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TECHNO-ECONOMIC ANALYSIS OF ELECTRIC DECORATIVE LIGHTS PRODUCTION FROM TREE TRUNK WASTE WITH ARDUINO IN SUPPORT OF SUSTAINABLE DEVELOPMENT GOALS

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Abstract

The purpose of this research was to analyze the economic technology of electric decorative light production from tree trunk waste using arduino in supporting sustainable development goals. The research method is to analyze the potential production of electric decorative lights for twenty years with several economic parameters, including gross profit margin, internal rate of return, payback period, and net present value. The results showed that the production of electric decorative lights from tree trunk waste has quite potential and is promising as a profitable business. This is based on the payback period which only takes three years. This production is also feasible with anticipated losses due to changes in selling prices and raw material prices, so it should be considered to support sustainable development goals. To ensure the feasibility of production, this study is complemented with estimates of ideal to worst-case conditions on production, raw materials, labor, sales, utilities, and other external conditions.

Keywords: Arduino, Electric decorative light, SDGs, Techno-economic, Tree trunk waste.

1. Introduction

Tree trunk waste is a significant component of organic waste produced through tree pruning, cutting, and processing [1]. Pruning trees and felling plantation forests create a significant amount of wood waste, estimated at 2-25 million tons per year in the European Union. Instead of burning or disposing of this waste, it can be utilized for economic benefits and sustainability by extracting bioactive compounds [2]. Managing tree trunk waste is crucial as it presents an opportunity for economic value creation through different production processes [3]. Furthermore, technological advancements are necessary to enhance environmentally friendly waste management and promote sustainable development [3, 4]. Utilization of tree trunk waste into high-value goods can be done through several things such as using waste for biochar production, power generation, reducing the need for raw materials for the pen and paper industry, and bio-plastic raw materials [5-8]. Previous research on the techno-economy and utilization of tree trunk waste has been carried out as listed in table 1.

Table 1. Research summary techno-economic analysis and tree trunk waste.

No.	Title	Ref.
1	Date palm tree waste recycling: Treatment and processing for potential engineering applications	[9]
2	Processing palm trunk waste into plywood to improve the economy in Dharmasraya regency	[10]
3	Orange trunk waste-based lignin nanoparticles encapsulating curcumin as a photodynamic therapy agent against liver cancer	[11]
4	Systematic production and characterization of pyrolysis-oil from date tree wastes for bio-fuel applications	[12]
5	Valorization of royal palm tree agroindustrial waste by isolating cellulose nanocrystals	[13]
6	Circular utilization of urban tree waste contributes to the mitigation of climate change and eutrophication	[14]
7	Techno-economic analysis on the production of zinc sulfide nanoparticles by microwave irradiation method	[15]
8	Techno-economic evaluation of hyaluronic acid production through extraction method using yellowfin tuna eyeball.	[16]
9	Techno-economic analysis of the business potential of recycling lithium-ion batteries using hydrometallurgical methods	[17]
10	Computational bibliometric analysis on publication of techno-economic education	[18]
11	Techno-economic feasibility study of low-cost and portable home-made spectrophotometer for analyzing solution concentration	[19]

Based on our previous studies [20-25], this research aims to analyze the economic technology of producing electric decorative lights from tree trunk waste using arduino in supporting sustainable development goals. This research not only illustrates the existence of renewable technology in converting tree trunk waste into products that have added value but can provide an overview of the potential economic impact that is profitable for companies in producing the production of this product, so this is the novelty in this research.

2. Literature Review

Figure 1 shows the production process of tree trunk waste into electric decorative lights, which begins with the selection of wood waste to be used based on wood quality and usage characteristics. In the second step, the tree trunk is cut and cleaned of bark and other coarse fibers. The third step is drying to reduce the moisture content in the wood so that it does not change shape or damage when used. The fourth step is further processing according to the desired design of the decorative light. This includes cutting the wood into parts that match the pattern and design of the light. The fifth step is the assembly of the wood waste parts according to the planned decorative light design. This uses special techniques such as gluing with special wood glue or the use of mechanical connections to ensure structural integrity. The sixth step is the installation of electrical components such as light sockets, electrical cables, and switches as well as the installation of an Arduino uno for the sound sensor. The last step is finishing the electric decorative light following aesthetics, which includes applying a protective coating to the light.

