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Techno-Economic Study of Coconut Husks Decomposing Machine for Farmer Group Scale

Dedie Tooy[1*], Dewinta Lantang[2], Ruland Aswin Rantung[3], David P. Rumambi[4], Ireine Adriana Longdong[5], Herry Frits Pinatik[6]

Agricultural Engineering Study Program, Faculty of Agriculture, Sam Ratulangi University, Manado, Indonesia.

*dtooy@unsrat.ac.id

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Abstract
Many coconut husks in coconut-producing área have not been maximally utilized, especially on a small scale for farmers. It happened due to the difficulty of obtaining simple small-scale coconut decomposing machines, and the region must import it from other regions. As a result, the utilization of coconut fiber in fiber and cocopeat is still minimal. Plus, when bringing in from outside, the logistics cost of the coconut husk decomposing machine is still high. This research aims to conduct a techno-economic analysis of a small-scale coconut husk decomposer from the machine designed and made. The research method was using the experimental method. The results showed that the equipment can produce cocofiber and cocopeat with 600 kg of husk per day for 6 hours of use. The results of economic calculations based on the IRR value, the net B/C ratio, and the payback period show that this machine is feasible to be developed on a small scale for Farmer groups. Technologically, this machine is simple and relatively easy to operate. Further research hopes this machine will prove its durability over long, heavy work periods.

Keywords— Coconut Husk, Techno-Economy, Farmer, Decomposer Machine

Introduction

North Sulawesi is one of the highest producers of coconut in Indonesia. For this reason, the coconut processing industry is relatively huge. However, the husk, which makes up 35% of the total coconut fruit, still needs to be maximized (Tooy et al.,2021). The husk processing business is relatively unreachable by small-scale farmer groups. It happens due to the lack of husk processing machines to make it into fiber and coco peat. Existing machines are often too expensive and complicated for small-scale farmers to afford.

Efforts to increase the role of processing technology to increase the added value of coconut products are a significant part of the coconut-producing area. There has been much discussion about the models and benefits of coconut fiber and the added value of coconut. However, this area does not offer practical and affordable coconut fiber processing tools. Although several models of husk processing equipment exist and have been socialized, almost all of the equipment comes from areas outside North Sulawesi (Tooy et al., 2022).

The derivative products of coconut husk are coir fiber coir dust (Sudjarmoko, 2007). The processing of coconut husk into coir fiber and coir dust can be done by biological and mechanical means (Lay & Pasang, 2003). The fibers are dried in the sun for 4 - 5 hours, then pressed to reduce the size and facilitate transportation. Biological shredding requires relatively little energy to separate the fibers from the husk because the husk has become soft. This processing method is readily applicable to farmers, but the processing process takes a long time.

Mechanical husk shredding is a popular method to be developed nowadays. The invention of a husk shredder (decomposer) helped speed up the shredding process. The decomposer consists of three process units: the processing material transport unit, the beater/crusher, and the coir fiber separator. The shredding process's length depends on the decomposer's size and processing capacity (Sepriyanto,2018).

Machines for processing coconut husk into fiber and ash have recently begun to develop and can be obtained commercially, both those produced by R&D institutions and by the private sector (Subiyanto, 2000). The main activities in fiber processing using these machines consist of four stages, namely (1) softening the coir, (2) shredding, (3) cleaning and sieving, and (4) packing (to facilitate transportation).

Various coconut husk decomposing machine design studies have been conducted. The resulting machine design comprises four parts: peeler, drive, gripper, and husk guide cover. The machine used for the production process generally consists of a diesel-powered decomposing machine that functions to convert coconut husk into coco fiber and an electric-powered sieving machine that functions to separate coco peat from fiber (Putra et al. 2022 and Apriani and Nurusman, 2019).

It has been successfully designed and made a coconut decomposer machine for the scale of farmer groups, which is expected to be sufficient for the scale of farmer groups with less than 10 ha of land. The problem is whether this coconut decomposer is feasible to be applied economically on a farmer group scale and can be practically used technologically. That is why this research was conducted. This research aims to conduct a techno-economic analysis of a small-scale coconut husk decomposer machine designed and made.

