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Enhancing Community Knowledge on Sawdust Waste Utilization through Particleboard Manufacturing

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ABSTRACT

Background: Sawdust is one of the most abundant by-products of wood utilization in rural communities near forest areas. In Manggang Village, West Kalimantan, sawdust waste is commonly piled up or burned, causing environmental problems. This community service activity aimed to introduce the utilization of sawdust waste as a raw material for particleboard production to increase its economic value and reduce environmental pollution.
Contribution: The activity promoted community awareness of sawdust waste utilization through the introduction of particleboard production as a value-added product.
Method: The community service activity was conducted in Manggang Village, Landak Regency, West Kalimantan. The implementation stages included planning, material preparation, demonstration of particleboard manufacturing, monitoring, and evaluation.
Results: Community understanding of environmental pollution caused by sawdust waste increased from 30% to 67%. Knowledge of particleboard manufacturing increased from 50% to 90%. Understanding of particleboard utilization as furniture increased from 43% to 100% and awareness of its economic potential increased from 50% to 100%. The results indicate that the activity successfully enhanced both environmental awareness and practical skills related to sawdust utilization.
Conclusion: The activity successfully improved community knowledge regarding sawdust waste utilization and particleboard manufacturing. The activity demonstrated that community education can support environmentally sustainable waste management while creating opportunities for value-added products in rural communities.

1. Introduction

Sawdust is a common byproduct of wood processing. The byproduct can be found in sawmills, furniture, building materials, and other community activities. The sawdust waste accounts for 12-15% of the sawmill industry's total production, accounting for 39.6 to 950.4 m3 per year [1]. The sawdust is typically landfilled, dumped into rivers, burned directly, or used as fuel in sawmills and other industries. It can harm the environment. Sawdust piles can decompose, sawdust dumped into rivers can pollute the water, and direct combustion can increase carbon emissions into the atmosphere [2]–[4]. Sawdust contains terpene, formaldehyde, fungi and their spores, and bacteria. The inhalable compounds can be allergenic, carcinogenic, and immunotoxin [5]. The sawdust can also impact human health, like respiratory symptoms [6]. Therefore, the utilization of sawdust needs to be optimized to help reduce the impact on the environment, including villages in forested areas.

Manggang is a village in the Mandor sub-district, Landak Regency, West Kalimantan, directly connected to a forest area. Communities surrounding the forest utilize forest resources to meet their daily needs [7]. Tree felling in the forest is usually done for raw materials for building houses and clearing agricultural land. The byproducts of tree felling include sawdust. Sawdust waste is generally burned, piled up, or dumped into rivers. It can increase carbon emissions and cause other environmental harm [8]. Proper waste management can benefit rural communities economically and reduce environmental impact. Particleboard production can help manage sawdust waste and can help the community and the environment [9]. Particleboard is a wood panel made from wood particles or other lignocellulosic materials bound with adhesive and pressed with a hot press for a specific period. Logging waste, such as wood, branches, and twigs, can be used as wood composite products [10]. Knowledge dissemination regarding particleboard production is necessary for village communities. Knowledge about particleboard manufacturing is expected to assist the community in waste management [11]. Wood waste processing must be accompanied by sufficient knowledge for the community to be economically profitable [12]. Furthermore, the community can develop innovations based on the knowledge provided in waste management.

Sawdust waste processing must be carried out optimally. Several studies have explored the utilization of sawdust for various purposes, including planting media [13], alternative fuel [14], [15], electrical energy production [16], [17], and artistic materials [18]. Another use of sawdust as an added value is as particleboard. Previous studies demonstrated that sawdust can be processed into particleboard with acceptable physical and mechanical properties and meets international standards [11], [19], [20]. Particleboard production has also utilized various types of hardwood and softwood waste from sawmills, indicating its potential as a value-added composite product [21]–[23]. Although previous studies have demonstrated the technical feasibility of producing particleboard from sawdust waste, most have focused on material development and product performance. Limited attention has been given to community education and the dissemination of particleboard manufacturing knowledge in rural communities surrounding forest areas.

