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Empowering the Community with Briquette Fuel: Utilizing Palm and Sago Waste

Jusuf Haurissa[1*], Gratia Deodata Haruina Dwi Puspita[2] , Mathina Mini [1], Kemuel Silak[1], Jefri Wayne[1], George Lekatompessy[1]
[1]Department of Mechanical Engineering, Universitas Sains dan Teknologi Jayapura, Jl. Raya Sentani Padang Bulan, Jayapura, 99351, Indonesia
[2]Department of Accounting, Universitas Sains dan Teknologi Jayapura, Jl. Raya Sentani Padang Bulan, Jayapura, 99351, Indonesia

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Abstract

In Suskun Village, waste from palm oil and sago pulp is abundant. This waste is not only an environmental issue but also a challenge for the local community in terms of management. This community service program aims to train the community in producing briquettes as an environmentally friendly alternative fuel from these waste materials. Additionally, the program seeks to teach the community how to calculate the selling price of briquettes, enabling them to achieve economic independence in running their briquette business. The methods used in this program include: a) Socialization on briquette production from palm oil and sago pulp waste, b) Training on briquette-making through practical workshops, c) Implementation of technology by the community, d) Assistance and evaluation of the briquette production process, e) Sustainability of the program as a briquette business for the Suskun Village community, and f) Active community participation in all program stages. Throughout the activity, mentoring and evaluation of production outcomes were conducted to ensure the sustainability of the briquette business, allowing it to grow into a viable enterprise for the community. This program has yielded positive results, as the community can now independently produce briquettes from palm oil and sago pulp waste. This initiative creates economic opportunities and helps reduce waste in Suskun Village.

*Corresponding Author

Jusuf Haurissa
E-mail: jhaurissa@yahoo.com1

INTRODUCTION

Biomass waste, such as sago pulp, palm oil mill residues, straw, and other plant residues, is a byproduct of agricultural and industrial activities that continues to increase in volume as raw material production rises. In many areas, this biomass waste is considered to have little economic value, often being discarded or burned.

Suskun Village is located near the PT. Tandan Sawita Papua Palm Oil Mill manages approximately 18,000 hectares of oil palm plantations and 10,000 hectares of sago palm forests. The processing of oil palm fruit in the factory and sago in the production houses generates significant waste, including palm oil mill residues (Fig. 1) and sago pulp from sago trees (Fig. 2).

When these waste materials are not properly managed, environmental issues arise, such as air pollution from burning and land and water contamination due to waste accumulation. Additionally, neglecting the potential of biomass waste means missing an opportunity to create an environmentally friendly alternative energy source (Musabbikhah *et al*., 2015).

With proper processing, however, biomass waste can be transformed into high-value economic products, such as briquettes, which can be used as a renewable energy source for communities (Oyejide *et al*., 2023; Sa'diyah & Baga, 2017; Wicaksono & Nurhatika, 2019). The processing of oil palm fruit in the factory and sago in traditional production houses generates waste in the form of palm oil mill residues (Fig. 1) and sago pulp from traditional sago tree processing (Fig. 2). This explanation highlights that Suskun Village has abundant natural resources that can be utilized as valuable assets.

Unfortunately, the local community is still unaware of how to manage this waste to gain

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optimal benefits. Waste is often discarded into rivers or simply left unattended, leading to environmental pollution. When discussing waste, the community perceives it as unimportant, including palm oil residues, sago pulp, and sawdust waste. However, with the right innovations, this waste can be transformed into briquettes that hold economic value (Haurissa et al., 2021, 2023). Beyond addressing environmental pollution, the rising cost of fuel, particularly kerosene, has become a major concern. The imbalance between the continuously increasing energy consumption and the limited availability of non-renewable energy sources is also a serious issue.

Fig. 1. Palm oil waste

Fig. 2. Sago pulp waste

The Community Partnership Program (PKM) offers a solution by converting palm oil mill waste and sago pulp waste into briquettes with economic value (Hendra *et al*., 2015). Producing briquettes from palm oil residues and sago pulp waste can help reduce environmental pollution and lower household expenses on fuel purchases (Haurissa *et al.*, 2021; Primastiyaningayu *et al*., 2024). Moreover, in the future, briquettes can serve as a business opportunity to improve the local economy in Suskun Village. Based on discussions with the community regarding priority issues, it was collectively agreed that palm oil mill waste and sago pulp are major contributors to environmental pollution. However, instead of being a problem, this waste can be transformed into a valuable resource, leading to the decision to convert it into briquettes. Briquettes are one of the renewable energy sources that can help the community overcome fuel shortages and rising fuel prices. Providing an alternative energy source that is renewable, abundant, and affordable makes it accessible to the wider community (Denitasari *et al*., 2011; Haurissa *et al*., 2018).