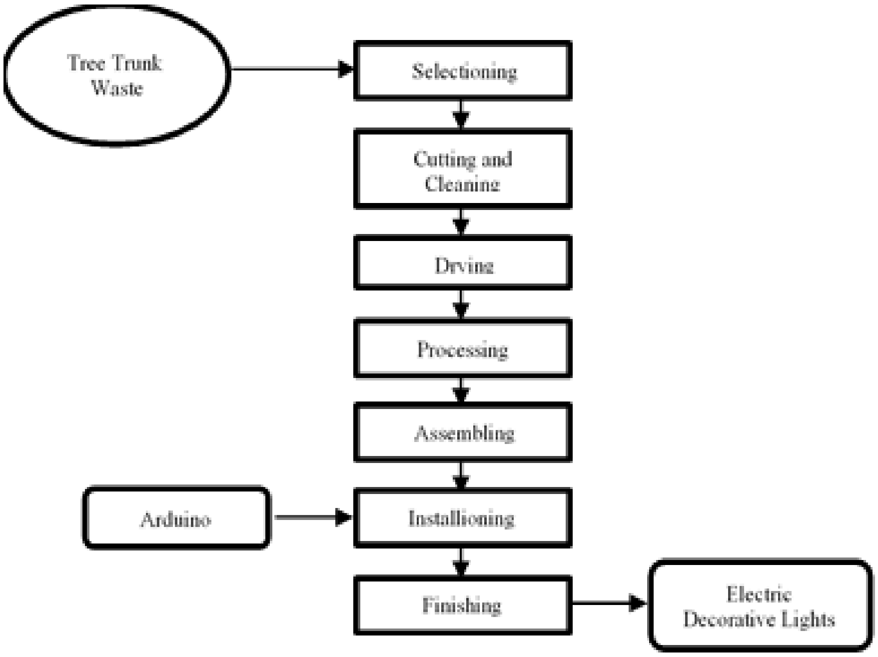

Fig. 1. Flowchart of electric decorative lights production from tree trunk waste.

3. Methods

This research method used some data based on average prices of commercially available products on online shopping websites to guarantee the current price of materials. All data were calculated using simple mathematical analysis. The techno-economic analysis was used to determine the business feasibility of producing electric decorative lights from tree trunk waste including raw materials and their price components, production capacity, selection of technological tools, required labor structure, and other financial feasibility analyses, such as net present value (NPV), break even point (BEP), and internal rate of return (IRR) [26-28]. Detailed information for the calculation is explained elsewhere [29, 30].

4. Results and Discussion

To further ensure the analysis of the economic feasibility of producing electric decorative lights from tree trunk waste, several assumptions are used to analyze and predict several possibilities that will occur in the implementation of production. Some of these assumptions are as follows:

(i) All financing analysis is denominated in USD with a value of 1 USD = 15,500 IDR.
(ii) The main raw material composition of production is tree trunk waste and arduino technology.
(iii) Equipment prices and actual conditions were determined based on commercially listed values.
(iv) The assumption used is that one production cycle of electric decorative lights from tree trunk waste using machines takes 2-3 hours.
(v) The selling price of the product is 15.15 USD/product.
(vi) Assumed production can process 100 packs/day.
(vii) Assumed employee costs of 5,400.19 USD/year with a total of 6 employees consisting of 5 technicians and 1 head of division.
(viii) The production project lasts for 20 years.

In the production process of this electric decorative light, the main materials needed are tree trunk waste and arduino uno equipment with an assumed production capacity of 100 packs/day. The raw materials used include fox glue, wood glue, wire, lacquer paint, light fittings, bolts, nails, cable, led light, jumper cable, korean glue, and cardboard. The estimated calculation of the cost of consumable raw materials required is 1,115.16 USD/day. While the cost of consumable raw materials needed to produce in one year amounted to 334,548.38 USD/year. The cost requirements incurred are used for large-scale production (scale up 1,000x).

