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EMPOWERING COMMUNITIES THROUGH THE USE OF AN APPROPRIATE STYROFOAM SHREDDING MACHINE FOR WASTE MANAGEMENT.

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Abstrak.

Program pengabdian kepada masyarakat ini bertujuan untuk meningkatkan efisiensi dan keselamatan kerja dalam pengolahan limbah styrofoam melalui penerapan teknologi tepat guna berupa mesin pencacah styrofoam. Kegiatan dilaksanakan pada mitra UMKM yang bergerak di bidang pengelolaan limbah styrofoam, dimana proses sebelumnya masih dilakukan secara manual sehingga kurang efisien dan berpotensi menimbulkan risiko keselamatan kerja. Metode pelaksanaan meliputi beberapa tahapan, yaitu identifikasi masalah, perancangan dan pembuatan mesin, sosialisasi, pelatihan, implementasi, serta evaluasi. Pendekatan partisipatif diterapkan untuk melibatkan peserta secara aktif dalam setiap tahapan kegiatan. Hasil kegiatan menunjukkan bahwa penggunaan mesin pencacah styrofoam mampu meningkatkan efisiensi proses, mempercepat waktu produksi, serta meningkatkan keselamatan kerja. Kegiatan pelatihan juga meningkatkan keterampilan teknis peserta dan kemampuan dalam mengoperasikan mesin secara mandiri. Selain itu, pengurangan volume styrofoam memberikan dampak positif terhadap kemudahan penyimpanan dan pengelolaan limbah. Secara keseluruhan, penerapan teknologi tepat guna yang didukung dengan pelatihan dan pendampingan terbukti efektif dalam meningkatkan produktivitas, keselamatan kerja, serta pengelolaan limbah pada tingkat UMKM. Program ini juga menunjukkan potensi keberlanjutan dalam mendukung pengelolaan lingkungan berbasis masyarakat.

Kata kunci: teknologi tepat guna, limbah styrofoam, mesin pencacah, UMKM, pengabdian kepada masyarakat

Abstract.

This community service program aims to improve the efficiency and safety of styrofoam waste processing through the implementation of an appropriate technology in the form of a styrofoam shredding machine. The program was conducted at an MSME partner engaged in styrofoam waste management, where the existing process was still carried out manually, resulting in low productivity and potential safety risks. The method of implementation involved several stages, including problem identification, machine design and development, socialization, training, implementation, and evaluation. A participatory approach was applied to ensure active involvement of participants in every stage of the program. The results showed that the application of the shredding machine significantly improved processing efficiency, reduced processing time, and enhanced work safety. The training activities also increased participants' technical skills and their ability to operate the machine independently. In addition, the reduction in styrofoam volume facilitated more efficient storage and waste handling. Overall, the integration of appropriate technology with training and assistance proved to be effective in improving productivity, safety, and waste management practices at the MSME level. The program also demonstrated the potential for

sustainable implementation of simple technology in supporting community-based environmental management.

Keywords: *appropriate technology, styrofoam waste, shredding machine, MSMEs, community service.*

Introduction

The increasing use of styrofoam as a packaging material in small and medium-scale businesses has raised significant environmental concerns. Styrofoam, or expanded polystyrene (EPS), is widely utilized due to its lightweight structure, low cost, and practical advantages in food packaging and distribution. However, EPS is a non-biodegradable material that is highly resistant to natural degradation, contributing to long-term environmental accumulation and solid waste problems [1], [2]. Its persistence in the environment and low recycling rate make it one of the most challenging plastic wastes to manage effectively [3]. In the context of micro, small, and medium enterprises (MSMEs), waste management practices are often still limited and informal. Based on field observations at UD. Tiga Putra in Desa Beton, Kecamatan Menganti, Kabupaten Gresik, styrofoam waste generated from production activities is still processed using conventional methods . The shredding process is carried out manually using simple tools, which is inefficient, time-consuming, and poses safety risks to workers. In addition, the bulky characteristics of styrofoam significantly reduce storage efficiency and increase handling difficulties [4].

Previous studies have highlighted that the application of appropriate technology (Teknologi Tepat Guna/TTG) can significantly improve productivity, operational efficiency, and occupational safety in small-scale industries [5], [6]. In particular, mechanical processing such as shredding plays an important role in reducing material size and improving waste handling prior to recycling processes [7]. Furthermore, integrating technology implementation with training and community participation has been shown to enhance the sustainability of community-based waste management programs [8]. Recent studies on plastic waste management also emphasize the importance of mechanical recycling and pre-treatment processes, including shredding, as key steps in improving the efficiency of plastic waste recovery systems [9], [10]. These approaches are particularly relevant for community-level applications where simple, low-cost, and easy-to-operate technologies are required.

