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Recycled Wood from Organic Solid Waste: Innovation for Equitable and Sustainable Future

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Abstract

Forests as critical ecosystems dominated by trees, face significant threats from extensive logging for infrastructure, manufacturing, and furniture industries, leading to deforestation and associated natural disasters such as floods and landslides. To address this, innovative solutions are needed to reduce reliance on forest wood. This study introduces an eco-friendly approach by developing recycled wood from organic solid waste, aligning with Sustainable Development Goals (SDGs), particularly Goal 9 (Industry, Innovation, and Infrastructure). Using an experimental method, recycled wood was produced from materials such as eggshells, sawdust, and marble waste. The process involved cleaning, drying, and pulverizing eggshells into powder, followed by oven-drying at 110°C for 45 minutes to achieve a maximum moisture content of 4%. The powder was mixed with a 60:40 polymer matrix and waste powder, with additional fillers like wood powder and marble waste, and molded into composite materials. Mechanical tests (tensile, flexural, compressive, water absorption, and density) revealed that natural fibers, such as coconut husk, enhanced mechanical strength, though water absorption remained high. The composite's density (0.41–0.52 g/cm³) complied with SNI 03-2102-2006 standards for particleboard. This innovation not only mitigates deforestation but also fosters sustainable industry practices and economic opportunities through accessible technology, supporting equitable and sustainable development for future generations.

Keywords: *Recycled Wood, Organic Solid Waste, Polymer Composite, SDGs.*

1. INTRODUCTION

Forests are expanses of land that form ecosystems containing biological resources dominated by trees (Eka Rudiana et al. 2023). The availability of large numbers of trees has led to high demand for timber production in various sectors, including industry, education, and others. Abundant timber production generates a lot of waste, most of which is simply discarded and burned. This causes environmental pollution, both from the burning of waste and the accumulation of wood waste in landfills. This has prompted the processing of wood waste to reduce environmental pollution and the accumulation of wood waste in landfills. Wood waste is classified as organic solid waste. The abundance of solid waste in the environment has prompted actions to reduce organic solid waste. Organic solid waste, which is , is often found in the form of furniture industry waste, household waste, coconut husks, and others.

Large-scale timber production also causes various disasters due to deforestation. One of the impacts that has been experienced is mudslides mixed with gravel that occurred in the Campurdarat and Besuki sub-districts in the southern part of Tulungagung. (TribunMataram.com News, 2024). The deforested areas around the disaster sites have been converted into corn fields, so when heavy rains fall, there are no trees to help absorb the water. A disaster also occurred in Pabuaran District, Sukabumi Regency, where flash floods were also caused by deforestation in the area. The Minister of Environment explained that 65% of the forests in the disaster area were deforested (detik.com, 2024). Several of these natural disasters were one of the impacts of deforestation. This is proof that trees are an important part of life and their availability must always be ensured.

The main cause of deforestation is large-scale logging for specific purposes, such as industry, land conversion, and others. The abundance of forest resources has made trees a highly valuable commodity in industrial production. Businesses often exploit these trees for their wood and large roots, particularly in the furniture and construction sectors. Based on quarterly forestry data for 2023 (DKT2023), the amount of timber production in Indonesia reached 68.22 million cubic metres ($m3$) (Eka Rudiana, 2023). If large-scale timber production continues, it will lead to an increase in the number of deforested areas. Various disasters can be triggered if this problem is not addressed immediately. Therefore, a solution is needed to minimise the use of timber so that timber production figures decline. One of the efforts that can be made is to use processed timber in the form of composite boards.

Composite boards are an alternative that can be used as a substitute for wood sourced from forests. Composite boards are boards composed of several materials with different shapes or compositions that are not soluble with each other (M. Hasan et al., 2021). Composite boards are made by recycling solid waste found in the surrounding area. The large amount of solid waste makes the production of composite boards or recycled wood one of the solutions to reduce solid waste in the environment. Solid waste management can be carried out in several ways, such as reusing waste to make new useful items (reuse), reducing consumption of products that generate waste (reduce), storing waste in a landfill, and making compost using organic waste such as vegetables, leaves, and animal manure through a specific process. In addition, waste can also be processed effectively through recycling. Recycling is the processing of waste into new products that have added value and are functional (Salmawati & Adi Putra, 2024).

