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PROTOTYPE DEVELOPMENT OF BOTTLE FILLING MACHINE TO SUPPORT CLEAN WATER DISTRIBUTION AND STUNTING PREVENTION

Nurul Widji Triana[1], Muchlisiniyati Safeyah[2], Diana Aqidatun Nisa[3], Zainal Abidin Achmad[4*]
[1]Chemical Engineering Department, Universitas Pembangunan Nasional Veteran Jawa Timur, Indonesia
[2]Architecture Department, Universitas Pembangunan Nasional Veteran Jawa Timur, Indonesia
[3]Visual Communication Design Department, Universitas Pembangunan Nasional Veteran Jawa Timur, Indonesia
[4]Communication Science Department, Universitas Pembangunan Nasional Veteran Jawa Timur, Indonesia
z.abidinachmad@upnjatim.ac.id

ABSTRAK

Abstrak: Akses terhadap air bersih sangat penting untuk meningkatkan kualitas hidup, khususnya di pedesaan Indonesia. Desa Kedungjambe, Tuban, menghadapi tantangan yang signifikan dalam pendistribusian air bersih karena kandungan kapur yang tinggi dalam air tanah, yang berkontribusi terhadap risiko kesehatan seperti stunting. Program pengabdian masyarakat ini bertujuan untuk meningkatkan akses air bersih, mendukung pencegahan stunting, dan memberdayakan masyarakat dengan meningkatkan keterampilan teknis. Program ini meliputi pendidikan kesehatan, pengembangan dan implementasi Prototipe Mesin Pengisian Botol Paralel hemat energi, dan pelatihan untuk pengoperasian dan pemeliharaan. Sebanyak 25 peserta, termasuk perangkat desa, guru, operator mesin, santri dan kader kesehatan, terlibat dalam kegiatan tersebut. Metode yang digunakan meliputi ceramah, pelatihan, dan praktik langsung. Evaluasi menggunakan kuesioner dan praktik mengungkapkan peningkatan 80% dalam soft skills, seperti kesadaran akan pentingnya air bersih dan stunting, dan peningkatan 90% dalam hard skills, khususnya dalam pengoperasian dan pemeliharaan mesin. Prakarsa ini secara signifikan meningkatkan pengetahuan kesehatan masyarakat dan efisiensi distribusi air bersih, sejalan dengan Tujuan Pembangunan Berkelanjutan 6. Prototipe ini menunjukkan potensi replikasi di daerah pedesaan lainnya, berkontribusi pada upaya nasional dalam mengatasi tantangan akses air dan mengurangi prevalensi stunting.

Kata Kunci: Air Bersih; Mesin Pengisi Botol; Pencegahan Stunting; SDGs 6; Pembangunan Pedesaan.

Abstract: *Access to clean water is fundamental in improving the quality of life, especially in rural Indonesia. Kedungjambe Village, Tuban, has considerable problems with the distribution of clean water due to its groundwater having high levels of lime, contributing to health risks such as stunting. This community service program aimed to enhance clean water access, support stunting prevention, and empower communities by improving technical and interpersonal skills. The program comprised health education, the development and implementation of a low-energy Prototype Parallel Bottle Filling Machine, and training for operation and maintenance. A total of 25 participants, including village managers, machine operators, student (santri) and health cadres, engaged in the activities. The methods included lectures, hands-on training, and participatory sessions. Evaluation using questionnaires and interviews revealed an 85% increase in soft skills, such as awareness of the importance of clean water, and a 90% increase in hard skills, particularly in machine operation and maintenance. This initiative significantly improved community health knowledge and the efficiency of clean water distribution, which aligns with Sustainable Development Goal 6. The prototype shows potential for replication in other rural areas, contributing to national efforts to address water access challenges and reduce stunting prevalence.*

Keywords: *Clean Water; Bottling Machine; Stunting Prevention; SDGs 6; Rural Development.*

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A. INTRODUCTION

Access to clean drinking water is a critical issue in many rural areas of Indonesia, particularly in villages like Kedungjambe, located in Singgahan District, Tuban, East Java (Soesanti et al., 2022). The groundwater in this region remains unsuitable for consumption despite advancements in infrastructure and water supply systems. High levels of lime and other minerals pose serious health risks, making it unsafe for consumption. Poor water quality is a significant health concern, with documented cases of stunting, a condition that hinders children's growth and development, particularly prevalent in East Java (Achmad, 2024). As part of a broader effort to address stunting and improve public health outcomes, the local government implemented the Techno Water multifunctional filtration system with support from UPN Veteran Jawa Timur. This solution has been proven successful as basic for clean water in the village (Utomo, 2023). One of the issues to still be tackled is water distribution or bottled water for other potential community uses in addition to those highlighted above.