MATERIALS AND METHODS

Materials and Methods contain the main materials used in service activities and problem-solving methods, including analysis.

Materials

Materials Used in the Community Service Program:

1. Sago Pulp
2. Palm Oil Mill Residue
3. Tapioca Flour as a binder
4. Hot Water

Equipment Used in the Community Service Program:

1. Box-shaped Briquette Molding Tool
2. Tube-shaped Briquette Molding Tool (Honeycomb)
3. Multi-function Machine (Charcoal grinder and mixer for charcoal + binder + hot water).
4. Sieve (100 mesh size).

Methods

In implementing the community service program, the Participatory Action Research (PAR) method is used as a real-action-based approach to drive social change. This method positions the community or target group as the main actors actively participating in every stage, from identifying problems to implementing collaboratively designed solutions.

1. Problem and Needs Identification
   a. The community or target group plays a direct role in identifying the issues they face.
   b. The identification process is conducted participatively through interviews, focus group discussions, and field observations.
   c. The main issue identified is sago pulp waste and palm oil mill residue, which can be utilized as an alternative fuel source.
2. Community Service Program Planning
   a. The community service program is developed by involving village officials to ensure local participation and support.
   b. Awareness campaigns on the utilization of sago pulp waste and palm oil mill residue as an

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alternative fuel source in the form of briquettes.

c. Introduction to briquettes' economic value and market potential as a sellable product.
d. Implementation of briquette-making practices, covering the preparation of raw materials, molding, and drying processes.
e. Testing the use of briquettes in cooking activities to evaluate their effectiveness as an alternative energy source.

3. Implementation of the Community Service Program

The stages of the Community Service Program activities are as follows:

a. Awareness campaign on briquette production from palm oil mill residue and sago pulp waste.

This program is a highly positive initiative in addressing the issue of palm oil mill residue and sago pulp waste in Suskun Village. Through this program, the community is educated about the potential of these waste materials, which can be transformed into briquettes with high economic value.

Additionally, training sessions are conducted for the community on briquette production, including honeycomb briquettes, enabling them to maximize the use of waste materials. Beyond waste management, this program also encourages the community to consider briquette production as a business opportunity, creating avenues for income generation (Prijanto & Prasetyanto, 2020). Thus, this program not only provides a solution to the waste problem but also economically empowers the local community through creative waste utilization (Bismala, 2017).

b. Briquette-Making Training (Practical Session)

The practical briquette-making process using palm oil mill residue and sago pulp waste is a concrete step in implementing solutions to the waste problem in Suskun Village. This process begins with collecting palm oil mill residue and sago pulp waste, followed by several stages, including drying, roasting, charcoal grinding, mixing charcoal with a binder, briquette molding, and briquette drying. Subsequently, the briquettes are tested in cooking activities to assess their effectiveness. Over a period of approximately three months, the community will actively participate in this practice, allowing them to directly understand each stage of the briquette-making process and providing them with opportunities to test and evaluate the results. Through this briquette-making practice, it is expected that the community will acquire new skills and experience direct benefits from utilizing waste for economic and environmental purposes.

4. Implementation of Technology by the Community

At this stage, the community itself utilizes the briquette molding machine technology.

a. Blending Machine (Mixing Machine) (Multi-Function Machine).

This machine mixes basic briquette ingredients, including charcoal powder (from palm oil mill residue and sago pulp), tapioca flour, and hot water (100°C) until evenly blended. This process ensures that all materials are thoroughly mixed, making the briquette mixture uniform and producing high-quality briquettes.

By using the blending machine, the time and effort required for manual mixing can be significantly reduced. This is especially beneficial for large-scale briquette production or in the briquette industry.

The use of a briquette blending machine ensures that each batch of mixture maintains consistent quality. This is crucial to guarantee that the produced briquettes are always uniform and meet the desired standards.

b. Hydraulic System Briquette Molding Machine (Tube Model)

The tube-model briquette molding machine features 14 holes, with a briquette diameter of 20 cm, a briquette tube height of 11 cm, and a compression pressure of 120 kg/cm². This machine ensures that the produced briquettes are highly dense and durable (Novalinda & Fernianti, 2022; Nugraha *et al*., 2017).

The holes in the briquettes allow for optimal airflow circulation during combustion, improving burning efficiency and producing a stable and even flame. Tube-shaped briquettes are more suitable for cooking large quantities of food, as they have a burning duration of approximately 3 hours and 30 minutes.

c. Box-Shaped Briquette Mold

The box-shaped briquette mold has sizes of 2 cm and 3 cm with a briquetting pressure of 120 kg/cm², playing a crucial role in the briquette production process. Box-shaped briquettes are designed for cooking smaller portions, such as grilling satay or fish.

d. Briquette Charcoal Sieve

The briquette charcoal sieve used in the production process has a 100-mesh size, serving several important functions, especially in obtaining the finest charcoal particles. The 100-mesh sieve has very small openings, allowing only ultra-fine charcoal particles to pass through. Sieving with a 100-mesh sieve ensures that the particle size remains uniform, which is crucial for maintaining consistency in briquette production.

