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PRODUCTION OF ECO-FRIENDLY ROPE FROM COCONUT FIBER WASTE TO SUPPORT SUSTAINABLE DEVELOPMENT GOALS (SDGS): TECHNOLOGY AND COST ANALYSIS

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Abstract

This study aimed to conduct a techno-economic analysis of the production of environmentally friendly rope from coconut fiber waste. The research method used was to carry out an analysis to inform the production potential of coconut fiber waste for twenty years with several economic parameters, such as gross profit margin, internal level, payback period, net present value, and so on. The results of this research show that the production of environmentally friendly rope made from coconut fiber waste is quite potential and promising. This is based on a payback period of only three years. This production simulation can be said to compete with market standards, the payback period (PBP) capital market, because the return on investment is relatively short, namely in the third year of production. This production is also feasible to carry out with anticipation of losses that will occur due to changes in selling prices and raw material prices. This is of course very worthy of consideration as a form of support in preserving the environment from the problem of coconut fiber waste. To ensure production feasibility, this research is equipped with estimates from ideal conditions to worst cases in production, raw materials, labour, sales, utilities, and other external conditions.

Keywords: Coconut fiber, Eco-friendly, Rope, Techno economic, Waste.

1. Introduction

Coconut is a tropical plant that is widely distributed in Asia and the Pacific region [1]. Indonesia is the largest head-producing country in the world [2, 3]. In the processing process, coconut produces copra coconut oil and other products in the form of coir which consists of 65% coconut fiber and 35% coconut powder [4]. Coconut fiber waste is waste that is generally just thrown away [5]. Coconut fiber is an organic waste that does not decompose easily because of its stiff texture [6]. In various coconut-producing areas, coconut fiber waste is a serious environmental problem and is handled properly and appropriately [7]. If processing is not carried out properly, coconut fiber waste, which continues to increase every day, become a problem for the environment, public, and animal health [8]. In recent years, many efforts have been made to convert coconut fiber waste into various products that have economic selling value [9-11]. One of these efforts is to produce environmentally friendly ropes made from coconut fiber [12, 13]. This is in line with world efforts to reduce the negative effects of pollution and dangerous environmental pollution because coconut fiber waste is a very important friendly environment to be processed [14]. Research on utilization coconut fiber waste has been widely used (see Table 1). Several reports regarding techno-economic analysis are explained in Table 2.

Table 1. Previous research on coconut fiber waste.

No.	Title	Ref.
1	Removal of methylene blue by adsorption onto activated carbon from coconut shell (cocous nucifera l)	[15]
2	The effect of comparison of soybeans and coconut water on bio-battery electrical power	[16]
3	The effect of the addition of coconut fibers and coconut shells on the mechanical characteristics of porous concrete	[17]

Table 2. Previous research on techno-economic analysis.

No.	Title	Ref.
1	Techno-economic assessment of coal to SNG power plant in Kalimantan	[18]
2	Techno-economic analysis on the production of zinc sulfide nanoparticles by microwave irradiation method	[19]
3	Techno-economic evaluation of hyaluronic acid production through extraction method using yellowfin tuna eyeball	[20]
4	Computational bibliometric analysis on publication of techno-economic education	[21]
5	Techno-economic evaluation of gold nanoparticles using banana peel (musa paradisiaca)	[22]
6	Techno-economic analysis of the business potential of recycling lithium-ion batteries using hydrometallurgical methods	[23]
7	Computational bibliometric analysis on publication of techno-economic education	[24]
8	Techno-economic feasibility study of low-cost and portable home-made spectrophotometer for analyzing solution concentration	[25]

This research aims to analyse the techno-economics of environmentally friendly rope production from coconut fiber waste. Based on our previous studies [26-29]. Novelty in this research not only describes the existence of renewable technology in converting coconut fiber waste into products that have added value but can also provide an overview of the potential economic impact of this process.