The water quality issue is not specific only to Kedungjambe, where Indonesia confronts this on a larger scale in countryside areas. Febriarta and Widyastuti (2020) esearch that water sources in various rural areas in Tuban Regency, being contaminated with high-mineral contents like lime could exacerbate health problems such as stunting. Such communities often require access to improved water treatment facilities, which can reduce the capacity to provide safe drinking water for every resident. The solution was presented to the Kedungjambe region by the Techno Water filtration system, which reduces the Total Dissolved Solids (TDS) at safe levels in these areas (Mulyadi, 2023). The system works thought to have the ability of producing drinking water. Nonetheless, a manual bottling approach from local facilitators is a significant barrier to scaling distribution and ensuring equal access across the community. This bottleneck underscores the need for technology to make water distribution methods more efficient in villages.

The community service Team project from Universitas Pembangunan Nasional Veteran Jawa Timur in 2024 introduced a new type of the community service program using an innovative system to design and make for a parallel bottle filling prototype upon its establishment. The design does much to improve the efficiency of the Techno Water system in Kedungjambe Village. The project aimed primarily to innovate the bottling process, greatly reducing the burden and time required by local operators but also standardising bottle sizes for a more efficient distributed process. This device is a modification of the bottle filling mechanism which previously thought by Mulyadi (2023) to dispersed like water in Kedungjambe. The machine is particularly notable for a very low energy consumption which makes it suitable for village areas where high-capacity electrical resources are not available.

This project is unique in that its innovative approach combines a low-cost and energy efficient bottling solution with an existing water filtration system to solve both the logistical issues encountered by the village and broader public health issue of water access. Ensuring the provision of clean and healthy water is contributing to achieve Sustainable Development Goal (SDG) number 6 (Rosida et al., 2024). The Prototype Parallel Bottle Filling Machine can definitely help to address the immediate needs in Kedungjambe Village, unlike most of previous investigatons that mostly focus on industrialized scale interventions such as, which is often impossible and resource-demanding for smaller communities. In addition, this innovation is also in line with Indonesia's development goal at large to improve health welfare in rural sectors as mandated in the National Medium-Term Development Plan (RPJMN) 2020-2024 that well which stipulated providing clean water and adequate sanitation are essential components to reduce stunting rates (BKKBN, 2021; Siscawati et al., 2020). The exciting potential of this project has the ability to revolutionise water distribution in Kedungjambe and meet some incredibly important challenges resulting in a huge positive transformation of the community. The water distribution system is not only a technological upgrade but also proof how our creativity and empathy can lead to the use of appropriate technology as an agent of positive transformation (Arviani et al., 2022).

There is also room for improvement in the difficulty with standardizing bottle sizes of water, operators of Techno Water system at Kedungjambe since it influences pricing structure on some available size and distribution channels. The system also rejected the full automation style, and result in community workers manually depending on water flow and size of bottle for accomplishing the order of customers. That could have proved to be a slow and wasteful process of only a few bottles being filled and sent over to the required places each day. In addition, this manual administration caused the quantities of water provided to be kept artificially similar which tricked consumers and sales points operators alike in regards to bottled water pricing.

The development of this prototype parallel bottle-filling machine has eliminated issues of inefficiency and laid down a procedure for the process of bottling. The machine is specially constructed to fill bottles of a particular size; in this case, the 600ml size commonly used in the village and other sizes as well. It has enhanced lesser workload to the operators and fairness in rationing of water, and easier pricing, customer satisfaction is achieved. Another advantage of the machine is that it is energy efficient and thus can be operated in areas of low electricity such as in the rural regions.