Therefore, this community service activity aims to implement an appropriate styrofoam shredding machine to support waste management practices at the community level. The program focuses on improving operational efficiency, enhancing worker safety, and reducing the volume of styrofoam waste through the application of simple and applicable technology.

Method of Implementation

The community service program was conducted using a participatory and implementation-based approach, focusing on the application of appropriate technology to address practical problems faced by the partner. The method emphasizes direct involvement of the community, particularly the MSME partner (UD. Tiga Putra), in every stage of the activity, including problem identification, technology implementation, and evaluation.

Table 1. Community Partnership Empowerment (PKM) Implementation Method

No.	Implementation Stage	Activities	Objectives	Expected Outcomes
1	Problem Identification	Field observation and interviews with MSME partner (UD. Tiga Putra) to identify constraints in styrofoam waste	To understand the initial conditions, technical limitations, and needs of the partner	Identification of key problems such as manual shredding, low efficiency, and safety risks

		processing		
2	Design and Development of Technology	Designing and fabricating an appropriate styrofoam shredding machine based on partner needs	To provide a suitable technological solution for improving shredding efficiency and safety	Availability of a functional styrofoam shredding machine adapted to MSME conditions
3	Socialization	Delivering information on the importance of proper styrofoam waste management and the benefits of using appropriate technology	To increase awareness of environmental issues and technology utilization	Improved understanding of waste management and technology adoption among participants
4	Training	Training on machine operation, safety procedures (OHS), and basic maintenance	To enhance user skills and ensure safe machine operation	Participants are able to operate and maintain the machine independently
5	Implementation and Assistance	Direct application of the shredding machine in the production process with continuous mentoring	To ensure proper use of technology and smooth transition from manual to mechanical process	Improved efficiency in shredding process and increased user confidence
6	Evaluation	Assessment of performance improvements, including processing time, efficiency, and safety conditions	To measure the effectiveness of the implemented technology	Evidence of increased productivity, reduced risk, and improved waste management practices

The implementation of the community service program was carried out through a structured and participatory approach involving the active engagement of the MSME partner. The stages of implementation were designed to ensure that the applied technology could effectively address the problems faced by the partner while also being sustainable in its use. Each stage was interconnected, starting from problem identification to evaluation, allowing a systematic transition from conventional to improved processing methods [11-12]. As presented in Table 1, the implementation began with problem identification through field observation and direct interviews with the partner. This stage aimed to understand the initial conditions, particularly the limitations in the manual styrofoam shredding process, which was inefficient and posed safety risks. The findings from this stage became the basis for determining the appropriate technological solution. The next stage involved the design and development of a styrofoam shredding machine tailored to the needs and operational capacity of the partner. The machine was designed with consideration for ease of use, safety, and suitability for small-scale industrial applications. Following this, socialization activities were conducted to increase awareness of proper waste management practices and the benefits of adopting appropriate technology. Training activities were then carried out to equip participants with the necessary skills to operate and maintain the machine safely. This stage emphasized hands-on practice and understanding of occupational health and safety procedures. Afterward, the machine was implemented directly in the partner's production process, accompanied by continuous assistance to ensure proper operation and adaptation. Finally, an evaluation stage was conducted to assess the effectiveness of the implemented program. The evaluation focused on improvements in processing efficiency, reduction in operational risks, and the overall usability of the technology. The results of this evaluation provided insight into the impact of the program and its potential for sustainable application within the community.

Figure 1. Preparation phase of the training with participants being introduced to styrofoam shredding machine

Results and Discussion.

A. Problem Identification

The problem identification stage was carried out through direct field observation and interviews with the MSME partner (UD. Tiga Putra). This stage aimed to obtain a clear understanding of the existing conditions related to styrofoam waste processing. The findings revealed that the shredding process was still conducted manually using simple cutting tools, resulting in low efficiency, inconsistent output size, and potential safety risks for workers.

Figure 2. Implementation of the Site Survey in the Community Service Program

The initial condition of styrofoam waste handling at the MSME partner is illustrated in Figure 2. The figure shows that the shredding and handling process was carried out manually using simple tools, with no standardized processing system in place. Large volumes of styrofoam waste were accumulated in the working area, indicating inefficient material handling and storage conditions. The manual processing method required significant physical effort and resulted in inconsistent output sizes. In addition, the absence of proper equipment increased the risk of workplace accidents due to direct contact with cutting tools. The unorganized arrangement of styrofoam waste also contributed to limited workspace efficiency and reduced productivity [13-14]. These conditions highlight the urgent need for the implementation of appropriate technology to improve the efficiency, safety, and overall effectiveness of styrofoam waste management. Therefore, the introduction of a styrofoam shredding machine was proposed as a practical solution to address these challenges and support more systematic processing activities. The manual method also required significant physical effort and increased the risk of injury due to direct contact with sharp tools. In addition, the bulky nature of styrofoam created difficulties in storage and handling. These conditions confirmed the need for an appropriate technological solution to improve productivity, safety, and waste management efficiency.

