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AROMATIC ART PAPER: CONCEPT, TECHNOLOGY, COST ANALYSIS, AND APPLICATION IN ECONOMIC BUSINESSES FOR TOURIST VILLAGE COMMUNITIES DEVELOPMENT

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Abstract

This study aimed to analyze the techno-economics of aromatic art paper production. The research method used was to analyze for 20 years comparing the price and composition of each component to obtain the best composition and the lowest price to produce aromatic art paper. The results showed that the production of aromatic art paper from various paper waste showed that the engineering analysis to convert 1 ton of paper waste per batch showed a total capital investment of 558,510,127.94 IDR. This value is relatively economical (i.e., the project requires less investment funds) to reduce 120 tons per year or 2400 tons waste paper per 20 years of the project. The manufacture of this aromatic art paper, despite the initial higher costs, is a profitable venture. It was still a loss in the first and second years, but in the third year, it started to make a profit for 20 years. The annual income is 6,000,000,000.00 IDR, which demonstrates the significant economic benefits of this project. The addition of lemon grass aroma adds a more aesthetic paper texture, making this paper anti-fungal and anti-bacterial.

Keywords: Aromatic art paper, Community development, Paper recycle, Waste paper.

1. Introduction

Techno-economic analysis plays a vital role in the industrial world, in this case, in processing waste paper into aromatic art paper (AAP). Techno-economics can be used to make a technological economic decision by considering economic feasibility and ease of production (see Table 1). Paper is made from cellulose pulp fibres derived from the wood pulping process. Art paper is a type of paper with an aesthetic appearance rich in natural and unique nuances. Art paper has different characteristics from paper in general. Namely, it is not easily torn, the colour does not fade, and it does not peel easily. Aromatics are added. Thus, the art paper is more textured and has a distinctive aroma, such as the smell of citronella (lemon grass). Aromatics are essential raw materials in the chemical industry for the production of synthetic rubber, synthetic resin, and synthetic fibres [1].

One example of making art paper in Ghana is done by exploring the possibility of recycling used cloth into good quality paper for use by Visual Arts teachers and students in skill development lessons [2].

Table 1. Techno-economic analysis researches.

No.	Title	Ref.
1	Techo-economic analysis for the production of titanium dioxide nanoparticle produced by liquid-phase synthesis method.	[3]
2	Techno-economic feasibility study of low-cost and portable home-made spectrophotometer for analyzing solution concentration.	[4]
3	Techno-economic analysis of a trigeneration system based on biomass gasification.	[5]
4	A techno-economic-environmental study evaluating the potential of oxygen-steam biomass gasification for the generation of value-added products.	[6]

Based on previous research [7-13], to save energy, waste paper can be re-produced into art paper that has economic value and can help the community develop a creative economy, especially in rural tourism communities. Aromatic art paper is a handmade paper (HMP) that can be produced by recycling any paper made from tree-free (non-wood) raw materials, as mentioned further, in an environmentally friendly manner.

Based on our previous studies [14-20], the purpose of this study is to analyse the techno-economics of AAP production made from waste paper by mixing lemon grass powder into paper pulp, resulting in art paper that is more textured and has a lemon grass aroma. The novelty of this study is mixing lemon grass powder into paper pulp to produce art paper with a therapeutic aroma. In addition to having high artistic value and textured, this paper also naturally has a distinctive aroma that can provide therapy for people who use it. Lemon grass has antibacterial and anti-fungal properties, so the art paper has antibacterial and anti-fungal resistance. This study also supports current issues in sustainable development goals (SDGs), as reported elsewhere [21-23].

2. Literature Review

The handmade paper is a semi-manual cottage industry product. The method of HMP making could be purified further by minimizing water, energy, and fossil-based additives demand [13].