Besides enhancing the organizational efficiency in an operation of its production, this project targeted at offering the new economic prospects in the village, for instance selling of the bottled water to the schools, mosques, and other business entities. It is postulated that having clean and portable water in these social places should enhance health because children and adolescents

are the most susceptible to worsened water conditions. In addition, the project is consistent with current trends in the support of rural communities' development by using technology and innovative business approaches. This way, local youths are actively engaged in the management and maintenance of the bottling machine which will enable the community to take ownership of the system for its intended purpose (Handayani et al., 2019; Wijayanti et al., 2022).

The most important contribution of the project is the aim to avoid stunting in the region which is prevalent in rural areas of Indonesia, particularly where access to water and sanitation is scarce (Ningsi et al., 2024). According to WHO, stunting is among the most important areas of concern in global health and nutrition, especially among children in low-and middle-income countries (LMICs), affecting their physical and mental development (Rahmawati & Qiftiyah, 2021). This project's significant component is that it provides equal access to clean drinking water to eliminate one of the main causes of stunting in Kedungjambe, and by doing so it is complementary to public health interventions.

The community service engagement within Kedungjambe Village has increased the development of various technical and interpersonal skills among participants and local stakeholders. In terms of health-related competencies, the program has improved knowledge on strategies aimed at preventing stunting. It highlighted a very important relationship between access to clean water and reduced health risks, particularly in reducing stunting among children. This knowledge will empower participants to implement health interventions that are specifically tailored for rural settings and, therefore, bring about improved public health outcomes.

The soft skills of the community are further built through empowerment by using mutual strengths in problem-solving and decision-making. This capacity building supports the community's ability to manage local resources and sustain health programs independently. Moreover, the program introduced concepts related to economic growth so that improved water systems can be used by inhabitants for broader socio-economic benefits. These broad skill sets correspond to national development goals, thus securing the long-term sustainability of access to clean water while concurrently addressing stunting problems. On the technical side, residents have learned to use and maintain the low-energy, efficient bottle-filling system coupled with the Techno Water filtration system. This ability would assure the community of a continued supply of clean water and therefore solve one of the major health problems in this area. In addition, the participants got knowledge of water management systems, thus equipping them to manage and maintain these technologies effectively.

B. METHOD

This community engagement project was conducted in Kedungjambe Village, Tuban Regency, involving 20 participants, including local residents and students from the Al-Barmawi Islamic boarding school (*santri*). These participants were carefully selected to ensure a diverse representation of community members actively engaged in managing water resources and improving local health standards. Their involvement played a critical role in the program's success and its alignment with the Sustainable Development Goal (SDG) 6—Clean Water and Sanitation.

The intervention comprised three main components: health education on clean water and stunting prevention, the construction and implementation of a Prototype Parallel Bottle Filling Machine, and community training on the operation and maintenance of the machine. The methods employed included interactive lectures, hands-on practice, and participatory training sessions. By incorporating local language and actively involving community leaders, the program ensured effective communication and community engagement (Chasanah & Achmad, 2022). The program implementation was divided into three phases:

1. Pre-Activity Phase

This phase involved preliminary planning and community engagement to identify the key challenges related to water access and public health. The team conducted needs assessments and worked with local leaders to tailor the intervention. Educational materials were designed to reflect local cultural contexts, enhancing understanding (Aesthetika et al., 2023).

2. Implementation Phase

Health Education: This included interactive sessions focused on the importance of clean water and stunting prevention. By using local languages and culturally sensitive teaching approaches, the program successfully raised awareness about the risks of contaminated water and the critical role of clean water in preventing stunting. Residents were taught practical behaviors such as water treatment methods and recognizing stunting signs, ensuring sustained health improvements (Jannah et al., 2021; Nuraina & Azizah, 2019).

Development and Installation of the Prototype: The prototype, a parallel bottle-filling machine_as an appropriate technology_was specifically designed to address the village's unique challenges, including frequent power outages and limited skilled human resources (Tranggono, et al., 2022). The machine supports 600ml bottles, reflecting the region's market demand, and incorporates energy-saving features for sustainable long-term use (Chairunissa et al., 2021). The machine was developed at UPNV Jatim Technopark and installed at Masjid NU Al-Barmawi, a central community location, to ensure accessibility and usability. Practice to operate and maintenance the machine: to get technical skills development. Operators

acquired essential skills for operating and troubleshooting the machine, enabling community self-reliance (Hartati et al., 2021; Majee & Hoyt, 2009).