B. Design and Development of the Styrofoam Shredding Machine

Based on the identified problems, an appropriate technology in the form of a styrofoam shredding machine was designed and developed. The machine was specifically tailored to meet the operational needs of the partner, with emphasis on simplicity, safety, and ease of use. The shredding machine consists of several main components, including a feeding hopper, rotating cutting blades, a driving motor, and a supporting frame. The mechanical shredding system enables the reduction of styrofoam into smaller and more uniform particles, which significantly improves material handling efficiency. The development of this machine provided a practical alternative to replace the conventional manual process.

C. Socialization Activity

The socialization activity was conducted to introduce the objectives of the community service program and to increase awareness of proper styrofoam waste management. During this stage, participants were informed about the environmental impact of styrofoam waste and the importance of adopting appropriate technology in improving waste processing efficiency. This activity also served as an initial step to encourage community participation and acceptance of the introduced technology. The interactive discussion allowed participants to better understand the benefits of the shredding machine and its role in supporting more sustainable waste management practices.

Figure 3. Socialization Activity of the UWP Team with Partner UD Tiga Putra

The condition of styrofoam waste handling activities at the MSME partner is illustrated in Figure 3. The figure shows that the processing activities were carried out in a semi-manual manner, involving several workers engaged in sorting, cutting, and handling styrofoam waste. The presence of multiple workers indicates that the process relied heavily on manual labor, which required significant physical effort and coordination among workers. As shown in the figure, the styrofoam waste was processed using simple tools, and the resulting pieces were irregular in size. This condition reflects the lack of a standardized processing system, which affects both productivity and output consistency. In addition, the accumulation of styrofoam waste in large volumes suggests inefficient material handling and storage practices. The involvement of several workers in different tasks, such as cutting, collecting, and arranging styrofoam, also highlights the labor-intensive nature of the process. This not only increases the workload but also exposes workers to potential safety risks, particularly due to direct contact with cutting tools and scattered waste materials in the working area. These findings confirm that the existing system was not optimal in terms of efficiency, safety, and organization. Therefore, the introduction of an appropriate technology, namely a styrofoam shredding machine, was considered necessary to improve processing performance, reduce manual workload, and enhance workplace safety. The transition from manual to mechanical processing is expected to create a more efficient, consistent, and safer working environment for the MSME partner.

D. Training and Implementation of the Shredding Machine

The training and implementation stage involved direct demonstration and hands-on practice in operating the styrofoam shredding machine, as illustrated in Figure 3. Participants were guided through the operational procedures, including material feeding, machine operation, and output handling. The results showed that the shredding machine was able to effectively reduce the size of styrofoam waste into smaller and more manageable particles. Compared to the previous manual method, the use of the machine significantly improved processing efficiency and reduced the time required for shredding activities. In addition, the enclosed cutting system improved safety by minimizing direct contact with cutting components. The hands-on training approach enabled participants to actively engage with the machine, improving their technical understanding and operational skills. As a result, participants were able to operate the machine independently after the training session.

Figure 4. Training and mentoring on the operation of the appropriate technology styrofoam shredding machine

The implementation of the styrofoam shredding machine training is illustrated in Figure 4, which shows a series of hands-on activities involving the instructor and participants during the operation of the machine. The training was conducted in a real working environment, allowing participants to directly observe and engage in the shredding process. Several participants were actively involved in different stages, including feeding styrofoam into the machine, observing the shredding mechanism, and collecting the output material. As shown in the figure, the shredding machine operated effectively in converting bulky styrofoam waste into smaller and more uniform particles. The output collected in the container indicates that the machine was capable of continuous operation with stable performance. Compared to the previous manual method, the use of the machine significantly reduced processing time and improved output consistency. The involvement of multiple participants during the training also demonstrates a collaborative learning process. Participants closely observed the machine operation and actively interacted with the instructor, which enhanced their understanding of both technical procedures and safety aspects. The structured guidance provided during the training ensured that participants were able to follow proper operational steps, including safe material feeding and maintaining appropriate distance from moving components [15-17]. In addition, the presence of documentation activities, such as note-taking during the training, indicates an increased level of participant engagement and knowledge absorption. This suggests that the training approach was effective in transferring both practical skills and conceptual understanding. Overall, the training activity not only improved participants' technical competence in operating the styrofoam shredding machine but also increased their awareness of safe working practices. The successful demonstration and direct practice contributed to the readiness of participants to adopt the technology in their daily operations, thereby supporting more efficient and sustainable styrofoam waste management at the MSME.

