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Waste Management Model Based on Community Participation Through Smokless Burn Barrel Technology

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Abstract: The problem of household waste management is still a major challenge, especially in areas that do not have an integrated management system. The practice of open burning that is commonly carried out by the community has a negative impact on the environment and health due to harmful gas emissions. This research aims to develop a waste management model based on community participation through the application of Smokeless Burn Barrel technology in Jayamekar Village, Sukabumi City. The method used is Participatory Action Research (PAR) which actively involves the community in the planning, implementation, observation, and reflection stages. Data collection techniques include observation, interviews, documentation, and Focus Group Discussions (FGD), with interactive qualitative data analysis. The results of the study show that the application of Smokeless Burn Barrel technology is able to significantly reduce the volume of waste and smoke emissions, as well as increase public awareness and participation in waste management. In addition, there has been a change in community behavior in sorting waste before processing. The resulting model consists of four main components, namely the identification of participatory problems, the implementation of appropriate technologies, changes in community behavior, and continuous evaluation. However, the sustainability of the program still requires further assistance and institutional strengthening. This research confirms that the integration of appropriate technology and community participation is an effective strategy in realizing sustainable waste management and has the potential to be replicated in other regions.

Keyword: Waste Management, Community Participation, Smokeless Burn Barrel, PAR, Environmental Sustainability.

INTRODUCTION

The waste problem is one of the main challenges in sustainable development, especially in organizational and rural areas that do not have an integrated waste management system. Population increases, urbanization, and changes in people's consumption patterns have led to a significant increase in the volume of waste. However, the available waste management capacity is often unable to balance the rate of increase. As a result, various waste management methods that are not environmentally friendly, such as littering and open burning, are still widely carried out by the community (Pratama and Ilham 2025) Open burning of waste is a common option because it is considered practical and fast in reducing the volume of waste. However, this method has a serious impact on the environment and public health, especially due to the emission of harmful gases such as carbon monoxide (CO), nitrogen oxide (NOx), and fine particles (PM2.5) that can cause respiratory distress and air pollution (Sunardi, Rahman, and Wibowo 2026) Therefore, a waste management approach is needed that is not only effective in reducing the volume of waste, but also environmentally friendly and sustainable.

One of the approaches that is increasingly developing is waste management based on community participation. This approach emphasizes the active involvement of the community in every stage of waste management, from sorting, processing, to reuse. Research shows that the success of waste management is greatly influenced by the level of awareness, participation, and changes in community behavior in managing waste independently (Hidayat, Suryani, and Prakoso 2024) Thus, strengthening the role of the community is the main key in creating a sustainable waste management system.

In supporting this approach, appropriate technology is needed that is easy to apply by the community. One of the innovations that can be used is the Smokeless Burn Barrel technology, which is a waste incinerator with a dual combustion system (primary and secondary combustion) designed to improve combustion efficiency and minimize smoke emissions. Research by (Fitroh and Ilham 2025) shows that this technology is able to reduce harmful particle emissions and produce less ash residue than conventional combustion methods (Fitroh and Ilham 2025) In addition, the implementation of this technology has also been proven to increase combustion efficiency by up to 43.5% and reduce ash residues by 66.7% (Sunardi, Rahman, and Wibowo 2026).

Furthermore, the integration between Smokeless Burn Barrel technology and the community participation approach has great potential in creating an effective and sustainable waste management model. This technology not only functions as a waste management tool, but also as an educational medium for the community to understand the importance of environmentally friendly waste management. Technology-based approaches accompanied by education and mentoring have been proven to be able to increase public awareness and encourage behavioral changes in waste management (Hidayat, Suryani, and Prakoso 2024) This activity was carried out in Jayamekar Village, Baros District, Sukabumi City, which faces similar problems related to household waste management. The limited waste management facilities and infrastructure and the low level of community participation are the main challenges in creating a clean and healthy environment. Therefore, the application of Smokeless Burn Barrel technology combined with a participatory approach is expected to be an effective and sustainable alternative solution in the region.