Literature Review

Coconut husk comprises organic and mineral elements: pectin and hemicellulose, lignin and cellulose, potassium, calcium, magnesium, nitrogen, and protein. The ratio of the above components depends on the age of the husk; lignin in husk fibers ranges from 40%- 50%; husk fibers are relatively short, fiber cells are approximately 1 mm long with a diameter of 15 µ, and a fiber consists of 30 - 300 cells or more, seen from a cross-section. Coir fiber length ranges from 15 - 35 cm with a 0.1 - 1.5 mm diameter. Coir fiber has high buoyancy, is resistant to bacteria and salt water, and is cheap, while its weaknesses are that it cannot be twisted well and is classified as a rigid fiber. The quality of coconut fiber is determined by color, percentage of impurities, moisture content, and the proportion between the weight of long and short fibers (Subiyanto, 2000).

The quality specifications of fiber products that industry standards use are (Sudarsono, 2010): Moisture content <10%, Cork content <50%, fiber length 2 - 10 cm, bale size 70 x 70 x 50 cm and weight/bale 50 kg/Bale. There are three types of fibers produced from coconut fiber: 1. Mat yarn fiber is a material with long and fine fibers suitable for making mats and ropes. 2. Bristle fiber is a material that has coarse fibers used for making brooms and brushes. 3. Matters have short fibers and are used as materials for mattress fillers.

Coconut husk processing machine

The processing of coconut husk into coir fiber and coir dust can be done by biological and mechanical means (Lay & Pasang, 2003). Machines for processing coconut coir into fiber and ash

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have recently begun to develop and can be obtained commercially, both those produced by R&D Institutions and by the private sector (Subiyanto, 2000). Various coconut husk machine designs have been conducted. The design of the husk peeling machine is based on the needs using the Quality Function Deployment (QFD) method as the basis for design. Similar research, namely designing a coconut fiber peeling, crushing, and sieving machine using an 8 HP diesel engine instead of an electric motor. The design of the coconut fiber peeling machine has been carried out with a participatory ergonomics approach consisting of stakeholders by looking at the level of wearer satisfaction. The resulting machine design consists of four parts: the peeler, drive, gripper, and coir guide cover. The machine used for the production process generally consists of a diesel-powered decomposing machine that converts coconut fiber into coco fiber and an electric-powered sieving machine that separates cocopeat from fiber (Apriani & Nurusman, 2019).

Economic Analysis

Economic analysis is used to determine the amount of costs that must be incurred during the processing process; with economic analysis, the amount of processing costs so that the benefits of the components used during the processing process can be calculated. Variable costs are costs that depend on the output produced. Where the more products produced, the more materials used. In contrast, fixed costs are not dependent on the number of products produced (Priyo, 2012). Types of economics are descriptive economics, economic theory, and applied economics.

According to Priyo (2012), descriptive economics is an economic analysis that describes the actual circumstances in the economy. Every science aims to analyze the reality of economic activity and predict events if a situation it affects changes. Applied economics is also known as the theory of economic policy, a branch of economics that examines the policies that must be implemented to overcome economic problems.

Cost Analysis

Priyo (2012) added that manufacturing cost analysis is used to determine the amount of costs that must be incurred during operation. With the analysis, the operating costs can be known so that the tool's benefits can be calculated. The operating costs of coconut fiber processing equipment are divided into 2: fixed and variable. Fixed costs consist of depreciation costs and building costs. In comparison, variable costs consist of operator wages, repair and maintenance, fuel consumption, and electricity costs.

Fixed Cost

These costs are usually not directly related to usage. So, fixed costs are the types of costs that, over a period, will remain fixed in amount. Fixed costs are often also called ownership costs. This cost is independent of the products produced, whether the machine works and the amount is relatively fixed. Thus, fixed costs can be defined as costs that do not change in total when the activity of an economic enterprise increases or decreases.