Based on the process path, there are at least 12 steps in producing AAP. The raw materials needed for the production process are paper, wood glue, lemongrass, and water (H2O). The process involves the following steps: (i) Initially, the used paper is shredded/cut into pieces, either using a tool or torn manually; (ii) The shredded paper is soaked in water for up to 5 h until the paper becomes soft; (iii) Next, the paper that has been soaked in water is ground in a paper blender, with a composition of 1 kg of paper requiring 3 L of water, until it becomes pulp; (iv) The fragrant lemongrass is dried with the help of a dryer or can be dried in the sun. The capacity of the dryer is 100 kg in 1 h; (v) After drying, the fragrant lemongrass is then chopped with a shredder until it is cut into small pieces; (vi) The chopped lemongrass is ground in a grinding machine with a capacity of 100 kg per h until it becomes lemongrass powder; (vii) Pulp is mixed with lemongrass powder, and wood glue with a ratio of 1 kg of pulp requires 100 grams of lemongrass powder, 150 grams of wood glue; (viii) After the glue is completely dissolved, pour the solution into a basin and stir; (ix) After the pulp and glue are perfectly mixed, then colored according to color taste with a composition of 1/10 bottle for 1 kg of pulp; (x) After all the ingredients are perfectly mixed, it is time to print recycled paper (aromatic art paper). Stir the pulp mixture and all the ingredients, then insert the screen printing into a basin or bucket. Lift the screen printing, filter until the water is almost gone, then smooth the filtered pulp on the screen printing; (xi) Wet the board's surface and place a cloth on top; (xii) The paper is dried in a dryer.

3. Research Methods

This study calculated techno-economic analysis for 20 years. The price was based on the average price of commercially available products on online shopping websites to obtain the cheapest price with good quality and the latest price. Simple mathematical analysis is used in all data calculations. Several economic evaluation parameters were used: cumulative net present value (CNPV), gross profit margin (GPM), payback period (PBP), break-even point (BEP), break-even capacity (BEC), internal rate return (IRR), return on investment (ROI), and profit index (PI). The experiment tested various conditions, including changes in raw materials, sales capacity, labor conditions, interest rates, weather conditions, and others. Detailed information for the calculation is explained elsewhere [24, 25].

4. Result and Discussion

Several assumptions are used to ensure the economic analysis; these assumptions are needed to analyze and predict several possibilities during the project. (i) The assumption is that all analyses use rupiah, but can be converted into USD with the calculation of 1 USD=16,500.00 IDR; (ii) pricing is based on commercially available prices, raw material prices are adjusted to conditions when this article was written; (iii) The price of equipment and its process conditions are determined based on commercially available equipment (See Table 1). (iv) Production costs can be changed and predicted from the beginning of the project; (v) Depreciation is estimated using direct calculations (Garrett, 2012); (vi) One process cycle requires paper soaking time (pre-production) for 5 h, then the production process makes pulp into AAP with the help of a machine (using electricity takes 5 h. In one month, production can be done for 20 days. So, in one year, which is 330 working days, the total maximum production per year is 1,200,000 sheets of AAP. (vii) To simplify the utility system, the utility unit can be described and converted into an electrical unit, for example, kWh (Ulrich & Vasudevan, 2006). Then, the electrical unit is converted into a cost by multiplying it by the minimum electricity cost standard. The utility cost is 0.15 USD/kWh based on the PLN basic electricity tariff in March 2018. Retrieved July 2017, from http://listrik.org/pln/tarif-dasar-listrik-pln/. (viii) The total labor wages per processing cycle are 20 USD (300,000.00 IDR); (ix) The discount rate is 15% per year; (x) Income tax is 10% annually; (xii) The project operating period is 20 years.

Assumptions of economic calculations for the production of AAP consist of: (i) Production capacity (0,95 ton/day); (ii) Factory in operation 240 day/year; (iii) Bank interest rate 0.45(4.5% per year) in 2024; (iv) Income tax per year 0.2 (20%); (v) Kurs dollar 1$ =16,500.00 IDR in 2024; (vi) Factory construction period 2 year (2024-2025); (vii) Factory operation in 2026; (viii) Investment in year one construction 0.7 (70%); (ix) Investment in year two construction 0.3 (30%); (x) Working capital 2nd year of construction; (xi) Production cycle per day 1 Cycle.

