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Development of Clutch Design Using Waste Wood bark, Nuts and Coconut Fiber

Etwin Fibrianie Soeprapto[1], Maulita[2], Mika Patayang[3]*

Politeknik Negeri Samarinda, Indonesia

**Email: etwin@polnes.ac.id[1]*, maulita@polnes.ac.id [2] mikapatayang@polnes.ac.id [3]*

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ABSTRACT

Currently, we often encounter household waste and workshop waste, such as wood shavings, peanut shells and coconut fiber waste. Many studies have raised the topic of composite processing of each of them, but the potential of composite boards from a mixture of the three is not yet known. This study on the processing techniques for the combination of the three materials is needed so that the potential of the material can be explored more. The board was studied for its processing techniques using an experimental approach and qualitative methods. The form of the experiment in the form of physical and mechanical tests was carried out on the composite board, to then conduct further studies on the development of composite board products into women's fashion products in the form of bags through the preliminary design, development and finishing product methods. The results of this study were obtained composite materials of wood powder, peanut shell powder and coconut fiber having a board density of 0.8 gr/cm3 and MOR 2.06 kg/cm2, which means that the density of the particle board has a very low flexural strength and is not suitable for construction boards but can be used as a material for making women's clutches. With the Preliminary Design, Design Development, and Final Design methods for composite board materials, an elegant clutch design was produced by displaying the distinctiveness of Indonesian culture, Kalimantan motif tumpar embroidery.

INTRODUCTION

Wood waste from exploitation and industry has not been utilized optimally (A.D. laksono.,et.al, 2021). Yield is the percentage of output produced to the input processed, can be used to indicate the level of efficiency of wood utilization (M. Ilyas, I. Taskirawati, and A. Arif, 2021). One way to control negative environmental impacts and realize environmental sustainability is to utilize the waste in panel-based products (R. J. Ross, 2020) and composites (A.D. laksono.,et.al, 2021; D. Purwanto, 1999; I. M. Trisatya, D. R. and Sulistiningsih, 2019).

Composite is a material consisting of two or more components that are different both physically, in terms of properties, and in terms of structure when mixed together will form a mechanical bond (D. Laksono., et.al., 2020). The elements that make up composite products vary in size and shape, including fibers, particles, splinters, veneers, laminates or boards. Many new materials have been found to replace wood. Most of the materials found come from waste or defective wood. Sawdust is waste obtained from sawing wood using machines or manually (R. E. S. Purba., et al., 2018). Sawdust can be used as a substitute for a mixture of lightweight bricks (Puspa Ningrum., et.al., 2022) that are soundproof (R. E. S. Purba., et al., 2018), as a furniture material (R. Hermita, 2016), as an absorber of lead metal (F. Herista, 2018), as a home decoration craft (Magfirah.,et.al., 2020), and other products.

In addition to wood waste and sawdust which are widely studied as recycling materials, there is also coconut fiber which has many useful values. Coconut fiber waste has great potential to be used as a reinforcement for new materials in composites. Some of the advantages of using coconut fiber as a new material for

environmentally friendly natural composites and support the idea of using coconut fiber into products that have

high economic and technological value such as helmets (M. Amin and R. Samsudi, 2010), reinforcing fibers (S. Hidayat, 2021), bags (T. A. Y. Hari Purnomo, Dian Janari, 2014), soundproofing materials (S. Amru, 2015), cocopots (D. A. Azzaki, 2020), furniture (T. Indahyani, 2011), and various environmentally friendly household equipment (I. E. Jumiati and N. Anriani, 2022).

Another material that is also widely studied is peanut shell waste. Peanut shells are processed into board material (N. A. Basundari,, 2016). Peanut shell boards are processed using PVAc adhesive or more familiarly called white glue (E. F. Soeprapto, S. G. Partiwi, and R. Widyaningrum, 2023). Previous research has been limited to the discovery of materials and their properties. The processing methods and products that can be produced from composites with other material blends have not been studied further. This research is a follow-up to basic research conducted by previous researchers on craft UMKM, namely strategies that can be developed to increase work productivity, the importance of developing organizational ambidexterity and organizational technological readiness and employee creativity in improving organizational performance, innovation performance (E. F. Soeprapto, S. G. Partiwi, and R. Widyaningrum, 2023, 2024). The purpose of this study is to explore composite board materials from sawdust, peanut shells and coconut fibers, to then be developed into a women's clutch design with local wisdom of Indonesian culture through Kalimantan motif tumpar embroidery accents

METHOD

This study uses a trial method of waste wood powder, peanut shells and coconut fibers, as well as the development of a clutch design using the composite board material using the Vinod Goel Method, there are 3 design stages, namely Preliminary Design, Design Development, and Final Design (Figure 1.).