Depreciation Costs

Depreciation costs are costs that will be calculated based on their economic life. The life of a tool is expressed in years or number of working hours, and the length will be greatly influenced by the method and maintenance.

Variable Cost

Variable costs are incurred when tools and machines are operating, and the amount depends on the use hours or work volume. If the number of units of a particular product rises, then the variable costs also rise. The calculation of variable costs is done in units of Rp/hour and Rp/year.

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Non-fixed costs consist of operator costs, electricity usage costs, maintenance and repair costs, electricity usage costs, fuel costs, and other unexpected costs. (Campbel and Brown, 2003).

Operator Cost

Operator costs are based on the city minimum wage in Rp/day or Rp/hour, which can be equalized with local labor wages (Agustina, 2013).

Maintenance and Repair Costs

Maintenance includes Lubrication, replacement due to wear and tear, and others. At the same time, repair costs are often the result of unexpected damage. Repair costs, painting, and cleaning management labor can be determined annually.

Cost of Electricity Usage

According to Mukhlis (2012), electricity usage costs are incurred to drive or operate a device that uses electricity by using the basic electricity tariff that applies in Rp / kWh.

Fuel Costs

Fuel costs are incurred to buy fuel needed for processing coconut fiber in Rp / hour (Agustina, 2013).

Total Cost

Total cost is the overall cost required to operate an agricultural tool; this cost is the sum of fixed costs and non-fixed costs expressed in units (Rp / hour).

Cost of Processing

The cost of processing is required when operating the coconut fiber processing process. If the capacity of the machine can be calculated, then the essential cost by dividing the total cost by the number of working hours of the machine and then multiplied by the machine's capacity.

Economic Feasibility Analysis

In calculating the economic feasibility analysis at an early stage, it is necessary to go through the same calculation steps, namely the preparation of cash flows each year during the business's life, both for the flow of costs and benefits (Giatman 2006). Several criteria can be used to analyze a business project's feasibility. The most widely used criteria are net present value (NPV), benefit-cost ratio (B/C ratio), internal rate of return (IRR), and break-event point (BEP) (Lantang et al., 2023).

Net Present Value **(NPV)**

It is a measure used to obtain the maximum net benefit that can be achieved with capital investment or sacrifice of other sources. NPV is calculated based on the difference between benefits and costs (costs) plus investment.

Net Present Value (NPV) is the present cash value in and out in a certain period. NPV is used to measure the value of future cash flows and to analyze the feasibility of a tool/machine at present and whether the tool/machine makes a profit in a certain period. To determine the present value (VP) of cash flow, you must first determine the Discount Factor (DF) value or interest rate (i) (Momongan et al.2021).

Benefit Cost Ratio **(B/C Ratio)**

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The B/C ratio is used to determine how much profit is compared to expenses during the project's economic life. The project is declared feasible if the B / C Ratio obtained is greater than or equal to one and not feasible if the B / C Ratio value obtained is less than one (Campbel & Brown, 2003).

IRR (Internal Rate of Return)

It is an interest rate that can make the NPV value of a business equal to zero (0) or the Net B / C Ratio value equal to one within a certain period.

Break-Even Point Analysis

BEP or break-even point, is a business management tool where income and expenses reach the same value (Giatman, 2006). The break-even point is a point of production or sales that must be done so that the costs incurred can be covered again or the value where the profit received is zero.

Research Method

Place and Time

Technical and economic tests were conducted at the production house in Tontalete Village, North Minahasa Regency. The research was conducted for 3 (three) months.

Materials and Tools

The materials and tools used are:

a. Coconut fiber

b. Small-scale coconut fiber decomposer

c. 12 HP gasoline engine

d. Measuring instruments (rpm meter, multimeter, stopwatch, counter).