Product development and value addition are significant aspects of designing HMPs. A few of the HMP product innovations by Auroville papers, demonstrating the development from cotton rags to HMP flowers, jewelry, and stationery[17]. The cost of raw materials can be explained as follows: Waste paper is needed per small scale production 500 kg/h with price 4000 IDR/kg; water is needed 1500 L with price 1,333 IDR/L; Citronella is needed 50 kg/h with price 15,000 IDR/kg; Wood glue is needed 75 kg/h with price 5,800 IDR/kg; Food coloring is needed 50 bottle with price 4000 IDR/bottle. Total price per day is 5,384,500.00 IDR. Total price per year is 1,292,280,000.00 IDR.

The equipment calculation for AAP production can be described as follows: (a) Rotary dryer, price per unit (in IDR) is 10,000,000,00; (b) Lemongrass chopping machine 1,550,000.00; (c) Powder-making machine grinder 15,000,000.00; (d) Paper pulp machine + 1 hp dynamo drive with 60 kg/h machine capacity 4,350,000.00; (e) Mixing machine 2,950,000.00; (f) Paper filter mold @ 38,000 x 100 1,900,000.00; (g) Dehydrator machine stainless 10,000,000.00; (h) Guillotine paper cutter 2,100,000.00; Container 100,000.00. The price per unit is calculated in IDR. All components have a quantity of 1, except for containers, which have a quantity of 10. Total equipment calculation for AAP production is 48,850,000.00 IDR.

Utility calculation for AAp production consist of: (a) Rotary dryer (1,4 kW); (b) Lemongrass chopping machine (1 KW); (c) Powder-making machine grinder (1,9 kW); (d) Paper pulp machine + 1 hp dynamo drive with 60 kg/h machine capacity (0,2 kW); (e) Mixing machine (0,2 kW); (f) Paper filter mold @ 38,000 x100 (1,5 kW); (g) Dehydrator machine stainless; (h) Guillotine paper cutter (0,2 kW). All tools used within 5 hours. Total proce per day for utility calculation is 139,000,00 IDR.

The production details are 1 kg produces ten sheets. One-month processes 10 tons of pulp, meaning that in one day, it produces 10,000/20 = 500 kg of pulp per day, producing 5000 sheets of AAP daily. In 1 month, there are 20 working days.

In one day, it produces 5000 sheets of AAP. In one month, it produces 100,000 sheets. In one year, it produces 1,200,000 sheets of paper per year. The sales can be calculated as follows: production capacity of 5000 sheets per day, total production capacity per year of 1,200,000 sheets. The selling price per sheet is 5,000.00 IDR. Income per year 6,000,000,000.00 IDR per year.

Determination of total capital investment for the manufacture of AAP is determined by Direct cost, Indirect Cost, Starting Up Fee. Direct cost consist of: (i) Maintenance cost 1 factor 87,476,250.00 IDR; (ii) Transportation cost 0.1factor, cost 8,747,625.00 IDR; (iii) Transportation insurance 0.007 factor, cost 612,333.75 IDR; (iv) Transportation to site 0.05 factor, cost 4,373,812.50 IDR; (v) Instrumentation installation cost 0.55 factor, cost 48,111,937.50 IDR; (vi) Instrumentation 0.3 factor, cost 26,242,875.00 IDR; (vii) Piping 0.5 factor, cost 43,738,125.00 IDR; (viii) Electrical 0.5 factor, 43,738,125.00 IDR; (ix) Utility 0.4 factor, 34,990,500.00 IDR; (x) Building cost 0.7 factor, 61,233,375.00 IDR; (xi) Insulation 0.06 factor, 5,248,575.00 IDR; (xii) Painting, fireproofing, safety 0.054,373,812.50 IDR; (xiii) Yard Improvement 0.08 factor, cost 6,998,100.00 IDR; (xiv) Environmental 0.7 factor, cost 61,233,375.00 IDR; (xv) Land 0.08 factor, cost 6,998,100.00 IDR. Total cost for direct Cost 444,116,921.25 IDR. Indirect Cost consis of: (i) Technicians and supervision, 0.1 factor, cost 8,747,625.00 IDR; (ii) Contractor's fee, 0.15 factor, 13,121,437.50 IDR; (iii) Contingency, 0.1 factor, cost 8,747,625.00 IDR. Total Indirect Cost is 30,616,687.50 IDR. Starting Up Fee consist of: (i) Off-site facilities, 0.2 factor, 17,495,250.00 IDR; (ii) Plant strart-up, 0.07 factor, cost 6,123,337.50 IDR; (iii) Working capital, 0.2 factor, cost 17,495,250.00 IDR. Total Starting Up Fee is 41,113,837.50 IDR. Fixed Capital Investment (FCI) is 474,733,608.75 IDR; Working Capital Investment (WCI) 0.2 factor, cost 83,776,519.19 IDR. Total Capital Investment (TCI) 558,510,127.94 IDR.