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Community knowledge regarding sawdust management and particleboard production in Manggang Village remains limited. Previous community activities have rarely emphasized practical training on converting sawdust waste into economically valuable products. As a result, the environmental and economic potential of sawdust waste remains underutilized. Therefore, this community service activity aims to introduce particleboard manufacturing from sawdust waste as an effort to increase its economic value and reduce environmental pollution.

2. Method

The community service activity was carried out at the Multipurpose Building of Manggang Village, Mandor District, Landak Regency, West Kalimantan. The activity was attended by 33 participants, consisting of the Manggang Village community. The PKM activity was also attended by the Head of the Mandor District Sub-district and the Head of Manggang Village (Figure 1).

Figure 1. Opening of the community service by the Sub-district Head, Village Head, and Dean of the Faculty of Forestry in Manggang Village

The community service activity in Manggang village was conducted through four stages including planning, preparation of particleboard samples, implementation of educational and demonstrative activities, and evaluation. The evaluation stage included pre-test and post-test assessments to measure participants' understanding of the materials presented (Figure 2).

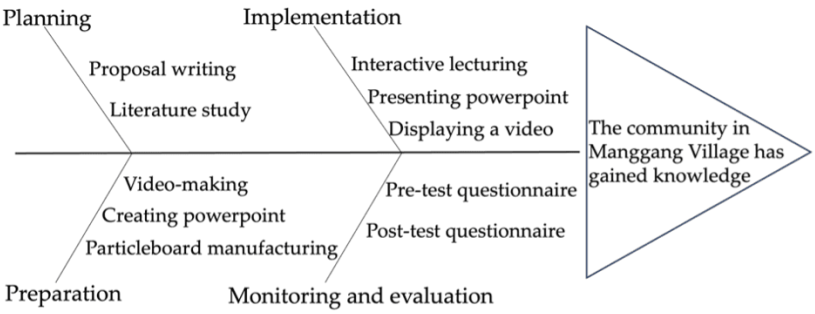

Figure 2. The flowchart of community service activity in Manggang Village

This community service activity employed educational and demonstrative approaches to enhance community knowledge regarding the utilization of sawdust waste into particleboard products. The educational approach was implemented through interactive lectures and discussions. The demonstrative approach involved presenting particleboard samples and videos of the manufacturing process. These approaches were selected because they enabled participants to understand both the theoretical and practical aspects of particleboard production. The technical process of particleboard preparation was conducted prior to community activity and served as demonstration material during implementation.

The planning stage was carried out by conducting an orientation and coordination an activity in Manggang Village regarding the utilization of sawdust waste, supported by a literature review related to sawdust utilization and particleboard production. The implementation stage consisted of PowerPoint-based presentations, interactive discussions, video screenings on particleboard manufacturing, and demonstrations of particleboard products prepared in the laboratory. Participants were introduced to the production process, potential applications, and economic benefits of particleboard products. This approach was expected to improve public awareness of sawdust waste management and encourage the development of value-added products while reducing environmental impacts.

2.1. The Sawdust particleboard manufacture

The particleboard stage was manufactured by preparing particleboards as examples of particleboard samples that will be shown to the community, as well as a video of particleboard making, so that the community can have a clear picture of the manufacturing process. The particleboard was manufactured in the Biomaterial Laboratory of the Faculty of Forestry, Universitas Tanjungpura.

The materials used were sawdust obtained from furniture or building supply stores and wood adhesive. The target particleboard density was 0.7 g/cm3, representing a medium-density particleboard for furniture applications. The sawdust was sieved through a mesh size of 8 and retained by 10. Next, the sawdust was oven-dried at 60°C ± 3°C until it reached a moisture content of ± 5% to improve adhesive bonding and reduce dimensional instability during pressing. The sawdust was mixed with adhesive, using a 10% adhesive ratio, which was considered sufficient to provide adequate bonding among particles. The mixture particle was stirred and poured into a 30 cm x 30 cm mold, where pre-pressurization was applied. The particleboard was then placed in a hot press. Pressing was carried out for 10 minutes at a temperature of 110 oC and specific pressure of 25 kg/cm2 [24]–[26]. The particleboard thickness was 1 cm. These conditions were selected to ensure proper adhesive curing and board consolidation. The finished particleboard was conditioned for 7 days. The particleboard manufacturing process can be seen in Figure 3.