Figure 1. Research Method

This study employed several data collection techniques, including a literature study, interviews, and processing and testing of sawdust waste, peanut shell powder, and coconut fiber. The literature study involved gathering information from relevant sources such as national and international journals, proceedings, web publications, and books. Interviews were conducted face-to-face with East Kalimantan craft UMKM representatives to understand user needs for innovation. The waste processing began by sourcing sawdust from workshops and woodworking facilities, followed by sieving to separate fine and coarse particles. Similarly, dry peanut shell waste and coconut fiber were crushed, sieved, and sorted into fine and coarse particles. These materials were then processed into composite boards using adhesives like starch glue and wood glue, forming 3mm thick boards. The composite materials underwent physical and mechanical property testing before being used to design women's bags. Finally, market testing of the innovations was conducted using a questionnaire to evaluate user responses and the viability of the product.

To obtain the desired results, the stages are carried out according to the planned research method, including through the stages:

1. Calculation and weighing of wood fiber material, peanut shells and coconut fiber

   In this trial, a particle mixture composition of 85% and 15% adhesive was used with a board size of 31 cm x 33cm x 1.12 cm with a trial error rate of 70%, then needed:

   a. The amount of material needed to make 1 (one) board is: 31 cm x 33cm x 1.12 cm x 70% grams / cm3 = 802.03 grams (rounded to 802 grams)
   b. The amount of particle mixture with an estimated water mass loss of 4% is obtained: 104% x 85% x 802 grams = 708.97 grams (rounded to 709 grams)
   c. The amount of resin adhesive (Urea Formaldehyde). Resin (Urea Formaldehyde) is an important type of resin for composite board production due to its high reactivity and board performance. The amount of UF adhesive needed, with an estimated 40% possibility of the adhesive sticking to the milling machine wall and an adhesive content of 15% is as much as: 15% x 1/40% x 802 = 300.75 grams
   d. The amount of each particle needed (estimated loss during weighing 5%): 105% x 709 grams = 744.45 grams

Number of wood particles (40%) = 40% x 744.45 grams = 297.78 grams
Number of peanut particles (30%) = 30% x 744.45 grams = 223.34 grams
Number of coconut fiber/dust (30%) = 30% x 744.45 grams = 223.34 grams

2. Oven the particles separately
   Oven the wood particles, peanut shells and coconut fibers in each container to remove the water content contained in each particle. Oven is done for 24 hours at a temperature of 100^{o} C.
3. Mixing particles in a rotating drum (drum mixer)
   Particles that have been ovened mean they have weight without water content. The particles are put into the drum mixer to then be given adhesive using a sprayer that is sprayed on the particles in the rotating drum mixer. This is intended so that the adhesive is perfectly mixed with the particles.
4. Particle printing on the mold
   After the UF adhesive is sprayed evenly on the particles in the mixer drum, the particles are then removed from the mixer drum and then evenly inserted into a 31 cm x 33 cm wooden mold. Before the mold is raised on the pressing machine, the mold is closed and stepped on so that it is evenly distributed on each surface.
5. Pressing/compressing
   The next stage is pressing/compressing. Compressing is carried out for 10 minutes with a pressure of 25 kgf/cm2 with a temperature of 130°C for boards with UF adhesive.
6. The results
   After reaching the desired temperature, the particle board is removed from the oven and released from the mold to then be tested physically on the particle board.

Physical properties testing of particle board

Density test

A test sample measuring 10 cm x 5 cm x 1.12 cm in air-dry condition was measured for length, width and thickness then its volume was calculated. The density of particle board is calculated using equation 1.

$$\rho = \frac{m}{V} \qquad (1)$$

There are 3 classifications of particle board density, namely low density with a value of <4 g/cm3, medium density with a value of 4 g/cm3 to 8g/cm3, and high density with a value of> 8g/cm3 (Maloney, 1993). All particle boards made are included in the classification of medium density particle boards. Medium density particle boards are defined as particle boards that have a density between 0.4 g/cm3 to 0.8 g/cm3. From the test results, the density of sawdust, peanut and coconut particle boards was 0.87 gt/cm3, which means they have a medium density. Such board models have great potential to be used as craft materials.

