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TECHNO-ECONOMIC ANALYSIS OF THE PRODUCTION OF SMART WHEEL EDUCATIONAL PROPS FROM MAHOGANY WASTE

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Abstract

This research aims to analyze the techno-economic of the production of educational teaching aids (APE) using mahogany wood waste as raw material. The research method used is an economic analysis of the use of mahogany wood 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 "smart wheel" educational teaching aids from mahogany wood waste is very prospective from a technical point of view and quite promising in economic evaluation. This can be seen in the payback period which only takes three years. This project can compete with PBP capital market standards because the investment is returned in a relatively short time. This production is also feasible to carry out with anticipation of losses that occur due to changes in selling prices and raw material prices. This is certainly not expensive to support environmentally friendly campaigns while making a positive contribution to the world of education and solving the problem of mahogany wood waste. To ensure production feasibility, this research is equipped with estimates of ideal conditions, raw materials, labor, sales, utilities, and other external conditions. From this economic evaluation analysis, we can conclude that this project is feasible to carry out. This study also supports current issues in sustainable development goals (SDGs), as reported elsewhere.

Keywords: Educational teaching aids (APE), Mahogany wood, Smart wheel, Techno economics, Waste.

1. Introduction

Education plays an important role in building quality human resources [1]. To achieve this goal, various methods and learning tools continue to be developed to improve the teaching and learning process [2-6]. One interesting innovation to be developed is the creation of educational teaching aids that can help students understand abstract concepts in a more real and interesting way. In an era that is increasingly concerned about environmental issues, utilizing waste as a production material has become a solution that is not only economical but also environmentally friendly [7]. One of the waste is wood [8-11]. Mahogany wood is included in the hardwood group with a cellulose content of 40 - 54%, lignin content of 18 -33%, and water content of 13% [12]. Mahogany wood contains 42.86 % cellulose, and 23.75% lignin, with a water content of 10.36% [13]. Judging from the fairly high cellulose content, mahogany wood waste has quite good potential as a production raw material that has high economic value. Mahogany wood is often produced as waste from the furniture and construction industries and has great potential to be processed into valuable goods. With creativity and the help of technology, many wood waste can be transformed into functional and aesthetic educational teaching aids (APE). Several previous studies have contributed to the study related to technoeconomics in Table 1.

Table 1. Previous research on techno-economic analysis.

No	Title	Ref.
1	Techno-economic assessment of coal to SNG power plant in Kalimantan	[14]
2	Techno-economic analysis on the production of zinc sulfide nanoparticles by microwave irradiation method	[15]
3	Techno-economic evaluation of hyaluronic acid production through extraction method using yellowfin tuna eyeball	[16]
4	Computational bibliometric analysis on publication of techno-economic education	[17]
5	Techno-economic evaluation of gold nanoparticles using banana peel (Musa Paradisiaca)	[18]
6	Techno-economic analysis of the business potential of recycling lithium-ion batteries using hydrometallurgical methods	[19]
7	Computational bibliometric analysis on publication of techno-economic education	[20]
8	Techno-economic feasibility study of low-cost and portable home-made spectrophotometer for analyzing solution concentration	[21]

This article aims to analyze the technical and economic aspects of the production of "smart whell" educational teaching aids (APE) made from mahogany wood waste. Technical analysis includes the process of selecting materials, processing techniques, and product design that ensures quality and safety for users. Meanwhile, economic analysis review production costs, selling prices, and potential profits from this product. Using a techno-economic approach, this research seeks to describe the potential for developing educational products based on mahogany wood waste. The novelty of this research lies in the combination of utilizing mahogany wood waste in educational teaching aids while making a positive contribution to the world of education. Apart from that, this research also inspires local entrepreneurs and craftsmen to develop similar products that support environmental sustainability and provide socio-economic benefits, adding new ideas to the current literature [22-25]. This study also supports current issues in sustainable development goals (SDGs), as reported elsewhere [26-30].

2. Literature Review

The process of making educational teaching aids (APE) "smart wheel" begins with making wood production materials from mahogany wood waste with the following stages: (i) heating, done to soften the wood which makes it easier to cut. Heating can be done by steaming (hot steam), or spraying hot water at a temperature of 93° C; (ii) stripping, the result of this stripping is a thin sheet of wood called finir. stripping is continued until the block diameter remains 5.5 to 4.0 inch; (iii) storage, what is meant is temporary storage before the finish is cut to size; (iv) drying, is carried out by spraying hot air onto the surface of the finish. the required temperature is reached 300°C to facilitate the gluing process; (v) gluing; (vi) investment viz after the face and core finishes are arranged as desired, they are then pressed using a machine with a pressure ranging from 110 – 200 psi, and (vii) completion from the press machine, the wood goes to the sawing machine to make standard sizes for the length and width of the wood. The plywood production flowchart can be seen in Fig. 1.

Fig. 1. Wood production flowchart.

3. Method

We analyzed the business feasibility of producing educational teaching aids (APE) made from mahogany wood waste. This techno-economic feasibility analysis includes analysis of determining raw materials and their price components, determining production capacity, selecting technological tools, and the required workforce structure and several other financial feasibility analyses including cumulative net present value (CNPV), break even point (BEP), internal rate return (IRR). Detailed information for the calculation is explained elsewhere [31, 32].