Figure 1. Mesin Pengurai sabut kelapa

Figure 2. Coconut Husk, Coco fiber, and Coco peat

Research Methods

This research was conducted in stages (1) Obtaining economic parameters, (2) technical

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and economic tests, (3) Data tabulation, (4) Data analysis. The research was carried out with experimental methods for making tools. For economic calculations, some secondary data were obtained from surveys and interviews with farmers, building shops, workshops, and the community. The data includes labor wages, rental costs, tool costs, and tool depreciation, while variable costs are water content of raw materials.

Economic analysis is seen from the IRR, NPV, and PB value. IRR is an interest rate that will equalize the sum of the present value of the expected revenue received with the sum of the present value of the investment expenditure. The amount of present value is calculated using the following approach:

Results and Discussion

Techno Operational Test

This coconut fiber decomposer is very easy to operate in terms of technology. For the entry of raw materials, enter through the Hopper. For operations, coconut fiber is entered individually to not accumulate in the Hopper. The uniformity of the husk size, or a manageable husk, will make the process of entering the decomposition chamber more effective. To further facilitate its operation, coconut husk material should be dried first so that it is not too wet and facilitates the decomposition process. Sun drying until the husk looks dry with a moisture content of about 14-15% will facilitate the following process. From the results of previous research, engine rotation of around 500-600 rpm is relatively normal for the operation of this machine (Yigibalom et al., 2022). The percentage of coconut fiber, coco peat, and dust produced highly depends on the coconut type and the coconut fiber's initial moisture content.

Economical Data

In this research, economic analysis is needed to see the benefits obtained from the coconut fiber decomposing machine and to determine the feasibility of the coconut fiber decomposing machine from an economic point of view. Table 1 shows secondary, survey, and experimental data from previous activities.

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Table 1. Economic data of coconut husk decomposer machine

No	Description	Value	Unit
1	Coconut fiber decomposer machine price *	15.000.000	Rp
2	Economic lifespan*	5	Year
3	Building construction price **	2.500.000	Rp
4	Number of main operators **	1	people
5	Working hours per day of the main operator**	6	hr/day
6	Main operator's wage**	150.000	Rp/day
7	Number of additional operators **	1	people
8	Working hours per day of additional operators**	6	hr/day
9	Additional operator wages **	125.000	Rp/day
10	Fuel consumption **	6	Litre/day
11	Fuel prices*	10.000	Rp/litre
12	Motor power*	12	Hp
13	Lubricant price *	Rp 47.000	Rp/litre
14	Economic life of the motor *	5	years
15	Bank interest rates**	10%	/year
16	Machine working capacity ***	400	kg/day
17	Machine working efective	300	kg/day
18	Working hour***	1944	hr/year
19	Working hour effective	1620	hr/year
20	Machine working capacity***	600	kg/day
21	Motor lubricant consumption **	12	Litre/year

Description: * Secunder data; **Survey data; ***Experimental Data

In an economic feasibility analysis, two types of costs are grouped into fixed and variable costs.

Fixed Cost

Fixed costs are incurred that do not depend on the production level produced by the tool or machine. These costs still apply whether the tool or machine is not used or used.

Recapitulation of Fixed, Variable, and Total Costs

In this study, several costs are calculated. Fixed, variable, and total costs (Total Cost) can be seen in Table 2.

Table 2. Cost of investment

No.	Description	Unit	Amount	Capacity	Price/unit(Rp)	Price (Rp)
1	Tempat Pengolahan	unit	1	20.000 kg	2.500.000	2.500.000
2	Mesin Pengurai	unit	1	224 kg/hari	15.000.000	15.000.000
3	Gerobak	unit	1		450.000	450.000
4	Sekop	buah	2		80.000	160.000
						18.110.000

Maintenance Cost

Maintenance costs are costs that must be calculated to extend the life of the tool/machine. The maintenance costs are bins, lubricants, grease, and power source parts.

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Table 3. Fixed cost

No	Description	Unit	Amount	Price/Unit	Price (Rp)
1	Maintenance	Set	1	3.622.000	3.622.000
2	Depreciation	Set	1	3.622.000	3.622.000
					7.244.000

Investment Costs

The cost of land or premises is incurred to rent land or premises used for a year. From the information found in the field, it was found that no land costs or rental costs were incurred.