2. Literature Review

The process of making environmentally friendly rope from coconut fiber waste goes through several stages (see Fig. 1), including (i) Preparing the raw material for coconut fiber, both dry and wet; (ii) Decomposition, which is a process that aims to break down or separate coarse fibers from leather material, fine fibers or dust. This process usually uses a cutting machine called a Crusher and Decorticator which has 1,800–2,100 kg/h for home scale; (iii) Cleaning, namely the sieving process which aims to remove dirt, dust, and other substances attached to coconut fibers; (iv) Drying, which is a process carried out to minimize the water content in coco fiber, thus that it becomes stronger and ready to be processed to the next stage. Various drying methods can be done either through natural drying in the sun or using a machine that regulates temperature and humidity accurately; and (v) Spinning, namely the final stage, namely the process of forming coco fiber into environmentally friendly rope. This spinning is done using a spinning machine that combines coco fiber into rope. To straighten the rope, the winding process is usually added using a winding machine. In this process, the strength, thickness, and structure of the rope are adjusted to meet the needs of the final product, namely rolls of spun rope. Rolls of spun rope produced from the machine, usually 750 m or 3 rolls of rope within 2 hours which weigh up to 9 kg.

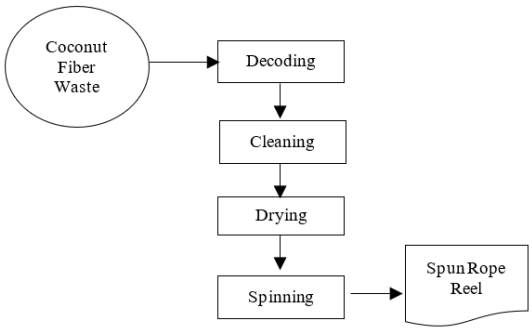

Fig. 1. Flowchart of environmentally friendly rope production from coconut fiber waste.

3. Method

This research method calculated techno-economic analysis to get information on the business feasibility of producing environmentally friendly rope made from coconut fiber waste. Techno-economic feasibility analysis includes analysis of raw materials and their price components, production capacity, selection of technological tools, required labour structure, and other financial feasibility analysis, such as cumulative net present value (CNPV), break-even point (BEP), internal rate return (IRR) [30, 31]. Detailed information for calculating techno-economic analysis is explained elsewhere [32, 33].

4. Results and Discussion

To further ensure the economic feasibility analysis of environmentally friendly rope production made from coconut fiber waste, several assumptions are used to analyse and predict several possibilities that will occur in implementation production. Some of the assumptions are as follows: (i) All financing analyses use USD with a value of 1 USD = IDR 15.949; (ii) The main raw material composition for production is coconut fiber waste which is based on commercial prices at website and-commerce which is USD 0.09/kg; (iii) Equipment price as well as actual condition is determined commercially listed values (see Table 3); (iv) The assumption is that one production cycle of environmentally friendly rope made from coconut fiber waste using a machine takes 2-3 hours; (v) The product sales price is USD 1.25 /kg; (vi) The production assumption is that it can process 16,000 kg of coconut fiber/day; (vii) Assumed employee costs are USD 15,047.97/year with 13 employees consisting of 12 operators and 1 coordinator; and (viii) The production project lasted 20 years.

The calculation of raw material costs required in one cycle consists of the cost components of coconut fiber waste and diesel fuel with an assumed production capacity of 16,000 kg per day. The estimated calculation of the cost of consumable raw materials required is USD 1,515.46/day. While the cost of consumable raw materials needed to produce in one year amounted to USD 454,636.65/year.

Table 3 shows the calculation of the cost of equipment components needed to process coconut fiber waste into environmentally friendly rope consists of components: (i) coconut fiber decomposing machine (crusher and decorticator) with a capacity of 2,000 kg/h is USD 3,699.29; (ii) coconut fiber sieving machine with a capacity of 1,000 kg/h is 2,507.99; (iii) coconut fiber drying machine with a capacity of 100 kg is USD 1,147.41; (iv) feeding machine is USD 3,442.22; and (v) coconut fiber rope spinning machine is USD 5,511.32. The total costs required are USD 16,308.23.