4. Results and Discussion

The following is the process of making educational teaching aids "smart wheel" made from mahogany wood waste which can be used as a learning medium [33]. Smart wheel is made from a board cut into a circle with a diameter of 45 cm, with a hole in the middle of the circle to install a bearing as a rotating axis. The basic support is made using 2 long pieces of wood measuring 45 cm and 49 cm. Then attach it using glue. The support part is made with a size of 52 cm and is integrated with the arrow for the swivel wheel instructions. This support is given 1 hole to unite the support with the rotating wheel. the bottom and top supports are joined with anchor glue. Then the support part is combined with the swivel wheel with bolts. After the media has been combined, it is sanded and colored with natural color wood stain. Puzzle stickers are available in 10 countries with the size of each sticker being 19x19 cm. The cutting sticker type uses st vinyl glossy paper. The finishing stage of the smart sticker spin wheel is shown in Fig. 2.

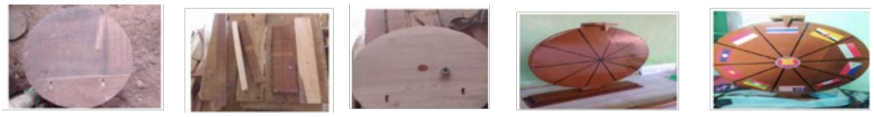

Fig. 2. Smart wheel.

To ensure the economic feasibility analysis of the production of "smart wheel" educational teaching aids (APE) from mahogany wood waste, several assumptions are used to predict several possibilities that occur in implementation, these assumptions are presented as follows: The production composition is mahogany wood waste: (i) all analyses use USD financing with a value of 1 USD= IDR 15.949; (ii) based on commercial prices sourced on the web regarding the raw material for mahogany wood waste USD 0,63/kg; (iii) total investment cost based on lang factor (citation); (iv) the assumption is that one production cycle of educational teaching aids (APE) made from mahogany wood waste using a machine takes 2-4 h; (v) product sales price USD. 9,40 /pcs; (vi) production assumptions are 200 pcs of educational teaching aids (APE) pcs/day and 20000 pcs/year; (vii) in utility simplification, each utility unit is converted as a kWh electricity unit, then converted into costs and multiplied by the electricity cost. Assumed utility costs are USD.29,66/day; (viii) assuming employee costs are USD.2,257.19/year with 5 employees consisting of 1 marketing, 1 finance, and 3 staff, and (ix) the production project lasted 20 years. Details of the costs of consumables is Mahogany wood waste 100kg, Urea Formaldehyde 6kg, Water 300L, Bolt 8kg, St Vinyl Glossy paper 5pax and Wood paint 5kg with an estimated daily production cost of USD 131 price/day and USD 39,331.61 price/year.

Furthermore, looking at the equipment aspect, the total cost required to process mahogany wood waste into educational teaching aids (APE) "smart wheels" is wood cutting machine, electric planner, wood Drying Oven, meter/term, mini core composer, hot press, sanding machine, smart sensors with a total cost of USD. 1,342.38. The total fixed costs after considering depreciation are USD.69,279.36. Total variable costs USD.64,322.40, which includes costs such as raw materials, Utilities, operational labor, labor-related costs, and sales-related costs. Estimated sales USD.188,099.57. The profit margin is 32%, and the profit to sales ratio is 1 .01 %. Table 2 provides a summary of production assumptions and costs associated with an educational teaching aids (APE) project or business venture.

Table 2. Production summary.

Component	Parameter	Cost (USD)
Fixed Costs	Capital related costs	63,721.11
	Depreciation	5,558.24
	Total fixed costs	69,279.36
Variable Costs	Raw materials	39,331.62
	Utilities	8,899.46
	Operating labor (OL)	2,257.19
	Labor related costs	677.16
	Sales related costs	13,166.97
	Total variable cost	64,332.40
% Profit Estimated	Sales	188,099.57
	Manufacturing costs	128,053.51
	Investment	59,576.79
	Profit	0.32
	Profit to sales	1.01
BEP	Units	20000
	Fixed costs	69,279.36
	Variable costs	64,332.40

In economic evaluation, it is necessary to have ideal conditions, which can serve as a reference and benchmark for a project.(see Fig. 3). shows a graph of the relationship between CNPV/TIC versus time. The y-axis is CNPV/TIC and the x-axis is lifetime (years). The graph shows a decrease in income in years 1 to 3, this is because initial capital costs such as tools needed during the production process of educational teaching aids (APE) were purchased. In the 4th year, the graph shows an increase in income, this condition is the payback period (PBP). Profits can cover the initial capital spent and profits continue to increase thereafter until the 20th year. Thus, the production of educational teaching aids (APE) "smart wheels" can be considered a profitable project because this project requires a short time to recover investment costs since the PBP is only about 3 years. This project is ideal for implementation in industrial production. 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.

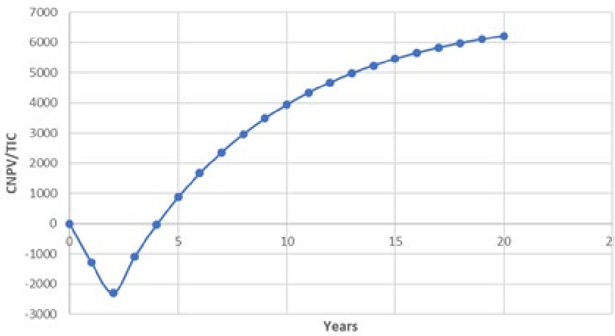

Fig. 3. Ideal condition for CNP/TIC regarding lifetime (years).

5. Conclusion

The production of educational teaching aids (APE) "smart wheel" from mahogany wood waste offers an innovative solution that harmoniously combines technical and economic aspects. This project is very prospective from a technical point of view and quite promising in economic evaluation. Payback period (PBP) analysis shows that the production of this material from mahogany wood waste is profitable after more than three years. The project can compete with PBP capital market standards due to investment returns in a short time. Apart from that, this project supports environmentally friendly campaigns while making a positive contribution to the world of education. Based on the economic evaluation analysis, it can be concluded that this project is feasible to run.

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