3. Evaluation Phase

This phase assessed through quesioners, observations, and practical demonstrations. Especially for technical skills, the evaluation emphasized outcomes: (a) Community involvement in the evaluation fostered a sense of responsibility, ensuring the machine's proper use and long-term maintenance (Syaharuddin & Ibrahim, 2017); and (b) Hands-on training allowed participants to gain practical experience under instructor supervision. This ensured a thorough understanding of machine operations and troubleshooting procedures, facilitating effective and sustainable technology adoption (Habibi et al., 2023; Sari et al., 2023).

C. RESULTS AND DISCUSSION

The community service project aimed to address two primary concerns in Kedungjambe Village, Singgahan District, Tuban: the lack of access to clean drinking water and the high prevalence of stunting, which is common in areas with poor water quality. The project achieved notable success through the implementation of three key activities: health education, the creation and use of the Prototype Parallel Bottle-Filling Machine, and the training of local operators to use and maintain the machine. Each activity contributed significantly to improving water provision, public health, and community development.

1. Pre-Activity Stage: Need Assessment, Community Introduction, Material Preparation

The pre-activity stage was a crucial phase of the community service program, aimed at laying a solid foundation for the project's success. This stage consisted of three essential components: needs assessment, community introduction, and material preparation, all tailored to address the unique challenges faced by Kedungjambe Village. An initial survey was conducted to understand the specific challenges related to water distribution and health issues, particularly stunting, which is prevalent in the village. The survey revealed that high lime content in the groundwater was a significant barrier to clean water access, exacerbating health risks such as stunting among children. The community also faced logistical inefficiencies in water distribution, as the manual methods used were time-consuming and lacked consistency. These challenges highlighted the need for innovative technology to improve water access while addressing public health concerns. Additionally, the assessment identified a lack of technical skills and awareness among residents regarding water treatment and stunting prevention.

To build trust and encourage active participation, local leaders played an integral role during this stage. Religious and community leaders acted as bridges between the project team and the villagers, facilitating

communication and ensuring community buy-in. Their involvement not only legitimized the program but also fostered a sense of ownership among the residents. Meetings and discussions were held to explain the program's objectives, outline its benefits, and address any concerns. This participatory approach was instrumental in gaining the community's commitment to the project, ensuring sustained engagement throughout its implementation.

The final component of the pre-activity stage focused on preparing training materials that were culturally and educationally relevant to the community. Materials such as brochures, posters, and videos were designed using the local language to ensure accessibility and comprehension. These materials included visual aids to address varying literacy levels within the community and focused on practical, actionable information (Figure 1). Topics covered included the importance of clean water for preventing stunting, proper water treatment techniques, and an introduction to the Prototype Parallel Bottle Filling Machine.

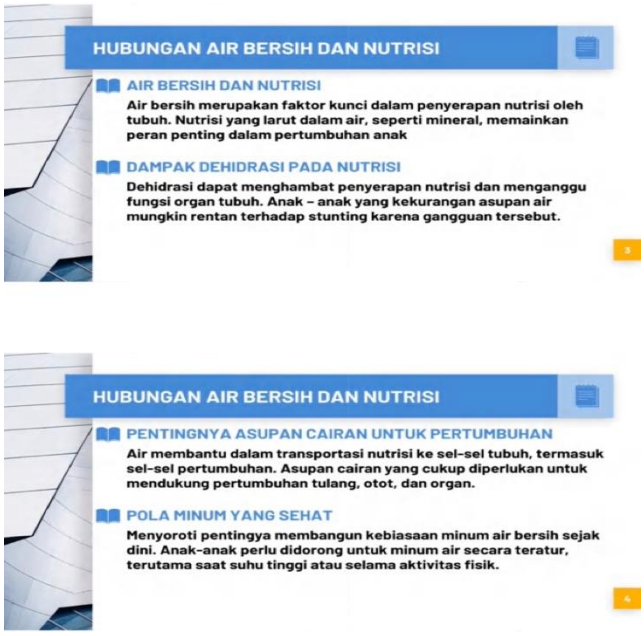

Figure 1. Training Materials "The Importance of Clean Water for Preventing Stunting

2. Implementation Stage: Health Education on Clean Water and Stunting Prevention

Kedungjambe Village faced long-standing issues with water pollution due to high lime content in local water sources. This led to health risks, particularly stunting among children. Stunting, defined as impaired growth in children due to malnutrition or chronic infections, is directly linked to the limited availability of safe water and sanitation (BKKBN, 2021; Rosida et al., 2024). Before the intervention, the community had little knowledge of the health consequences of drinking contaminated water, particularly for children and pregnant mothers. The villagers were unaware of the connection

between poor water quality and stunting, which is a widespread problem in rural areas (Lestari et al., 2024).