The process of recycling organic solid waste into recycled wood or composite boards is an innovation that can be carried out to reduce the production of forest wood while also reducing waste in the community. The process of making composite boards is carried out by mixing organic solid waste such as wood waste, eggshells, and coconut husks, which will then be processed and bound with polyvinyl acetate (PVAc). Polyvinyl acetate (PVAc) is a type of polymer with strong adhesive properties, compatibility with organic fillers, ease of use, low toxicity, resistance to microorganisms, and low compressive stress (Siska et al., 2023). Composite boards are made with This innovation is also in line with the Sustainable Development Goals (SDGs).

The SDGs themselves are a framework of sustainable development goals established by the member states of the United Nations. The Sustainable Development Goals (SDGs) cover 17 points that are targeted to be achieved by 2030. Based on the 17 points in the SDGs, the innovations developed support the SDGs in point 9. The innovations carried out support the success of SDG point 9, which covers infrastructure, industry, and innovation. In the context of infrastructure, recycled wood can be utilised for construction with strong yet lightweight materials. In the industrial process, recycled wood will enhance industrial productivity, which can also create new job opportunities for the community. Meanwhile, in the context of innovation, the production of recycled wood requires technology and processing methods that will drive innovation to make the processing more efficient.

The production of recycled wood also supports the principle of equitable development. This means that with recycled wood, which focuses on natural resource efficiency, future generations will still be able to enjoy good quality natural resources. Not only that, recycled wood utilises simple technology so that all communities have a fair opportunity to develop and benefit from its production. Thus, the production of recycled wood also supports the realisation of SDGs points 10 and 12. SDG point 10 contains the SDG goal of reducing inequality or disparity. The production of recycled wood using simple technology can be an economic solution for the lower-middle class to participate in collecting waste, processing it, and producing recycled wood, which can later improve the community's economy. Meanwhile, SDG Goal 12 focuses on sustainable consumption and production by processing waste into something of commercial value. Additionally, production that meets SNI standards can make the product a sustainable commercial alternative.

Thus, this innovation will be a solution to the problem of excessive use of timber from forests in various sectors as well as the problem of organic waste in the surrounding environment. (Argumentation of the advantages of experimental timber). This research was conducted based on various problems that have occurred and is expected to be a solution to these problems. The research, entitled Recycled Wood from Solid Organic Waste: Innovation for a Fair and Sustainable Future, presents an innovation that aims to strengthen natural resource management and support economic sustainability, while promoting social justice that can be sustainably passed on to future generations.

2. RESEARCH METHODOLOGY

2.1 Materials and Equipment

This study employs a range of equipment to facilitate the experimental process, including stainless steel molds with standard dimensions for composite fabrication, a digital balance for precise mass measurements, an oven with a temperature range of 0–250°C, scissors, and a small spatula for material preparation, and a 1000 mL basin. Additionally, a blender, mortar, sieves with mesh size of 120 for particle screening, a press, and a Universal Testing Machine (UTM) for mechanical testing are utilized. The materials include eggshells, marble waste powder, wood powder, and other organic waste as filler components alongside polyvinyl acetate (PVAc) as polymer matrix and stabilizers and gelling agents.

2.2 Experimental Procedure

The experimental procedure begins with the processing of organic waste. Eggshells are cleaned, sun-dried, and pulverized using a blender to produce a fine powder. The powder is sieved using mesh of 120 to achieve a uniform particle size distribution. The sieved powder is then dried in an oven at 110°C for 45 minutes to reduce the moisture content to a maximum of 4%. Subsequently, the powder is mixed with a PVAc (60% polymer, 40% waste powder) and stirred for 6 minutes. Additional fillers, such as wood or marble waste powder, are incorporated, followed by an additional 2 minutes of mixing. The mixture is molded and dried to form the composite material. Control samples are prepared with the same procedure without the fiber filler while stabilizers and gelling agents added to enhance the stability and mechanical properties of the composites. Characterization is conducted to evaluate mechanical strength and physical characteristics. The data are compared against reference standards like SNI 03-2105-2006 to assess performance and identify potential improvements.

2.3 Mechanical Testing

Mechanical testing was conducted using a Universal Testing Machine (UTM) after particleboard synthesis to evaluate structural integrity. Standardized tests, including tensile strength, bending strength, flexural properties, and compressive strength, were performed in accordance with SNI 03-2105-2006. Complementary physical characterizations, such as water absorption, thickness swelling, and density, were also assessed to ensure full compliance with the aforementioned standard. Prior to testing, all samples were conditioned to a solid phase. The moisture content of particleboard samples must not exceed 14%, and thickness swelling not surpassing 12%. Furthermore, the density of particleboard shall range between 0.40 and 0.90 g/cm³, as stipulated by SNI 03-2105-2006.