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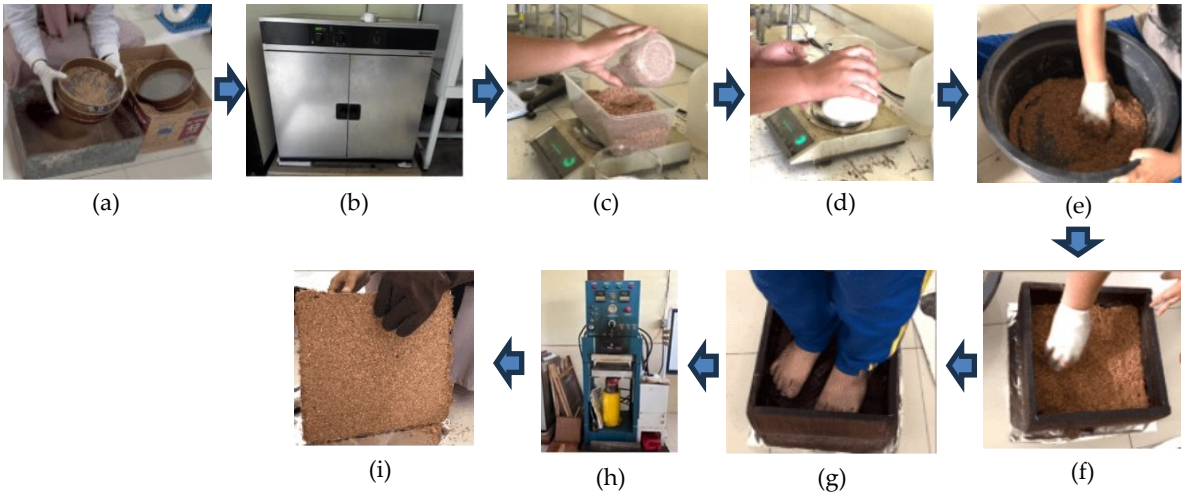

Figure 3. The particleboard manufacturing process (a) sawdust sieving, (b) sawdust oven-dried at 60oC until MC ⌾5%, (c) weighing sawdust, (d) Weighing UF adhesives and paraffin, (e) Mixing sawdust, adhesive, and paraffin, (f) Sawdust was place into a mold, (g) Pre-pressure application, (h) Hot-pressing at 120 oC for 10 minutes, (i) Sawdust particleboard.

2.2. Collecting and evaluating data on community service activities

Data collection was conducted through observation and assessment of participant engagement during the activity. Data from the activity will be presented descriptively and documented through images during the activity. The evaluation phase involved pre-test and post-test questionnaires administered before and after the activity to assess in participants understanding. The completion of the questionnaires served as an indicator of the success of the material delivery. Details of the questions in the questionnaire can be seen in Table 1. The collected information was evaluated using percentages to provide a more accurate picture of the distribution of each category in the questionnaire. These findings were utilized to form conclusions and make recommendations for enhancements or future development.

Table 1. List of evaluations activities

No	A list of questions
1.	Do you think sawdust can pollute the environment?
2.	Do you know about sawdust processing?
3.	Do you know the definition of particleboard?
4.	Do you know about particleboard manufacturing?
5.	Do you know about particleboard application?
6.	Do you know that particleboard can be made from agricultural and plantation waste such as rice husks, rice straw, and oil palm?
7.	Do you think particleboard can be made into furniture such as a table, a cupboard, a wardrobe, etc?
8.	Do you think that particleboard can be made into furniture, making it easier to sell to the general public?
9.	Do you think sawdust particleboard is an alternative to support the local economy?
10.	Do you think particleboard can be an effort to preserve forests?

3. Results and Discussion

Village communities have a tradition of processing their natural resources. Wood is obtained from forests for further processing to meet the timber needs. Generally, sawn timber is the result of this wood processing. A byproduct of this wood processing is sawdust waste. Sawdust waste is a solid byproduct of sawn timber cutting and sanding with a fineness of 80-180 mesh [27]. This waste is usually left to pile up or burned. Burning is one of the easiest ways to dispose of this waste. However, burning sawdust can have adverse effects on the environment. One negative impact of burning sawdust waste is air pollution due to the release of carbon into the atmosphere [28].