Test Modulus of rupture (MoR))

Bending strength at fracture is the maximum load capacity that can be borne by particle boards (the maximum resistance of particle boards to loads until the particle board is damaged or cracked) Bowyer, et al (Sadiyo & Agustina, 2005). The average fracture toughness value of particle board ranges from 18.20 kg/cm2 – 99.31 kg/cm2. The highest value is produced by particle board with 14% adhesive content, which is 99.31 kg/cm2. MOR testing is carried out using a universal testing machine (UTM) with a test material measuring 10 x 5 cm. The fracture toughness is calculated using the equation:

$$MOR = \frac{3BS}{2lt^2}$$

$$MOR = \frac{3x0{,}864x10}{2x5x1{,}12^2}$$

$$MOR = 2{,}06 kg/cm^2$$

From the calculation results, MOR is 2.06, so the particle board has a very low flexural strength (figure 3.1) and is not suitable for construction boards. So, from this analysis, it can be seen that the board is suitable for use as a material for making women's bags/clutches.

Figure 2. *Partikel boar character*

Design Development

At this stage, the activity of developing the design of women's bags made of wood fiber particle board, peanut shells and coconut fibers was carried out. Because it turns out that the particle board material has a low MOR so that the particle board when cut will fall off a little, therefore the use of sanding sealer is needed before cutting with the aim of increasing the resistance of wood to moisture and damage, closing and repairing defects in the wood surface and protecting the coating layer on its surface. From the calculation results, MOR is 2.06, so the particle board has a very low flexural strength (figure 3.2 and is not suitable for construction boards. So, from this analysis, it can be seen that the board is suitable for use as a material for making women's bags/clutches.

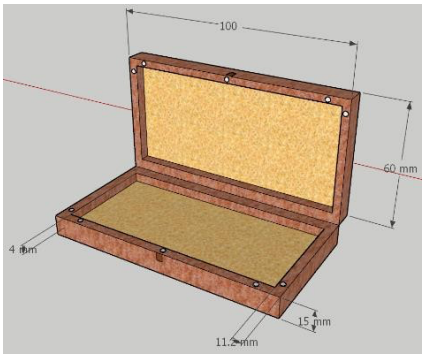

Figure 3. *clutch design*

Final Design

The clutch design uses a combination of bark material on the front and back areas, which is then added with East Kalimantan motif embroidery accents. The East Kalimantan motif chosen is a modernized vine motif with a vector shape (Figure 5.15). Tumpar Embroidery is a traditional embroidery craft native to the Benuaq Dayak tribe. Tumpar embroidery is usually applied to fabric. This fabric is also a traditional fabric typical of West Kutai Regency

Figure 4. Perspective Clutch equipped with wood skin and tumpar embroidery accents Kaltim

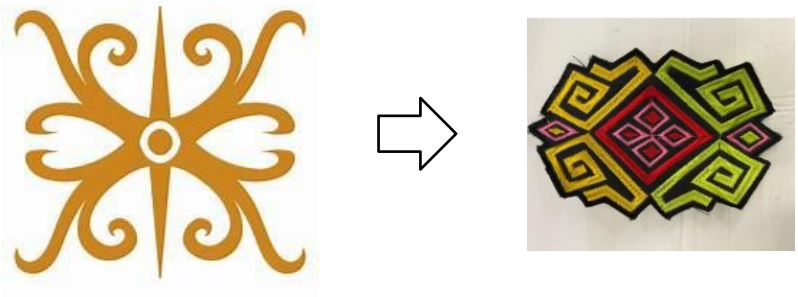

Figure 5. Analysis of East Kalimantan motif

Figure 6. Clutch in front and back view

RESULTS AND DISCUSSION

Because the MOR value of particle board is low so that it cannot be treated further, the clutch shape is a box with dimensions of 100 mm x 60 mm x 30 mm, and the particle board is only used as a frame and in the middle is formed using 3mm plywood coated with wood bark. For the same reason, the bag can only be given a small lock of 34 mm x 32 mm, and a pair of 90-degree hinges to combine the two parts of the clutch

Aesthetic analysis is a value that creates an attraction to a product, both in terms of shape, color, size and consideration of user aspects. The analysis of the aesthetic elements of clutch products includes: 1. Particle board used as a construction/frame presents a special character on its surface, the presence of peanut shell powder and coconut fiber provides beauty and aesthetic accents. 2. The finishing on this particle board does not require other external paint, it is enough to be given a clear matte varnish to make it look natural. 3. In the middle, another natural impression is presented by giving wood bark on the surface and on top of it is embroidered with East Kalimantan motifs, thus adding to the traditional impression of East Kalimantan.

CONCLUSION

The design development using waste particle board material of teak wood dust, peanut shell dust, and coconut fiber produces an attractive clutch product. Although the MOR value of the particle board is low, in terms of strength it is considered sufficient to be made into a clutch. To increase the strength of the material, special treatment is needed on the particle board before it is cut and assembled, namely by providing sanding sealer. As a suggestion for product development with similar materials, it can be tested with a different composition of each particle so that it has better strength.

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