Total manufacturing costs can be explained: Total life time is 20 years; Raw material 1,615,350,000.00 IDR; Utilities 38,626,250.00 IDR; Loan Interest 7% of loan. Labor-related cost consists of: (a). Payroll overhead 30% of labor 21,600,000.00 IDR; (b). Supervisory, misc. labor 25% of labor; (c). Laboratory charges 12% of labor. Capital related cost consist of: (a) maintenance 6% of labor 4,320,000.00 IDR; (b) Operating supplies 15% of maintenance 648,000.00 IDR; (c) Environmental 15% of (equipment) 7,327,500.00 IDR; (d) Depreciation 10% of (FCI) 47,473,360.88 IDR; (e). Local taxes insurance 4% of (FCI) 18,989,344.35 IDR; (f) Plant overhead cost 100% of (OL) 474,733,608.75 IDR. Sales related cost consist of: (a) Packaging 1% of sale 60,000,000.00 IDR; (b) Administration 2% of sale120,000,000.00 IDR; (c) Distribution and marketing 2% of sale 120,000,000.00 IDR; (d) Research and development 1% of sale 60,000,000.00 IDR; (e) Patents and royalties 1% of sale 60,000,000.00 IDR. Total product cost (TPC) 2,721,068,063.98 IDR.

Based on the results of the 20-year trial, aromatic art paper was produced. From 1 kg of pulp mixed with other materials, ten sheets of aromatic paper with a paper thickness of 300 Gsm are produced, with the expected size of A4 paper. There was still a loss in the first and second years of the business scale due to the high cost of equipment. However, since the third year, it has started to make a profit, which continues to increase until the 20th year. The profit cycle is shown in Fig. 1. This study adds ideas regarding economic evaluation as reported elsewhere [24, 25].

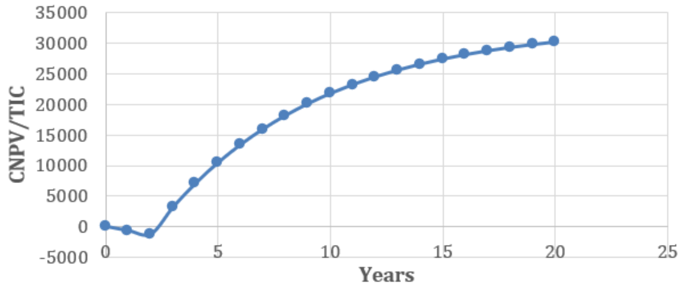

Fig. 1. Results of economic analysis for aromatic art paper production.

5. Conclusion

The economic analysis of aromatic art paper production offers a promising solution to the problem of paper waste and the development of souvenir potential in tourist villages in Indonesia. It is based on a comprehensive comparative analysis of prices and compositions over 20 years, which allows us to identify the most cost-effective composition for producing aromatic art paper. The results show that the technical process for converting 1 ton of waste paper per batch requires a total reasonable equipment acquisition cost of 48,850,000.00 IDR. However, this investment has the potential to generate a significant annual income of 6,000,000,000.00 IDR from the sale of aromatic art paper.

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