouraged

knowledge transfer and practical learning for both students and community members. The following figures illustrate the stages of program implementation and the active participation of all stakeholders involved in the community empowerment activities.



Figure 2. Participants of the Community Empowerment Program for Fishermen After the Technology Installation Activity.

Figure 2 shows the implementation stage of the Community Empowerment Program for Fishermen Through Technology and Engineering-Based Assistance, where the research team, community members, and local participants gathered after the installation and demonstration of an appropriate technology unit. The image illustrates a collaborative atmosphere involving university lecturers, students, and residents, including several fishermen and youth participants. In the centre of the image, a technological device resembling a small combustion or processing unit, constructed from metal and brick, can be observed. This equipment represents engineering-based support for local economic activities, potentially related to fish processing, drying, or waste management. The presence of various participants around the equipment indicates active community engagement and highlights the program's participatory approach.

Furthermore, the image reflects the strong community participation and knowledge transfer that occurred during the empowerment program. The involvement of students and community members demonstrates the educational and social impact of the activity, in which engineering knowledge was directly applied to address practical challenges faced by fishing communities. Through demonstrations and hands-on interaction with the introduced technology, participants understood the operational principles and the potential benefits of the equipment for improving productivity and efficiency. This collaborative environment also strengthened relationships between academic institutions and local communities, encouraging sustainable development and long-term adoption of appropriate technologies that can enhance the livelihood of fishermen and surrounding residents.

Figure 3 illustrates the active involvement of university students in the Community Empowerment Program for Fishermen Through Technology and Engineering-Based Assistance. The image shows a group of students gathered at the project location after participating in the implementation of the community service activities. Their presence demonstrates the role of higher education institutions in supporting community empowerment through practical field engagement. The students, mostly from engineering backgrounds, contributed to the preparation, installation, and demonstration of the technology introduced to the fishermen's community. The informal yet organised group arrangement in the image reflects the participants' collaborative spirit and enthusiasm during the program activities.



Figure 3. Student Team Participating in the Community Empowerment Program for Fishermen.

In addition, the figure highlights the importance of student participation as a bridge between academic knowledge and real-world community needs. Through direct interaction with the local community, the students gained practical experience in applying engineering principles to solve real problems faced by fishermen and rural residents. This activity not only strengthened the students' technical and social competencies but also promoted teamwork, communication, and community awareness. Their involvement helped ensure that the technology assistance program was implemented effectively while fostering a sustainable partnership between the university and the local fishermen community for future development initiatives.



Figure 4. Site Preparation and Cleaning Activities for the Installation of Engineering-Based Technology.

Figure 4 illustrates the preparation stage of the Community Empowerment Program for Fishermen Through Technology and Engineering-Based Assistance, where students and participants actively clean and organise the installation area for the technological equipment. In the image, several participants are seen working collaboratively with tools such as brooms, shovels, and a wheelbarrow to remove debris, leaves, and soil from the surrounding area. This activity was carried out to ensure the working area was

clean, safe, and suitable for installing and operating the engineering-based technology introduced during the program. The presence of the technological structure in the background indicates that the preparation process was conducted near the location where the equipment would be installed and utilised by the community.

Moreover, this activity demonstrates the importance of teamwork and community participation in implementing community empowerment programs. Students' involvement in physical preparation activities reflects their commitment not only to technological innovation but also to practical fieldwork and community engagement. By working directly in the field, the students gained valuable experience in project preparation, environmental management, and cooperation with fellow participants. At the same time, this collaborative effort helped strengthen the relationship between the university team and the local community, creating a supportive environment for the successful implementation and sustainability of the technology introduced to assist fishermen and improve their daily economic activities.



Figure 5. Environmental Cleaning Activities Around the Installed Engineering-Based Technology Facility.

Figure 5 presents the continued preparation and environmental management activities carried out during the Community Empowerment Program for Fishermen Through Technology and Engineering-Based Assistance. In this image, several participants, primarily students in the community service program, are actively cleaning and organising the area around the installed technological facility. The structure visible in the image, constructed from brick and metal components, represents the engineering-based equipment introduced to support community activities. Participants can be seen sweeping leaves, collecting waste, and clearing soil with tools such as brooms, shovels, and a wheelbarrow. These activities were necessary to ensure the operational area around the technology installation remained clean, accessible, and safe for long-term community use.

Furthermore, the activities depicted in **Figure 5** demonstrate the importance of maintaining the surrounding environment to sustain community-based technological interventions. By directly engaging in site maintenance and preparation, the students not only contributed to the project's immediate needs but also promoted awareness of environmental cleanliness and proper facility management among local community members. This collaborative effort reflects the practical implementation of engineering-based community empowerment, where technological assistance is complemented by collective responsibility and teamwork. Such participation strengthens the relationship between academic institutions and local communities, encouraging ongoing collaboration to improve the productivity and welfare of fishermen and other community members.