2.4 Data Analysis

Data from the characterization is analyzed to evaluate the mechanical properties of the material against reference standards. Conclusions are drawn based on the research objectives, with recommendations for future studies to enhance composite quality. This study aims to provide a foundation for developing sustainable materials from organic waste, aligning with zero-waste principles.

3. RESULTS AND DISCUSSION

This study focuses on the production and characterization of recycled wood from organic solid waste. We discuss how it is produced and then characterize its properties. The aim is to show how this innovation can support the Sustainable Development Goals (SDGs) and equitable development. Additionally, the data and its interpretation from the experiments will be discussed, then compared with similar research results on smaller composite dimensions, as well as compared with particleboard standards based on the American National Standard Particle Board (ANSI A208.1-1999) and the Indonesian National Standard for Particleboard (SNI 03-2105-2006).

3.1 The Process of Making Recycled Wood from Organic Solid Waste

The process of making recycled wood is quite simple and does not require expensive and hard-to-find tools and materials. We utilize organic solid waste around us and turn it into useful items. The steps of the experiment include the following.

a. Preparing Tools and Materials
The first step is to prepare the tools and materials, including

Table 1. Tools and Materials

Tools		**Material**
Stainless steel mold	Blender	Eggshells
Digital scale	Mortar	Marble waste powder
Oven	Sieve	Wood powder
Scissors	Pressing tool	Other organic waste
Small spatula	100 mL bowl	

b. Preparing Eggshell Powder and Wood Powder
The eggshells are dried in the sun until they are dry and clean. Next, the eggshells are blended into powder, then sieved using 80, 100, 120, and 180 mesh sieves to obtain a uniform particle size distribution. The powder was then dried in an oven at 110 °C for 45 minutes until the maximum moisture content reached 4%.

Picture 1. Wood Wate Powder

c. Mixing and Forming Composites
Eggshell powder is mixed with a polymer matrix (60% polymer, 40% waste powder) and stirred for 6 minutes. Additional fillers such as wood powder or marble waste are then added and stirred again for 2 minutes. The mixture is molded and dried to form a composite material.

Picture 2. Sample Top View

Picture 3. Sample Side View

d. Preparation of Control Samples
Control samples were prepared by adding stabilizers and gelling agents. For other samples, a combination of new fillers was used in the research variations.

e. Mechanical Testing
Mechanical testing was performed using a Universal Testing Machine. To perform this mechanical testing, the samples had to be shaped into small dumbbells. The length of each sample was standardized to facilitate data processing. In addition, the material had to be in a solid phase to perform this mechanical testing. The data obtained from this testing is in the form of a stress-strain curve. Using this curve, the Young's modulus of the synthesized composite can be calculated.

f. Material Characterization
Characterization was performed on all samples to test the strength, tensile strength, flexibility, water absorption, and density of the wood.

g. Evaluation and Conclusion
Characterization data was compared with reference standards to evaluate material performance and identify potential improvements. In addition, analysis was conducted with a focus on pre-established research objectives, and overall conclusions were drawn.

3.2 Characterization of Recycled Wood from Organic Solid Waste

Recycled wood derived from organic solid waste offers great potential as an alternative material, but its characteristics need to be thoroughly understood for optimal application. In this study, we will examine the effect of fiber addition on the physical properties of recycled wood, including how it affects water absorption and material density. This experiment is important for identifying methods to improve the quality of recycled wood so that it can be used more widely in various applications, while also contributing to the reduction of solid waste.

3.2.1 The Effect of Fiber Addition

To optimize the utilization of recycled wood waste from organic waste, experiments on the effect of adding fiber are very important. The addition of fiber is expected to improve the mechanical and physical properties of the material, thereby opening up opportunities for wider applications. The research data presented below will explain how variations in fiber type and proportion affect the main characteristics of recycled wood.