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e. Assistance and Evaluation of Briquette Production Implementation
This section includes the chronology of community service activities, covering the activity design, procedures, instruments, and analytical techniques used to address the identified issues.
Additionally, the description of the implementation process of the community service activities should be supported by references to ensure that the explanation is scientifically valid and acceptable.

4. Assistance and Evaluation of Briquette Production Implementation
Ongoing assistance and evaluation are provided throughout the briquette-making training and even after completing the PKM program. The purpose of assistance and evaluation is to ensure that participants effectively acquire the necessary skills and knowledge.
The first step in evaluating the PKM program involves a comprehensive assessment of each stage, including awareness campaigns, training, practical briquette production, and business opportunity discussions (Bismala, 2017). This includes identifying achievements and the challenges and obstacles encountered during program implementation.
5. Sustainability of the Program as a Briquette Business for the Suskun Village Community.
Ensuring the program's sustainability in the field after the activities have been completed is a crucial step in achieving the program's objectives and maintaining its long-term impact. Raising awareness about the opportunity to develop briquette production as a business for the community in Suskun Village is a significant effort to empower the local economy.
Through this initiative, information is provided to the community regarding the economic potential of producing briquettes from palm oil mill residue and sago pulp waste. The community is educated about the prospects of the briquette business, including production processes, marketing strategies, and business management.
The goal of this awareness campaign is to encourage active community participation in creatively utilizing waste as an additional source of income. This initiative is expected to motivate the community to start their own briquette businesses, create local employment opportunities, and ultimately enhance economic well-being in Suskun Village.
6. Community Participation in Program Implementation
The community's participation in the PKM program includes preparing the venue for the briquette-making training activities. The community provides locations for the training sessions, such as the traditional hall or vacant land suitable for the activities. Additionally, they provide facilities such as tables, chairs, electricity, and sanitation to ensure the comfort of the training participants. The community also contributes by supplying raw materials and other necessary resources for the program.

Here is the framework for problem-solving solutions faced by the community of Suskun Village, Keerom Regency (Table 1).

Table 1. Solution of dedication

Problem	Solution	Output
The main issue prioritized in discussions with partners is the utilization of palm oil waste and sago residue as raw materials for briquette production.	The Community Partnership Program (PKM) offers an innovative solution by transforming palm oil residue and sago waste into briquettes as an alternative to fuel oil.	The community has successfully produced box-shaped and cylindrical (honeycomb) briquettes using sago residue and palm oil waste.
The community still faces challenges in developing its economy.	Partners are taught to analyze the economic value of briquettes and develop them as a business opportunity.	Document on Briquette Economic Value Calculation.

RESULTS AND DISCUSSION

The results of the community service activities in Suskun Village included assistance and training in briquette production from sago pulp waste and palm oil mill residue.

Awareness Campaign on Briquette Production from Palm Oil Mill Waste and Sago Pulp Waste

The awareness campaign was conducted to educate the community on how to utilize palm oil mill residue and sago pulp waste to produce briquettes as an alternative to kerosene. Two awareness sessions were held: First Session – was "Briquette Production from Palm Oil Mill Residue and Sago Pulp Waste". This session, titled "Utilizing Waste as Briquettes to Replace Kerosene," took place on October 12, 2024. Second Session – "The Economic Value of Briquettes from Palm Oil Mill Residue as a Business Opportunity". This session was conducted on October 17, 2024. Both sessions were held at the traditional hall of Suskun

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Village and were attended by 20 community members (Fig. 3, Fig. 4, and Fig. 5). The activities ran smoothly and were well received by the participants.

Fig. 3. Awareness campaign on briquette production

Fig. 4. Awareness campaign on the economic value of briquettes and business opportunities

Fig. 5. Suskun village community

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Assistance in Briquette-Making Training

The briquette-making training assistance began with the handover of briquette molding tools to the community (Fig. 6). After the handover of briquette molding tools, the briquette-making training was conducted in October 2024. The training covered the entire briquette production process, including charcoal production, grinding, sieving, and blending with a binder.

Fig. 6. The signing of the official report and handover of briquette molding equipment

The first step in briquette production is carbonising palm oil mill residue and sago pulp waste into charcoal (Fig. 7). The waste is burned in a drum with limited airflow to prevent complete combustion, ensuring that it produces charcoal with a high carbon content. After the charcoal is formed, the next step is grinding the charcoal using a machine to achieve smaller and uniform particles (Fig. 8). This process is essential to ensure that the briquettes produced have a dense texture and are easily combustible. The charcoal grinding is carried out using a multi-function machine.