Building Costs

According to Pramudya (2001), building costs are estimated at 1% of the initial price per year. In this calculation, the value for building costs is Rp.2,500,000/year.

Variable cost

Variable costs consist of raw material costs, with the calculation of one cart costing Rp. 40,000, - fuel costs and lubricant costs.

Main Operator Cost and Additional Operator Cost

The main operator cost is the salary/wage cost paid to the primary operator who operates the machine. The primary operator's wage is Rp.150,000 / day with working hours of 6 hours per day. Additional operator costs are the salary/wage costs that will be paid to additional operators with six working hours; one additional operator gets a wage of IDR 125,000.

Fuel Cost

For fuel used in decomposing coconut using a coconut decomposing machine, namely diesel fuel. The cost of fuel is obtained at Rp. 10000 per liter, requiring 1 l / day, or 30 l/month.

Table 4. Variable Cost

No	**Description**	**Unit**	**Amount**	**Price/Unit (Rp)**	**Value(Rp/Year)**
1	Raw material	Cart	60	40.000	28.800.000
2	Fuel costs	liter/month	30	300.000	3.600.000
3	Lubricant costs	litre	12	47.000	564.000
4	Labor costs	people	2	5.500.000	66.000.000
					98.964.000

Lubricants

From the calculation of lubricant costs, the results obtained lubricant costs of 1 liter per month.

Total Cost (TC)

Total cost is the sum of each fixed cost plus each non-fixed cost.

Table 5. Total cost

No	Description	Total Cost (Rp/month)
1	Fixed cost	7.244.000
2	Variable cost	98.964.000

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106.208.000

Table 6. Yearly Income expectation

No.	Year	Serat Sabut (Rp)	Coco peat (Rp)	Income (Rp)
1	0			
2	1	97.200.000	54.000.000	151.200.000
3	2	97.200.000	54.000.000	151.200.000
4	3	97.200.000	54.000.000	151.200.000
5	4	97.200.000	54.000.000	151.200.000
6	5	97.200.000	54.000.000	151.200.000

Income

Income is obtained from the difference between receipts and expenses. To determine the amount of income (Table 6), the revenue and expenses must first be calculated. In order to calculate the income, the price of coco fiber is assumed as Rp. 2000/kg and coco peat Rp. 1500/kg.

a. revenue, from the calculation results obtained, the annual revenue amount amounted to Rp. 183,600,000 / year.

b. Expenses (Cost), from the calculation results obtained a total expenditure of Rp. 106,208,000 / year.

c. Total profit per year: from the calculation results, the total income per year is Rp. 77,392,000 / year.

Table 7. Feasibility Analysis

Year	Fixed Cost (FC)	Variable Cost (TVC)	Total Cost (TC)	Income	(Net Benefit)	DF(i=10%)	Present Value
	Rp	Rp	Rp	(Rp)	(Rp)		
0	18.110.000	-	18.110.000	-	- 18.110.000	1	- 18.110.000
1	7.244.000	98.964.000	106.208.000	183.600.000	77.392.000	0,90909091	70.356.364
2	7.244.000	98.964.000	106.208.000	183.600.000	77.392.000	0,82644628	63.960.331
3	7.244.000	98.964.000	106.208.000	183.600.000	77.392.000	0,7513148	58.145.755
4	7.244.000	98.964.000	106.208.000	183.600.000	77.392.000	0,68301346	52.859.777
5	7.244.000	98.964.000	106.208.000	183.600.000	77.392.000	0,62092132	48.054.343
Amount	54.330.000	494.820.000	549.150.000	918.000.000	368.850.000	5	
						NPV	275.266.570

Feasibility Analysis

Net present value (NPV) is the present value of cash in and out in a certain period. NPV is used to measure the value of future cash flows and to analyze the feasibility of a machine in the present, whether the machine makes a profit in a certain period. To determine the present value (PV) of cash flow, first determine the Discount Factor (DF) value with an economic life of 5 years and an interest rate (i) of 10%.