In this study, preliminary research was conducted before varying the size to obtain the best composite mixture. The size variation referred to is the size of organic waste in the form of eggshells, using a blender to obtain sizes of 80, 100, 120, and 180 mesh. Before the experiment using these variations, coconut fiber was added to the composite. The purpose of adding coconut fiber was to enhance the mechanical strength of the composite. From the samples obtained, fiber measurements were then conducted. The following data were obtained from the measurements.

Table 2. The Effect of Fiber Addition on Mechanical Strength

Sample Name	Test Direction	Maximum Load (N)		
		Tension	Flexure	Compression
Non Fiber	x	55,59	13,97	1109,8
	y	47,55	21,10	1455,34
Fiber	x	277,03	28,19	2928,78
	y	436,56	35,27	2100,98

Overall, the addition of fiber shows a very significant increase in material strength. In the tensile test, the “Fiber” sample showed an extraordinary increase in maximum load compared to the “Non-Fiber.” For example, in the x-direction, tensile strength increased nearly fivefold (from 55.59 N to 277.03 N), and in the y-direction, the increase was even more drastic, exceeding ninefold (from 47.55 N to 436.56 N). This aligns with composite theory, which states that fibers, especially those with high modulus and strength, are highly effective in withstanding tensile loads, serving as the primary elements bearing stress and preventing premature failure of the matrix.

Similarly, in the flexural test, the “Fiber” sample also showed a substantial increase in strength. The maximum load increased by approximately twofold in both the x-direction (from 13.97 N to 28.19 N) and the y-direction (from 21.10 N to 35.27 N). During flexural loading, the material experiences tensile and compressive stresses. The presence of fibers significantly aids in resisting the tensile stress occurring on one side of the material, thereby enhancing the composite's resistance to deformation and fracture when bent.

In compression tests, the addition of fibers also resulted in a significant increase in strength. The “Fiber” sample was able to withstand much higher loads, as seen in the x-direction (from 1109.8 N to 2928.78 N, an increase of over 2.5 times). A similar increase, though slightly less dramatic, was also observed in the y-direction (from 1455.34 N to 2100.98 N). Although fibers are most well-known for their tensile strength, they also contribute to compressive strength by preventing buckling in the matrix and providing internal support. These results are consistent with the theory that fibers help increase a material's load-bearing capacity under compression, although fiber-matrix interactions and fiber orientation become particularly important in this loading mode.

Overall, the experimental data strongly support the basic theory of composite materials: the addition of fibers effectively increases the tensile, flexural, and compressive strength of the material. The most drastic increase is seen in tensile strength, where the fibers act as the primary load-bearing element. The difference in strength between the x and y directions in fiber-reinforced composites also confirms the anisotropic characteristics of composites, enabling the design of materials with tailored mechanical properties for specific applications.

A study conducted by Okta Viano et al. (2025) showed that the addition of fibers, such as coconut and plastic fibers, to composite boards increased the elastic modulus, while a reduction in fiber content resulted in a lower modulus. Mechanical tests, such as tensile and flexural tests, ensure compliance with standards such as SNI 03-2105-2006 or ANSI A208.1-1999 (Viano et al., 2025).

3.2.2 Water Absorption and Thickness Swelling Tests

Water absorption testing was conducted by immersing composite specimens measuring 3 x 5 cm and 5 x 1 cm in 200 mL of water. The samples were immersed for 10 hours, then weighed, and the difference in mass and volume was calculated.

Picture 4. Water Absorption Testing Scheme

Table 3. Water Absorption Test Results

No.	Sample	Sample Description	W (t=0) (gram)	W (t)	WA (t)
1.	Sample A	10 hours, 100	53	81	52,83%
2.	Sample B	10 hours, 150	56	98	75%

From the data we obtained, the water absorption rate was quite high because the composite was made solely from organic materials, without the addition of plastic waste. Based on SNI 03-2105-2006, the moisture content of particle board must not exceed 14%. Data shows that particle boards made purely from organic materials have very highwater absorption (52.83% to 75%), far exceeding the maximum water content standard (14%) set for particle boards by SNI 03-2105-2006. There are several factors that cause this to happen, one of which is the hydrophilic nature of organic materials. Natural fibers, such as those found in wood waste or coconut fiber, are mostly composed of cellulose, hemicellulose, and lignin compounds. Cellulose and hemicellulose have many free hydroxyl (OH) groups on their surfaces. These OH groups are highly polar and have a high affinity for forming hydrogen bonds with water molecules (H_2O) (Musa & Onwualu, 2024).