To address these issues, the community service team conducted a health education campaign. This initiative involved significant community members, such as families, teenagers, young mothers, educators, and religious leaders, to raise awareness about the risks of unsafe water consumption and its connection to stunting. The educational campaign utilized local language materials such as brochures, posters, and videos to make the information accessible to all demographic groups in the village. Engaging religious and community leaders helped disseminate the message more effectively, ensuring that the information reached a wider audience (Shofiya et al., 2022). As a result, community members gained a better understanding of how to protect water safety, recognize stunting signs, and adopt good hygiene practices at home. These efforts helped eradicate fears about waterborne diseases and promoted significant behavior changes within the village, as families implemented the learned practices to protect their children's health (Figure 2).

Figure 2. Health Education, Advisory on Clean Water and Stunting

In this case, out of the effected education greater awareness was created on the need to promote clean water and its contribution towards the prevention of stunting among children. The community members said and demonstrated they understood ways to protect water safety and health; they adapted good hygiene practices in their respective homes. Fear of disease was eradicated as the local families sought to make drastic changes that would enable their children benefit from clean water through measures learnt from such workshops. In addition, both religious and school heads displayed concern about these educational intervention projects, implying that they wanted to sustain such endeavours in the endeavours in enhancing of the people's health. This project is relevant to the established literature in the subject in as much as it supports calls for carrying out education within the community in an effort to enhance overall well-being in rural settings. According to Arviani et al. (2022), the sovereignty of communities in making change toward behavior betterment is highly encouraged where traditional

practices differ with modern health standards. This proves the ability of this intervention to increase knowledge on clean water and stunting bringing a spotlight to culturally appropriate health promoting messages.

3. Implementation Stage: Design and Implementation of the Prototype Parallel Bottle-Filling Machine

The introduction of the Techno Water filtration system was critical to providing clean drinking water to the village. However, bottling the water posed significant challenges due to the inconsistency in bottle sizes, time-consuming manual processes, and limited scalability (Ambare et al., 2021). These inefficiencies created logistical bottlenecks and hindered the potential for widespread water distribution. These conditions reflects broader issues encountered by many rural communities in Indonesia when implementing a clean water system, which is not considered the necessary technology for efficiency. Implementing water purification technologies in rural areas undermines the potential benefits of clean water access (Sari et al., 2023). To address these challenges, the team developed a custom-designed Prototype Parallel Bottle-Filling Machine, which could simultaneously fill 600ml bottles, the most commonly used size in the region. The prototype was specifically tailored to meet the energy constraints of Kedungjambe, which experiences frequent power outages (Figure 3).

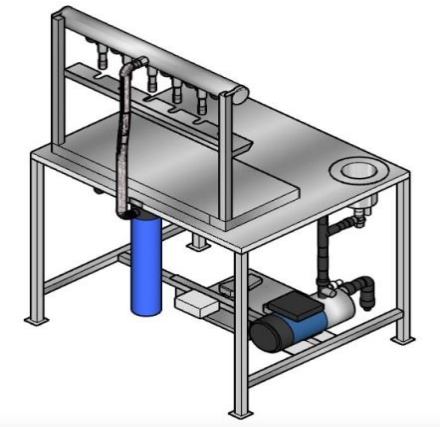

Figure 3. Layout Design of Parallel Bottle-filling Machine

The design of the prototype was flexible and significantly improved upon the previous manual system. It allowed for a faster, more efficient bottling process, enabling the community to distribute larger quantities of clean water daily (Mulyadi, 2023). The energy-saving features of the prototype made it sustainable, with minimal resource consumption required for its operation (Klimecka-Tatar & Ingaldi, 2024). The machine's efficiency empowered local operators to handle the bottling process independently, reducing the need for multiple personnel. This advancement played a critical role in overcoming the logistical challenges of water distribution and empowered the community by providing ownership over the machine's operation and maintenance.