However, most of the previous research still focused on the technical aspects of the use of Smokeless Burn Barrel or partial community service activities. Studies that integrate technological aspects, community participation, and systematic and sustainable waste

management development models are still relatively limited. This shows that there is a research gap that needs further research.

Based on this description, the formulation of the problem in this study is: (1) what are the conditions and level of participation in the waste management community; (2) how is the implementation of Smokeless Burn Barrel technology in community-based waste management; (3) the extent of the effectiveness of the technology in reducing waste and environmental pollution; (4) what factors affect the success of its implementation; and (5) how is the sustainable community participation-based waste management model through this technology. The formulation of this problem will be discussed in the discussion and answered systematically in the conclusion section.

METHOD

This activity uses the Participatory Action Research (PAR) approach, which is an approach that integrates active community participation with real actions in solving problems collaboratively. According to Lewin , PAR is a cyclical process that involves planning, action, observation, and reflection to produce sustainable social change. This approach was chosen because it is in line with the purpose of the activity, which is to develop a waste management model based on community participation through the application of Smokeless Burn Barrel technology. PAR not only focuses on data collection, but also on the process of community empowerment through direct involvement in each stage of activities (Baum, MacDougall, and Smith 2006).

The activity was carried out in Jayamekar Village by involving the local community as the subject as well as the activity partner. Participants consisted of households, community leaders, and village officials involved in environmental waste management. The selection of participants was carried out purposively by considering the level of involvement and concern for environmental issues. According to John W. Creswell, purposive sampling was used to select participants who were considered to best understand the phenomenon being studied Creswell.

The activity procedure follows the PAR cycle which includes four main stages, namely: (1) planning, (2) action, (3) observation, and (4) reflection. In the planning stage, the identification of waste management problems is carried out through Focus Group Discussion (FGD) and field observation. The action stage is carried out through the implementation of Smokeless Burn Barrel technology, including socialization activities, tool making training, and assistance in the use of it by the community. The observation stage is carried out to monitor the effectiveness of the use of technology, changes in community behavior, and its impact on reducing the volume of waste. The reflection stage is carried out with the community to evaluate the results of activities, identify obstacles, and formulate program improvements to be sustainable (Kemmis and McTaggart 2014).

The data collection techniques used included participatory observation, in-depth interviews, documentation, and targeted group discussions (FGDs). Observations were conducted to see firsthand the conditions of waste management and technology implementation in the field. Interviews were used to explore perceptions, experiences, and levels of community participation. Documentation was used to support visual and administrative data, while FGD was used to build mutual agreement in the process of reflection and preparation of community-based waste management models (Morgan 2019).

Data analysis was carried out qualitatively using interactive analysis techniques developed by Matthew B. Miles and A. Michael Huberman, which included data reduction, data presentation, and conclusion drawing (Miles, Huberman, and Saldaña 2014). The validity of the data was maintained through triangulation of sources and methods, as well as the active

involvement of the community in the process of verifying the results of activities to increase the credibility of the findings.

Through the PAR approach, this activity not only produces academic findings, but also produces an applicable and sustainable waste management model based on community participation through the use of Smokeless Burn Barrel technology.

RESULTS AND DISCUSSION

The results of the implementation of community service in Jayamekar Village show that the application of Smokeless Burn Barrel technology based on community participation is able to be an alternative solution for more effective and sustainable household waste management. These findings can be analyzed through a theoretical approach and supported by the results of previous research.

At the FGD stage and initial observation, it was found that the community's waste management pattern was still dominated by open burning and waste disposal without sorting. This condition shows low community awareness and skills in waste management. In the perspective of Arnstein community participation theory, the FGD process is an important part in building participation at the consultation to partnership level, where the community begins to be involved in identifying problems and determining solutions together. These findings are in line with a community-based waste management study in Yogyakarta which shows that community involvement from the problem identification stage is able to increase the effectiveness of sustainable waste management programs.