Indrayanti et al. (2024) found that composites made from durian wood shavings and PVAc exhibit high water absorption due to the smaller particle size, requiring a greater number of particles for the same weight compared to larger particles. Therefore, in the next production run, it will be necessary to add varnish to the boards that will be made. Despite this shortcoming, the idea of producing recycled wood provides opportunities to reduce and recycle organic solid waste.

3.2.3 Density

The composite mass is the mass of the composite board produced, weighed using digital scales. The following is the density of the domestic waste-based polymer composite produced.

Table 4. Composites Density

No.	Sample	Sample Description	Mass (grams)	Volume (cm^3)	Density (g/cm^3)
1.	Sample A	2 hours, 100	100	367,5	0,41
2.	Sample B	2 hours, 150	150	367,5	0,52

Based on SNI 03-2105-2006, the density of particleboard ranges from 0.4 to 0.9 g/cm3. The composite boards you produced yielded density test results of 0.41 and 0.52 g/cm3, thus meeting the quality requirements for particleboard. In line with these results, a study conducted by Sari & Mora (2020) found that the density values ranged from 0.87 g/cm3 - 1.03 g/cm3. The lowest density value of particle board was found in the 70%:0% composition with a density value of 0.87 g/cm3, while the highest density value of particle board was found in the 0%:70% composition with a density value of 1.03 g/cm3. The test results show that adding cocoa shell particles increases the density value of the particle board produced, while adding wood powder particles decreases the density value until it reaches the value specified in SNI 03-2105-2006 (Sari & Mora, 2020).

From this study, we predict significant differences in characteristics between composite recycled wood and conventional plywood, although the exact properties will depend on the specific formulation and production process of the wood. Specifically, in terms of internal tensile strength, composite recycled wood shows lower values than plywood. The integrity of the bonds between waste particles may not be as strong as the bonds between layers of wood in plywood. This is important because internal tensile strength reflects the material's resistance to delamination or internal structural failure when pulled.

This study produced several aspects related to SDGs and equitable development. The composite density produced ranged from 0.41 to 0.52 g/cm3, which is classified as low to medium density particle board. This results in a material that is lightweight and easy to move, making it suitable for use as interior elements/furniture at a low cost. This will reduce dependence on tree felling and primary forests and promote the use of previously problematic organic solid waste, in line with the target of more sustainable industrial development.

3.3 Recycled Wood Becomes an Innovation in Sustainable Development Goals (SDGs) and Equitable Development

Wood waste is currently a serious environmental and economic problem. In the European Union alone, around 50 million cubic meters of wood waste are produced every year. Unfortunately, the potential for recycling wood waste is still low due to limitations in applications or sustainable recycling processes. Most wood waste can be processed through various methods such as heat, chemical, or mechanical treatment. However, challenges arise because many processed woods contain preservatives with organic and inorganic contaminants (Berger et al., 2020). Therefore, research is focusing on finding sustainable ways to recycle wood waste into useful materials.

Innovations in the use of recycled wood from organic solid waste have a significant impact on achieving Sustainable Development Goal (SDG) 9: Industry, Innovation, and Infrastructure. This utilization promotes the development of a more sustainable industry by transforming waste such as sawdust or wood scraps into new raw materials. This approach reduces reliance on primary forest logging, minimizes the environmental impact of deforestation, and adds value to materials previously considered waste. Manufacturing, construction, and furniture industries can access a more stable, environmentally friendly supply of raw materials, potentially reducing long-term production costs.

In addition, the use of recycled wood also sparks innovation in various sectors. The process of collecting, sorting, processing, and producing products from recycled wood requires the development of new technologies and methods. This includes innovations in waste processing machinery, more efficient wood composite manufacturing techniques, and product designs that maximize recycled materials. Such innovations not only enhance product efficiency and quality but also open up new business opportunities, create jobs, and drive research and development in the fields of circular economy and biotechnology. These innovations are crucial for building a resilient industry capable of adapting to future resource challenges.

In the context of infrastructure, recycled wood offers innovative and sustainable solutions. This material can be used for green infrastructure development, such as pedestrian bridges, decks, or urban landscape elements, which often require strong yet lightweight materials. Additionally, recycled wood-based products, such as particleboard or fiberboard, can be applied in the construction of affordable and environmentally friendly, sustainable housing. By integrating recycled materials into infrastructure projects, we not only reduce the carbon footprint of construction but also promote more efficient and resilient development. This aligns with SDG 9's target to build quality, reliable, sustainable, and resilient infrastructure, including regional and cross-border infrastructure, to support economic development and human well-being.