Fig, 7. Carbonization of palm oil mill residue and sago pulp waste

Fig. 8. Charcoal grinding

The ground charcoal is then sieved to ensure uniform particle size (Fig. 9). Larger charcoal pieces are separated during this stage and can be crushed again until they reach the desired size. Sieving helps produce higher-quality briquettes with even combustion. Next, 1 kg of charcoal is mixed with 200 grams of tapioca flour (binder) and 800 ml of hot

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water (Fig. 10). The binder functions to bind the charcoal particles, ensuring that the briquettes form a solid structure. The ratio of these ingredients must be precise to produce briquettes with good strength without being too brittle.

Fig. 9. Charcoal sifting

Fig. 10. Mixing charcoal, tapioca (binder), and hot water

After the ingredients are mixed, the blending process or further mixing is carried out to ensure that all charcoal particles, binder, and hot water are thoroughly and evenly combined (Fig. 11). The blending process uses a charcoal grinding machine, which also functions as a mixing machine, to achieve a uniform consistency throughout the mixture.

Figure 11. Further mixing (blending)

The briquette-making training was successfully conducted, covering all stages from drying raw materials (sago pulp and palm oil mill residue), carbonization (charcoal production), mixing, molding, and drying the briquettes under sunlight (Fig. 12, and Fig. 13). After the sun-drying process, the next step was the practical use of box-shaped and tube-shaped briquettes for cooking. The heat generated from the combustion process was utilized by the community for cooking activities (Fig. 14).

(a) (b)

Fig.12. Briquette molding, (a). Tube-shaped briquette, (b). Box-shaped briquette

Fig. 13. Sun drying process

(a) (b)

Fig. 14. Practical use of briquettes for cooking, (a) Cooking using tube-shaped briquettes, (b) Cooking using box-shaped briquettes

The community showed great enthusiasm in participating in the briquette-making training, which included moulding square-shaped briquettes and practicing the production and use of honeycomb-shaped briquettes. Initially, none of the 25 group members had any skills in this field. However, 18 participants (approximately 72%) could produce briquettes independently after completing the training.

From an economic perspective, briquettes made from sago pulp and palm oil waste present a promising potential as a more affordable alternative energy source than kerosene, especially when supported by a steady supply of raw materials and

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an efficient production and distribution infrastructure. Moreover, using briquettes provides additional benefits in terms of environmental conservation and contributes to increasing local economic value (Baltrocchi *et al*., 2023).

The following are the changes resulting from the implementation of community activities for the Suskun Village community, Keerom Regency (Table 2). The community service program in South Sumatra has developed the utilization of palm oil waste into briquettes as an alternative fuel source (Lestari *et al*., 2022). Meanwhile, in Southwest Papua, briquettes made from sago pulp have been developed as an environmentally friendly alternative fuel solution (Abu *et al*., 2024). Innovation in the community service program in Suskun Village lies in using sago pulp and palm oil shell waste as raw materials, along with the development of briquettes in square shapes and honeycomb-shaped designs (source).

Table 2. Changes resulting from service activities

Initial Condition	Intervention	Condition Change
The community's knowledge of processing sago residue and oil palm fronds into briquettes is still limited.	Training and transferring briquette-making skills as an alternative to kerosene fuel to the Kampung Suskun, Keerom Regency, Papua Province community.	There has been an increase in knowledge and skills for the briquette business group in the village (20 people). The group has successfully produced briquettes and conducted a cooking trial using them.

The approach implemented includes training on briquette production and socialization in developing micro, small, and medium enterprises (MSMEs). As part of the sustainability plan, the program aims to establish a production house that will later be developed into a small business. The level of community participation in this program is considered high, with active involvement reaching 72%.

CONCLUSION

During implementing the Community Partnership Program (PKM) in Suskun Village, residents successfully transformed palm oil waste and sago pulp into fuel briquettes. This activity resulted in two types of briquettes, a dense square model and a cylindrical honeycomb model, which allows for better airflow and thus facilitates easier combustion. Out of a total of 25 group members, 18 individuals (72%) successfully mastered the briquette production technique independently after completing the training.

Despite these encouraging outcomes, challenges remain to be addressed, particularly concerning working comfort, as a proper production facility has yet to be established. Developing a dedicated production facility has become a primary focus of sustainability efforts. The availability of such a facility is expected to empower the community of Suskun Village to manage briquette production independently. This initiative presents an opportunity to create new jobs, increase community income, and simultaneously support environmental sustainability by reducing the open burning of sago and palm oil waste, which had previously gone unused. The use of briquettes provides additional benefits in terms of environmental conservation and promotes the enhancement of economic value at the local level.

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