Table 3. Prices for environmentally friendly rope making equipment from coconut fiber waste.

No.	Tool Name	Unit Price (USD)	Amount	Total Price (USD)
1	Crusher and decorticator machine	3,699.29	1	3,699.29
2	Cleaning machine	1,254.00	2	2,507.99
3	Drying machine	1,147.41	1	1,147.41
4	Feeding machine	3,442.22	1	3,442.22
5	Spinning machine	5,511.32	1	5,511.32
	Total			**16,308.23**

Table 4 provides a summary of production assumptions and costs associated with a project or venture business. The total fixed costs after considering

depreciation are USD 120,347.62. Total variable costs are USD 2,138,804.94 which includes costs such as raw materials, utilities, operational labour, labor related costs, and sales related costs. Estimated sales USD 23,700,545.49. The profit margin is 91%, and the profit to sales ratio is 212.63 %.

Table 4. Production cost assumption factors.

Component	Parameter	Cost (USD)
Fixed cost	Capital related cost	110,935.69
	Depreciation	9,411.93
	Total fixed cost	120,347.62
Variable cost	Raw material	454,636.65
	Operating labour (OL)	15,047.97
	Labor related cost	10,082.14
	Sales related cost	1,659,038.18
	Total variable cost	2,138,804.94
% Profit estimated	Sales	23,700,545.49
	Manufacturing cost	2,249,740.63
	Investment	100,882.95
	Profit	0.91
	Profit to sales	212.63
BEP	Unit	18,900,000
	Fixed cost	120,347.62
	Variable cost	2,138,804.94
	Sales	23,700,545.49
	BEP	66,142.72
	Percent profit on sales	0,90507642
	Return on investment	142,899.79
	Pay out time	0.004385756

In economic evaluation, it is necessary to have ideal conditions, thus that they can be used as a benchmark for a project. Figure 2 shows ideal conditions by analyzing the relationship between CNPV/TIC and age (years).

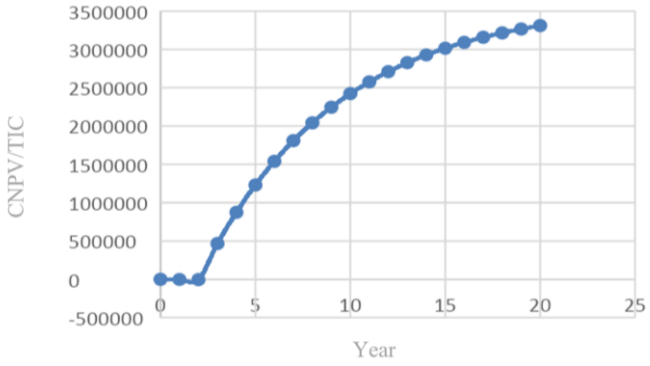

Fig. 2. Ideal conditions for CNPV/TIC to a lifetime (year).

The curve shows that the CNPV/TIC value stagnated until the 2nd year. However, after the 3rd year to the 20th year, it can be said to be profitable because it has

increased. In the 3rd year, income increases and reaches the payback period (PBP). PBP can be achieved only in a short time, namely in the 3rd year and the income obtained tends to increase until the 20th year. This shows that the environmentally friendly rope production project made from coconut fiber waste has great potential and promise. The results of the PBP analysis reveal that the point at which the return of capital is less than the planned life of the project is said to be profitable [34].

5. Conclusion

The results of the techno-economic analysis carried out in this research, it can be concluded that the production of environmentally friendly rope from coconut fiber waste material is quite potential and promising. This production simulation can be said to compete with market standards, the payback period (PBP) capital market, because the return on investment is relatively short, namely in the third year of production. This production is also feasible to carry out with anticipation of losses that will occur due to changes in selling prices and raw material prices.

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