Proper utilization of sawdust waste can reduce waste volume, positively impact the environment, and provide added value to the community, especially from an economic perspective. Particleboard can be an alternative raw material for furniture or other applications to replace wood. Particleboard is a wood panel product made from sawdust waste bound with a specific adhesive under certain pressure, temperature, and time. Particleboard can be an alternative as a raw material for furniture or other applications to replace wood. The raw materials of different densities can produce particleboard with almost the same quality. This particleboard is recommended as a heat insulator, sound insulator, and furniture [29].

3.1. Empowerment community

During the socialization activity, introductory material on particleboard production was provided in the form of a lecture (Figure 4), a video of particleboard production was shown, and samples of finished sawdust particleboard were shown to the community. The material provided included knowledge about the negative impacts of sawdust on the environment, current sawdust processing, the definition of particleboard, the particleboard manufacturing process, the uses of particleboard, and other non-wood raw materials. These materials were provided to understand the role of village communities in protecting the surrounding environment and the forms of utilization that have been carried out on forest resources and their waste. The socialization has a vital goal to optimize the role of the community and government in preserving the environment [30]. It will also help maintain and protect the forests of the KHDTK area of Universitas Tanjungpura, not only by utilizing forest resources and planting trees but also utilizing the waste generated from their processing. The educational and demonstrative approaches used in this program facilitated participants understanding of particleboard production and its potential benefits. The combination of lectures, videos, and product demonstrations was considered effective in improving knowledge and increasing participants engagement during the activity [31].

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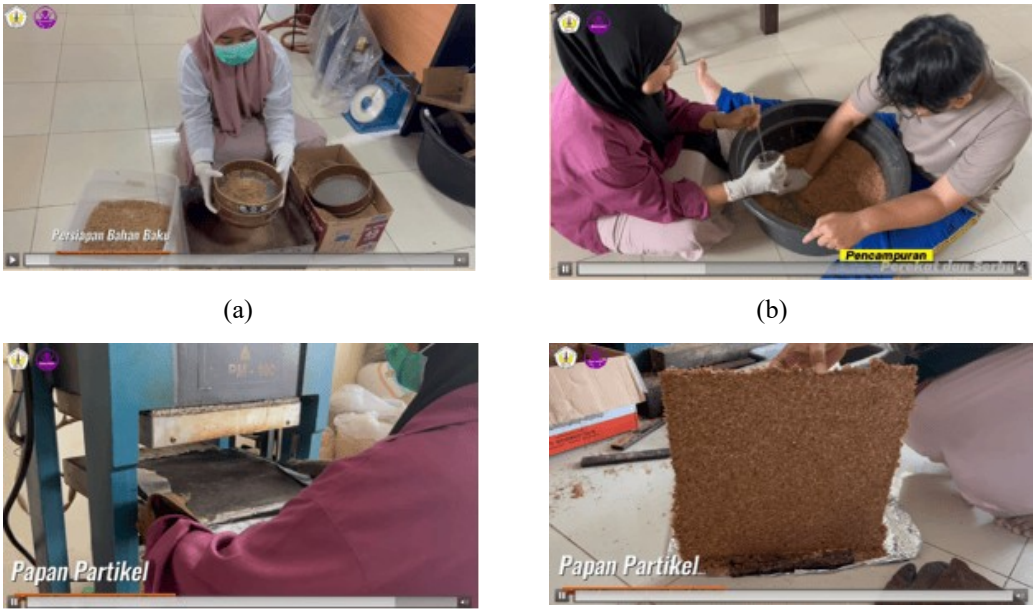
(a) (b)

Figure 4. Providing material in the form of a lecture with PowerPoint (a), and particleboard samples are shown to the participants (b).



(a) (b)

(c) (d)

Figure 5. Video clip of the particleboard manufacturing process from raw material preparation (a), mixing sawdust and adhesive (b), pressing the board (c), and the finished particleboard.

The knowledge regarding the particleboard manufacturing process is crucial. It allows the community to understand the stages of particleboard manufacturing. Videos showing the stages of particleboard manufacturing can provide a concrete picture. Several video clips of particleboard production can be seen in Figure 5. Although villagers cannot produce particle board locally directly due to limited equipment, such as hot presses, they can collaborate with those with the equipment, such as raw materials suppliers. Particleboard manufacturing technology continues to be developed, especially without the use of hot presses, so that villagers can implement it and become an additional source of income for the community.