E. Implementation and Assistance

Following the training stage, the shredding machine was directly implemented in the partner's production activities with continuous assistance from the PKM team. This stage ensured that the

technology was used correctly and consistently in daily operations. The assistance process helped the partner adapt to the new system and overcome initial technical challenges. The transition from manual to mechanical processing resulted in more consistent output, reduced physical workload, and improved overall productivity. Furthermore, the mentoring approach increased user confidence and strengthened the sustainability of technology adoption.

F. Evaluation of Program Implementation

The evaluation stage was conducted to assess the effectiveness of the implemented program. This process involved direct observation, discussions with participants, and comparison of conditions before and after the intervention. The results indicated improvements in several aspects, including processing efficiency, work safety, and waste handling practices. The reduction in styrofoam volume significantly facilitated storage and transportation, while the improved safety conditions reduced the risk of work-related accidents. Overall, the evaluation confirmed that the application of the styrofoam shredding machine, combined with training and assistance, successfully enhanced the operational capacity of the MSME partner. The program also demonstrated the effectiveness of integrating appropriate technology with community empowerment in supporting sustainable waste management practices.

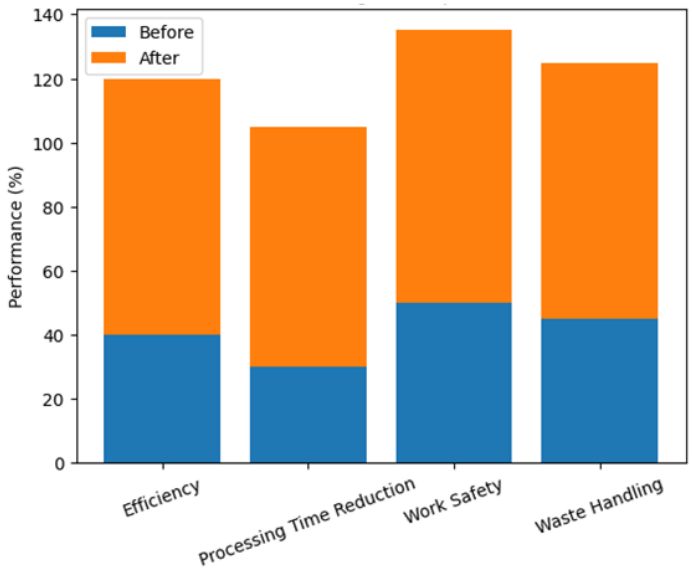

Figure 5. Evaluation of Program Implementation

The evaluation stage was conducted to assess the effectiveness of the implemented styrofoam shredding machine in improving operational performance at the MSME partner. The evaluation results are presented in Figure 5, which compares the conditions before and after the implementation of the program. As shown in the figure, there was a significant improvement in all evaluated aspects. Processing efficiency increased substantially after the introduction of the shredding machine, indicating a more effective and structured workflow. In addition, the reduction in processing time reflects the advantage of mechanical processing compared to the previous manual method. Work safety also showed a notable improvement, as the use of the machine minimized direct contact with cutting tools and reduced the risk of injury. Furthermore, waste handling became more efficient due to the reduction in styrofoam volume, making storage and transportation more manageable. Overall, the evaluation results demonstrate that the implementation of the styrofoam shredding machine has successfully improved productivity, safety, and waste management practices. The integration of appropriate technology with training and assistance proved to be effective in enhancing the operational capacity of the MSME partner.

Conclusion.

The community service program involving the implementation of a styrofoam shredding machine has been successfully carried out and demonstrated significant improvements in the operational performance of the MSME partner. The introduction of appropriate technology effectively addressed the limitations of the previous manual processing method, which was inefficient, labor-intensive, and posed safety risks. The application of the shredding machine enabled a more efficient and consistent processing of styrofoam waste, resulting in reduced processing time and improved output quality. In addition, the machine contributed to enhanced occupational safety by minimizing direct contact with cutting tools and providing a more controlled working environment. The training and assistance activities played a crucial role in ensuring the successful adoption of the technology. Through hands-on practice and continuous mentoring, participants were able to operate the machine independently and apply proper safety procedures. This indicates that the integration of technology with participatory learning approaches is effective in supporting sustainable implementation at the community level.

Furthermore, the reduction in styrofoam volume achieved through the shredding process improved waste handling, storage, and potential recycling opportunities. Overall, the program has demonstrated that the use of appropriate technology can significantly enhance productivity, safety, and environmental management in small-scale industries.

Future programs are recommended to focus on scaling up the technology implementation and integrating further processing methods to increase the economic value of styrofoam waste, thereby supporting long-term sustainability and community empowerment.

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