The calculation of the cost of equipment components needed to process tree trunk waste into electric decorative lighting products is 319.87 USD. The main production equipment is tree trunk waste and arduino uno. To produce good and high quality electric decorative lighting products, the main production machines including is electric chainsaw, grinding machine, drilling machine, resistor, and breadboard with total cost is 277.16 USD. While supporting equipment to produce electric decorative lamps include: screwdriver full set, hammer, pliers, knife/wood chisel, sandpaper, brush, scissors, meter, gloves, and boots with total cost is 35.3 USD.

Table 2 provides a summary of production assumptions and costs associated with a project or venture business. The total fixed costs after considering depreciation is 3,766.25 USD. The total variable costs is 377,646.8 USD which includes costs such as raw materials, utilities, operational labor, labor related costs, and sales related costs. Estimated sales 483,871 USD. The profit margin is 21%, and the profit to sales ratio is 35.54 %.

Table 2. Production cost assumption factors.

Component	Parameter	Cost (USD)
Fixed cost	Capital related cost	3,496.55
	Depreciation	269.70
	Total fixed cost	3,766.25
Variable cost	Raw material	334,548.4
	Utilities	177.09
	Operating labor (OL)	5,419.35
	Labor related cost	3,630.97
	Sales related cost	33,870.97
	Total variable cost	377,646.8
% Profit estimated	Sales	483,871
	Manufacturing cost	381,143.3
	Investment	2,890.86
	Profit	0.21
	Profit to sales	35.54
BEP	Unit	30,000
	Fixed cost	3,766.25
	Variable cost	377,646.8
	Sales	483,871
	BEP	1,063.67
	Percent profit on sales	0.21
	Return on investment	38.09
	Pay out time	0.03

Figure 2 shows the results of the cumulative net present value (CNPV) analysis and total investment cost (TIC) to obtain production capacity requirements for electric decorative lighting products. In the fig. 2, CPNV shows a detailed prediction of the time when the production of electric decorative lights will be profitable for business actors. In addition, the CNPV curve shows a graph of the relationship between CNPV/TIC and the time (year) of profit. The electric decorative light business will show profits when production has reached the third year and beyond. In the first and second years, it has not been able to make a profit due to the large initial capital costs for purchasing equipment needed in the production process of electric decorative lights. While in the fifth year the graph shows a significant increase in income, this condition is the payback period (PBP). The profits earned can cover the initial capital and profits continue to increase until year 20. Thus, the production of electric decorative lights can be said to be a profitable business because this project takes a fairly short time to recover investment costs, which is about 3 years. This business is ideal for industrial production to support the program to increase the quality of the selling value of bamboo stem waste into creative products.

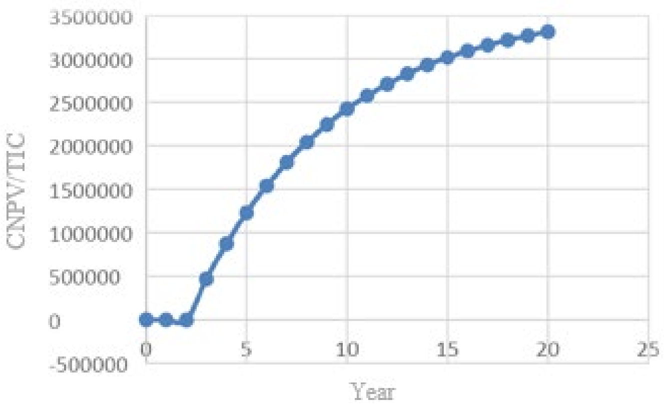

Fig. 2. Curva of ideal conditions for CNPV/TIC to a lifetime (year).

5. Conclusion

The production of tree trunk waste to produce electric decorative lights is still very rarely done, even though it has a lot of potential to be developed. With the use of technology, tree trunk waste can become a quality creative product, so that it can be utilized by business actors in creating products. Based on the results of the economic analysis shown through the CNPV curva, it shows that the production of electric decorative lights will benefit in the third year. Meanwhile, the first and second years have not shown any profit. This is due to the initial capital costs which are quite large for the purchase of equipment needed in the production process of electric decorative lights. However, from the third year to the following year shows a significant increase in income, this condition is the payback period (PBP). The profits earned can cover the initial capital and profits continue to increase until year 20. Thus, the production of electric decorative lights can be said to be a profitable business because this project takes a fairly short time to recover investment costs, which is about 3 years. This business is ideal for industrial production to support high-value creative product programs.

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