Table 7 shows the five-year cash flow with DF at an interest rate of 10% per year. The value of Net Present Value (NPV) is obtained from the value of Present Value Benefit (PVB) minus Present Value Cost (PVC) so that the NPV value is Rp. 275,266,570. To determine the feasibility of a machine requires the following decision-making criteria:

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1) If NPV > 0, the decomposing machine is economically feasible.
2) If NPV = 0, then the investment in the decomposing machine does not provide economic benefits. Benefit = cost.
3) If NPV < 0, then the decomposing machine is not feasible.

Based on the decision-making criteria above with an NPV value of Rp 275,266,570, it can be concluded that this decomposing machine is feasible to use because the calculation shows that the total revenue is greater than the total cost (Table 7).

Benefit / Cost Ratio

(B / C Ratio) is a comparison between benefits or income and costs assessed from the present or present value. The B/C Ratio can be determined by dividing the sum of the Present Value Benefit (PVB) and Present Value Cost (PVC). The B/C Ratio value obtained is 16,199. Decision-making on the feasibility of the Benefit / Cost Ratio (B / C Ratio) is seen from the following criteria:

1) If Gross B/C>1, then the use of the decomposing machine is feasible, whereas
2) If Gross B/C <1, then the decomposing machine is not feasible.

From the calculation results of the B / C Ratio of 16,199 with decision-making criteria if B / C> 1, it is stated that the decomposing machine is feasible to use. This is because the benefits of the machine are more significant than the costs incurred. Because the B / C Ratio value is greater than 1, investment in purchasing a coconut fiber decomposing machine is considered feasible and profitable.

Internal Rate of Return (IRR)

Internal Rate of Return (IRR) can be the basis for decision-making or a reference for calculating whether or not an investment is feasible. An investment can be made if the rate of return is more significant than if investing elsewhere, or in other words, the rate of return of a tool used is greater than that of other tools. In this study, the comparison rate of return is the bank interest rate, which is 10%. The results of calculating the Internal Rate of Return (IRR) using Excel. Based on the calculation results, the IRR value is 427%. To determine whether or not an investment is feasible based on the IRR value, the decision-making criteria can be seen as follows:

1. If IRR > discount rate, then the business is feasible.
2. If IRR < discount rate, then the business is not feasible.

Based on the decision-making criteria above, with an IRR value of 427% greater than the discount rate of 10%, it can be concluded that the investment in a coconut decomposing machine is economically feasible. With an IRR value more significant than the bank interest rate (discount rate), it illustrates that the investment is more profitable than just putting money in the bank. In the Payback period calculation, the result is 0,257 with 3,08 months and 13,4 weeks.

Sensitivity Analysis

The potential for change in the field is the cost of husk raw materials if the price increases due to competition, higher public awareness, and the selling price of coconut fiber. For this reason, a sensitivity analysis was carried out if the cost of husk raw materials increased by 100% from Rp. 40,000 per cart to Rp. 80,000, and if the selling price of coconut fiber is Rp. 2000 per kg, fell to Rp. 1,500 per kg. The NPV calculation results in Rp. 43,270,419 where NPV>0, IRR = 85%, Net B / C ratio = 3.39 and Payback period to 14.76 months. It is still economically feasible.

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Conclusions

Technologically, this coconut decomposing machine is relatively simple to operation. Including coconut husk raw materials of uniform size and dry coconut husk raw materials with sun drying will facilitate decomposition. The results of economic calculations with this machine are feasible for use in coconut decomposing machines. Sensitivity analysis with the cost of coconut husk materials increased by 100%, and the price of coco fiber decreased by 25%, the investment in this tool is still feasible. However, the Payback period is getting longer. This machine is very promising for producing coconut fiber and cocopeat to increase the value of coconut husk to be of economic value and benefit for small-scale farmers groups.

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