Figure 1: FGD with the Village Government and the Community

At the stage of making the Smokeless Burn Barrel, the community is directly involved in the process of designing and manufacturing the tool. This involvement strengthens the concept of Participatory Action Research (PAR) developed by Lewin , where the process of social change is carried out through tangible actions that actively involve the subject. In this context, the community is not only the beneficiary but also the main actor in the innovation process. This is strengthened by research on PAR-based waste management interventions in Malang which shows that participatory approaches are able to increase environmental awareness and technical skills of the community.



Figure 2 : Implementation of Smokeless Burn Barrel Technology Manufacturing

From the perspective of Everett Rogers' innovation diffusion theory, the community's success in understanding and making Smokeless Burn Barrel shows a good acceptance of innovation. Rogers explained that the adoption of technology is influenced by five main factors, namely relative advantage, compatibility, complexity, trialability, and observability. In this program, Smokeless Burn Barrel technology is considered to have relative advantages because it is more environmentally friendly than open combustion, is easy to make, and can be directly tested and benefited by the community.

At the stage of technology utilization, the observation results show that the use of Smokeless Burn Barrel is able to reduce the volume of household waste, especially organic waste, as well as reduce the intensity of combustion smoke. These results show the effectiveness of technology in supporting more environmentally friendly household waste management. These findings are in line with previous research that showed that closed combustion technology is more effective in reducing emissions than open burning and can be an alternative solution in areas with limited waste management facilities (Mulasari et al. 2024).



Figure 3 : Utilization of Smokeless Burn Barrel Technology

In terms of behavior change, the community began to implement simple waste sorting before the incineration process. This change can be explained through the Theory of Planned Behavior, which states that behavior is influenced by attitudes, subjective norms, and perceived behavioral control. Socialization and training in this program have succeeded in forming a

positive attitude towards waste management and creating new social norms in the community to be more concerned about environmental cleanliness.

At the evaluation stage, the results of the evaluative FGD showed that the community considered this technology to be practical, easy to use, and helped reduce the accumulation of household waste. However, there are still obstacles in the form of uneven adoption of technology and the need for further assistance. This is in line with the results of a systematic study that shows that the success of participatory-based waste management programs is greatly influenced by the sustainability of mentoring and strengthening local institutions.

Overall, the results of this service confirm that the integration between appropriate technology and community participation is an effective strategy in building a sustainable waste management system. The model produced in this activity consists of four main components, namely participatory problem identification, implementation of appropriate technology, community behavior change, and sustainable evaluation. This model strengthens the concept of community-based waste management that places the community as the main actor in maintaining environmental sustainability. Thus, this model has the potential to be replicated in other regions with similar problem characteristics.

CONCLUSION

The results of the implementation of community service in Jayamekar Village show that the application of Smokeless Burn Barrel technology based on community participation is able to increase the effectiveness of household waste management. The results of the FGD and initial observations show that the community still manages waste with open combustion and without sorting, which shows low environmental awareness and limited waste management facilities.

Through the Participatory Action Research (PAR) approach according to Lewin active community involvement in planning, manufacturing, and utilizing technology has been proven to increase participation and a sense of belonging to programs. This is in line with Arnstein theory of participation which emphasizes the importance of community involvement in the success of community-based programs.

From the perspective of Everett Rogers' innovation diffusion theory, the Smokeless Burn Barrel technology is well received because it is easy to make, simple to use, and provides direct benefits in the form of reducing the volume of waste and minimizing combustion smoke. In addition, based on the Theory of Planned Behavior from Icek Ajzen , this program also encourages changes in people's behavior in sorting and managing waste more responsibly.

However, the sustainability of the program still requires further assistance and strengthening institutional support so that technology adoption can run more consistently and widely.

The implementation of the service program through Smokeless Burn Barrel technology shows that waste management based on community participation can be an effective and sustainable alternative solution. This program has succeeded in increasing knowledge, skills, and community participation in waste management as well as reducing the volume of waste and the impact of pollution from open burning.

The resulting model consists of four main components, namely problem identification, technology application, behavior change, and continuous evaluation. This model has the potential to be replicated in other regions with the support of ongoing mentoring and collaboration.

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