4. Implementation Stage: Training in Machine Operation and Maintenance

The sustainability of the Prototype Parallel Bottle-Filling Machine depended on the ability of local operators to effectively manage and maintain the machine. Prior to the project, most villagers lacked the necessary technical skills to operate and maintain such machinery, and there were concerns about potential breakdowns due to insufficient knowledge place (Achmad, Wuryandari, et al., 2022; Taufikurrahman et al., 2023). To mitigate these risks, the team provided comprehensive training to 10 local operators, including villagers and *santri* from the local Islamic boarding school. The training was divided into two main components: machine operation and maintenance. Operators were taught how to use the machine efficiently, including switching between bottle sizes and troubleshooting minor issues. They were also trained on how to clean the machine, replace worn parts, and assess its performance (Figure 4). Practical, hands-on experience during the training sessions ensured that operators could operate the machine independently, without further assistance from the project team (Sari et al., 2023). Additionally, technical user guides and easy-to-follow maintenance logs were provided in the local language, further enhancing comprehension and usability (Taufiq & Asiah, 2020; Wardhani et al., 2022).

Figure 4. Operational and maintenance training for local operators at Masjid NU Al-Barmawi, Kedungjambe Village.

This training not only ensured the continued operation of the bottle-filling machine but also empowered the community to manage the technology independently. By promoting ownership and responsibility, the training increased the likelihood of long-term sustainability (Bardhan & Bhattacharya, 2022; Tranggono et al., 2022). The training also developed the technical capacity of the community to handle future challenges and reduced the need for external technical support. The involvement of local leaders in the training process further strengthened the project's impact, in ensuring the long-term success of community-driven initiatives (Izzah & Habib, 2024).

5. Evaluation Stage

In summary, the program was successful in improving both the health awareness of the community and the technical capabilities of local operators. Through the educational campaign on clean water and stunting prevention, the development of the Parallel Bottle-Filling Machine, and the training program, the community of Kedungjambe was empowered to sustainably manage their water supply, thereby contributing to improved public health outcomes and the prevention of stunting. This intervention also demonstrates the potential of appropriate technology in overcoming challenges in rural development, empowering local communities to improve their quality of life (Wijayanti et al., 2022; Wuryandari et al., 2020).

Through the distribution of pre-test and post-test questionnaires, and through observation and practice, there was an increase in public knowledge and understanding (soft skills). In providing clean water and stunting material to 25 participants, the average correct answer was 20% during the pre-test to 100% correct answers during the post-test (80% improvement). In understanding the design and function of the prototype given to 25 people, the same increase was obtained, namely from 20% to 100% (80% improvement). In mastering the practice of operating the prototype (hard skills), which ten operators followed, there was an increase of up to 90%. Initially, only one operator could operate without being given an example because they understood the material and the machine's design and function. At the end of the practice stage, ten operators could operate and practice how to maintain the bottle-filling machine.

Table 1. Skills Mastery of Target Audience

Type Skills	Initial Mastery	Final Mastery	Improvement
Knowledge about Clean Water and Stunting	20%	100%	80%
Understanding the Design and Function of the Machine	20%	100%	80%
Practice of Machine Operation and Maintenance	10%	100%	90%

(Source: Primary Data).

The achievement of this project is a perfect example of how technology can be deployed in a way that is appropriate for rural villagers, which ensures that the logistical issues for water delivery have been resolved and helps empower the local economy.

D. CONCLUSION AND RECOMMENDATION

The community service program in Kedungjambe Village successfully improved participants' skills and addressed water distribution challenges and stunting issues. The health education sessions increased public awareness of clean water and stunting prevention, contributing to an 80% improvement in soft skills. Meanwhile, technical training on the Prototype Parallel Bottle Filling Machine led to a 90% improvement in hard skills, enabling participants to independently operate and maintain the technology. The program improved water distribution efficiency, public health outcomes, and economic opportunities in the village, supporting Sustainable Development Goal 6.

Future community service programs should focus on expanding training to include a broader segment of the community, such as local businesses and schools, to maximize impact. Additionally, implementing periodic evaluations and maintenance checks can ensure the long-term sustainability of the technology. Replication of this program in other rural areas should consider adapting the technology to specific local challenges, fostering greater community involvement, and integrating complementary health interventions to amplify its benefits.

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