Figure 6 presents the engineering-based technology that was introduced during the Community Empowerment Program for Fishermen Through Technology and Engineering-Based Assistance. The image shows a combustion or processing unit constructed of brick materials, with a metal door system designed for durability and efficient heat management. This technology was developed as an appropriate technological solution to support local community activities, particularly those related to fish processing or waste management. The cylindrical structure with a chimney-like exhaust system

indicates that the equipment is designed to control heat distribution and smoke emission during operation. In the figure, several students from the engineering team are standing beside the equipment, indicating that they are explaining the device's function and operational mechanism to community members.



Figure 6. Engineering-Based Combustion Technology Installed for the Community Empowerment Program.

Furthermore, the figure demonstrates the practical application of engineering knowledge in solving real problems faced by the fishermen communities. The technology is designed to be simple, durable, and constructed using locally available materials such as bricks and metal plates, allowing the community to maintain and operate the system independently. The presence of students alongside the equipment also reflects the knowledge-transfer process, in which technical explanations and demonstrations are provided directly to the community. Through this approach, the fishermen and residents can better understand how to utilise the technology effectively to improve productivity and efficiency in their daily activities. This initiative highlights the role of engineering-based assistance in promoting sustainable community development and strengthening the collaboration between academic institutions and local communities.

Figure 7 illustrates the operational stage of the engineering-based technology introduced in the Community Empowerment Program for Fishermen Through Technology and Engineering-Based Assistance. The image shows the combustion chamber in operation, with organic materials such as dry leaves, small branches, and other biodegradable waste being burned in the furnace. The visible flames and smoke indicate that combustion is occurring effectively within the enclosed chamber. The furnace structure, constructed of bricks and reinforced with a metal door, is designed to withstand high temperatures while maintaining a controlled burning process. The presence of ventilation openings on the metal door also helps regulate airflow, allowing oxygen to enter the chamber and support efficient combustion.

Furthermore, the operation of this furnace demonstrates how appropriate engineering technology can be utilised to support environmental management and community productivity. By converting organic waste into a controlled combustion process, the technology helps reduce waste accumulation in the surrounding environment while providing a practical solution that local communities can easily adopt. The simple design, using locally available materials and straightforward operating procedures, ensures

that fishermen and community members can manage the system independently after receiving initial guidance. This technological intervention highlights the role of engineering-based assistance in promoting sustainable community practices, improving environmental cleanliness, and strengthening the overall effectiveness of the community empowerment program.



Figure 7. Operational Process of the Engineering-Based Combustion Technology for Organic Waste Management.

The novelty of this community service article lies in the integration of engineering-based appropriate technology with participatory community empowerment for the fishermen communities. Unlike previous community service programs that generally focus only on social outreach or training activities, this program combines direct technological implementation, environmental management, and active student involvement in the field. The introduced brick-based combustion technology was designed using locally available materials, making it affordable, easy to maintain, and suitable for rural community conditions. In addition, the program emphasises a hands-on, collaborative approach, with students, academics, and community members jointly participating in the preparation, installation, and operation of the technology. This integrated approach not only improves community understanding of practical engineering applications but also promotes sustainable environmental practices and strengthens the long-term adoption of appropriate technology within fishing communities.

4. Conclusion

The Community Empowerment Program for Fishermen Through Technology and Engineering-Based Assistance has demonstrated that integrating appropriate engineering technologies and participatory community engagement can effectively support environmental management and community capacity development in fishing communities. The implementation process, which included a preliminary assessment, site preparation, technology installation, operational demonstration, and evaluation, successfully encouraged active collaboration among academics, students, and local community members. Through these activities, the community gained a better understanding of environmental management practices and the practical use of engineering-based technology for managing organic waste. The installed combustion technology, constructed with locally available materials such as bricks

and metal components, proved to be a simple, affordable, and effective solution for managing organic waste in the community. The participatory approach applied in this program also strengthened community involvement and ownership of the introduced technology, which is essential for ensuring its long-term sustainability. Furthermore, students' involvement in community service activities provided valuable practical learning experiences while supporting the transfer of technical knowledge to the local community.

Overall, the program contributes to improving environmental cleanliness, promoting sustainable waste management practices, and strengthening collaboration between universities and local communities. The integration of engineering-based technologies with community empowerment activities underscores the importance of interdisciplinary approaches to addressing environmental and socio-economic challenges in rural and coastal communities. Future community service programs are expected to develop further and expand similar technology-based initiatives to support sustainable development and improve the welfare of the fishermen communities.

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