3.2. Monitoring and evaluation of socialization

The socialization activity regarding the introduction of particleboard production from sawdust waste was complemented by monitoring and evaluation. The participants'

monitoring and evaluation were conducted through a questionnaire. Participants' understanding regarding the introduction of particleboard production from sawdust waste showed an increase after the material was provided. The questionnaire results can be seen in Figure 6. The pre-test results indicate that environmental pollution caused by sawdust, sawdust processing, and the definition of particleboard are still poorly understood by the village community. However, the understanding that particleboard can be made into furniture has a percentage of 75%. It is in line with the community's awareness that the presence of sawdust processed into particleboard is relatively high and can improve the community's economy. The questionnaire results show a community awareness percentage of more than 80%. Community awareness regarding the use of sawdust as a raw material for particleboard is an effort to conserve forests.

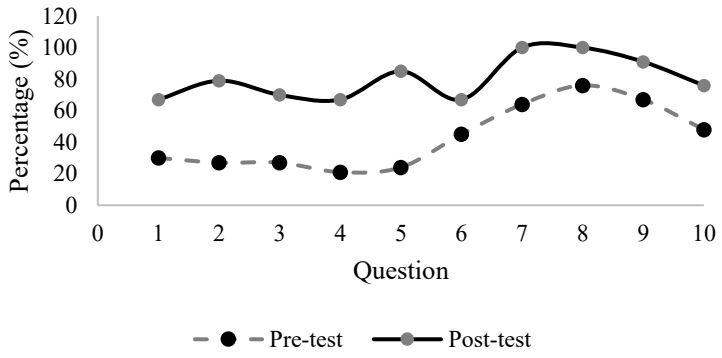


Figure 6. Evaluation results in the form of pre-test and post-test questionnaires for particleboard introduction

The socialization of particleboard manufacturing has positively impact on the village community (Figure 7). This result can be seen from the post-test, which showed that sawdust can pollute the environment. This increase increased by 67%. It can be an input that indicates the awareness of the Manggang Village community in protecting the environment. This finding indicates that the educational and demonstration activities effectively increased participant awareness regarding the environmental impacts of improper sawdust disposal. The environment can be maintained through the efforts of many parties, including the villagers who live around the village [32]. The improved post-test results suggest that the socialization activities were effective in increasing community awareness of sawdust waste management and its potential economic value. In addition, the village community is expected to develop creativity in utilizing raw materials other than sawdust for particleboard. Particleboard can be made from rice straw, banana stems, oil palm trunks, oil palm fronds, and other agricultural waste [33]–[35].

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Figure 7. Socialization activities for the community of Manggang Village, Mandor District, Landak Regency

Participants gained knowledge about the definition of particleboard, the particleboard manufacturing process, and particleboard applications. In addition, the community also realized that particleboard that has been processed into products can support the local economy. It can be seen from the questionnaire results which increased from 50% to 90%. In addition, knowledge of particleboard as furniture has risen from 43% to 100%. The improvement indicates that the educational and demonstrative approaches were effective in increasing participants' understanding [36]. Particleboard processed into furniture can be more easily commercialized. This can be seen in the increase from 50% to 100%. Sawdust waste is easily obtained because people often utilize natural resources around them, which can be an alternative for the community in utilizing it to use their daily needs. In addition, the community can also process the particleboard into furniture, which can be an added value for the community, especially from an economic perspective. The sustainability of this program depends on continued stakeholder collaboration and follow-up training activities. In addition, locally available biomass resources provide opportunities for the further development of community-based particleboard products.

4. Conclusion

The community service activity successfully increased participants knowledge regarding the environmental impacts of sawdust waste and its utilization as a raw material for particleboard. Participants also recognized the potential economic value of converting sawdust into value-added products, such as furniture materials. These findings indicate that community education can improve awareness of waste utilization and support sustainable resource management. Future activities should focus on practical training and the development of appropriate technologies to enable community-based particleboard production and strengthen local economic opportunities.

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