Furthermore, recycled wood innovation also supports the principle of equitable development. The utilization of wood waste can create new economic opportunities, particularly for local communities with limited access to resources. By developing affordable and accessible recycling technologies, communities can be empowered to transform waste into value-added products, such as particleboard, furniture, or construction materials. This not only reduces environmental issues but also enhances livelihoods and promotes inclusive economic growth.

Further development of recycling technologies, including effective processing methods to remove contaminants from treated wood, is essential to maximize the potential of wood waste. Research focused on innovative techniques, such as more efficient thermal, chemical, or mechanical processing, will be instrumental in creating a sustainable wood waste value chain. Thus, this research not only seeks solutions to waste problems but also contributes to creating a more sustainable and equitable future for all.

3.4 SWOT Analysis (Strengths, Weaknesses, Opportunities, and Threats)

In the process of implementing innovations in the utilization of organic solid waste into recycled wood, several analysis results were used as a reference for the sustainability of this innovation, as shown in the following table.

Table 5. SWOT Analysis

Analysis	**Explanation**
Strength	a. There is an abundance of organic waste raw materials (solid waste accounts for ± 60% of the total composition of waste in Indonesia). b. Wood recycling technology already exists. c. Wood waste management reduces deforestation and prevents waste burning. d. In line with SDG 9.
Weakness	a. Significant initial investment. b. Lack of public awareness. c. Unclear regulations on the utilization of wood waste.
Opportunity	a. Recycled products are valued for their eco-friendly qualities. b. Material innovations (such as new composites) and green building trends increase product competitiveness. c. Supports the creation of the United Nations Sustainable Development Goals (SDGs). d. Waste processing reduces waste management costs and opens up new economic opportunities through the waste value chain.
Treath	a. Lack of public education on the use of recycled wood. b. Fluctuating (seasonal) supply of organic waste and unintegrated supply chain.

4. CONCLUSIONS

The The process of making recycled wood starts with preparing tools such as moulds, ovens, blenders, sieves, and materials such as eggshells, marble powder, and wood powder. The eggshells are cleaned, dried, pulverised, and sieved to produce a uniform powder, then dried in an oven so that the moisture content in the powder is a maximum of 4%. The powder was mixed with PVAc polymer in a ratio of 60% polymer and 40% powder, and then additional filler, stirred until homogeneous, moulded, and dried. The control sample used a stabiliser and gelling agent, while the other samples used a combination of fillers. Tests were conducted with a Universal Testing Machine to obtain stress-strain data, then characterised for mechanical strength and material composition.

The mechanical strength characteristics of recycled wood are also influenced by the composition used. The addition of natural fibres, such as coconut fibre, was shown to significantly increase the mechanical strength of the composites. Test results show that samples with fibres have significantly higher tensile, flexural, and compressive strength than samples without fibres. Water absorption and density tests were then conducted as a form of feasibility test. Water absorption testing revealed that composites made from organic materials have a weakness in moisture resistance, with a water absorption rate of up to 75%. This suggests the need for the addition of varnish in the manufacture of subsequently recycled wood. Even so, the density of the composite met the SNI 03-2105-2006 standard with values between 0.41 and 0.52 g/cm³, indicating that the material has a density suitable for use as a particleboard.

Innovations in recycled wood production are ideas that support the achievement of Sustainable Development Goals (SDGs) 9: Industry, Innovation and Infrastructure. In the industrial sector, the use of recycled wood encourages the development of a more sustainable industry by turning waste into new raw materials. The manufacturing, construction, and furniture industries will obtain quality raw materials with efficient production costs. In the infrastructure sector, recycled wood will be a solution in development by offering strong and lightweight raw materials. The use of recycled wood supports new innovations such as waste processing machines, more efficient wood composite material manufacturing techniques, and product designs that maximize recycled materials. Recycled wood innovation also supports the principle of equitable development. The utilization of wood waste can create new economic opportunities, especially for local communities with limited access to resources. The use of recycled wood also ensures a fair and sustainable future, where reducing existing forest resources and simple recycled wood processing can be done by anyone, thereby creating new jobs as an economic solution. Therefore, recycled wood production is worth implementing in the community.

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