Energy and economic prospects from the utilization of sawdust waste as biomass briquettes in East Nusa Tenggara

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Article Info

Article history:

Received Jul 31, 2023
Revised Sep 15, 2023
Accepted Oct 5, 2023

Keywords:

Biomass
Briquettes
Economic
Energy
Sawdust waste

ABSTRACT

The utilization of sawdust waste in East Nusa Tenggara has not been utilized optimally. This waste is only burned, so it sometimes causes air pollution. So there needs to be an effort to overcome these problems by making alternative energy in the form of briquettes. Analytical description method with observation, literature study and economic and energy analysis is used in this research. Sources of data in this observation came from direct observations in the field through questionnaires and interviews. Based on the data of sawdust waste produced can reach 20-60 kg per day and can be used as other forms of energy. This energy can be used as a source of electrical energy to replace conventional energy which is less environmentally friendly and fuel for burning fishery products in East Nusa Tenggara. Based on the value of the benefit-cost ratio (BCR) and payback period, good results were obtained with a value of 2.13 with a return on investment of 0.82 years. The generated electricity biomass can replace conventional electrical energy and provide cost savings of 19.2% per kWh. In addition, the utilization of this energy can have a positive impact on regional income, health, schools, and transportation as well as agriculture.

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1. INTRODUCTION

The furniture and timber industry is an industry that includes the processing of raw materials in the form of various types of wood which are processed to increase added value and higher benefits into goods products [1]–[4]. Indonesia is a country that has a large and varied potential for raw materials, and is known to have high competitiveness in the international market [5]–[13]. Furniture production areas are located throughout the province, with a relatively high number of producers. Based on data from the Ministry of Industry, the number of the furniture and timber industry reached 1,019 places, and 3 locations were in East Nusa Tenggara. The results of this industry provide state revenues of up to USD 703.21 million. In the last few years, the trade balance of the wood-based furniture industry has continuously increased from around USD 1.2 billion in 2017, 2018, and 2019, strengthening its surplus value to around USD 1.4 billion in 2020. In 2021, the surplus value of the trade balance of wood-based furniture reached USD 1.8 billion. In the first three months of 2022, the trade balance of wood-based furniture products has recorded a surplus value of around USD 0.5 billion, which if annualized is predicted to exceed the surplus performance of previous years [14]. The types of wood that are usually the main commodities in the East Nusa Tenggara region include acacia, jabon, teak, mahogany, sengon, and coconut. The production value of this wood reached 37.24 billion [15]–[17]. With such a large forestry product, of course it will produce a lot of waste, so special attention is needed from this waste rather than being wasted.

The use of wood as a raw material in the furniture industry produces wood waste that is comparable to the input of wood in the production process. Improved operational practices, technological changes and reduced waste through reuse, recycling and remanufacturing are steps towards cleaner production and are aspects that should be considered to identify opportunities for cleaner production that will make wood consumption more rational and sustainable. This is in line with the social and environmental responsibility program in the environmental sector which is directed at implementing cleaner production [18]–[27]. Clean production is a pattern of management approach to raw materials and processes, efforts to increase efficiency and productivity, prevent and reduce the generation of waste directly from the source. One of the clean production efforts in dealing with waste is through recycling (recycle) [13], [28]-[39].

Waste from small and medium industries is often ignored because the size of the business is considered insignificant and not too dangerous, so it does not need to be regulated carefully. Many small and medium industries have varied impacts on the local environment. Studies show that most of the pollution in urban areas is the result of the spread of small and medium Industries. Some small and medium industries have realized that they have an impact on the environment because of the production process or because of the total production contribution in each business [12], [34], [40]–[48].

Based on direct observations made, several furniture industry units and sawmills in Indonesia still do not provide and manage the waste they produce. If waste is disposed of continuously without maximum treatment, it can cause balance disturbances and can cause the environment to not function as before in terms of health, welfare and biosafety. Furniture industry activities produce waste in the form of sawdust, cut ends, etc. The waste of end and sebetan pieces is reused as firewood and as an addition to furniture products that require small components during the assembly and finishing processes [1], [2], [13]. Of course, there are so many wood industry companies that produce a lot of waste. There are many types of waste, starting from logging activities, processing logs into sawmills, processing, to final sanding before finishing. The large number of types of waste can and needs to be reviewed again so that in the future it can be used as material for other productions that are more useful.

The timber industry produces a large amount of waste and the amount is not small. Wood waste in a timber industry can reach 58.85%. This can be judged by the live trees which are then cut down, resulting in more than half the waste. If the calculation starts from sawing and splitting, the final waste process can reach 37.08%. So, the raw material that can be used from wood reaches 62.92%. While wood waste in products without carving can reach 34.21% with the wood used reaching 65.79%.

The furniture industry produces waste in the form of sawdust as much as 12-15% of the wood raw materials used. The potential for sawdust waste to be produced is very abundant, at least every furniture industry is capable of producing 20-60 kg of sawdust waste per day. However, this abundant potential has not been utilized optimally. The sawdust has not been processed and is simply burned for nothing. Handling sawdust waste by burning it will cause pollution due to the combustion process and waste a lot of energy that should still be utilized. In fact, sawdust can be processed into sound absorbers, bricks, alternative energy sources, powdered charcoal, lump charcoal, activated charcoal, soil conditioning, compost, composted charcoal, charcoal briquettes and so on. So that it can increase the income of industry players and maintain environmental balance [9], [26], [29], [47], [49]. Seeing the potential utilization of sawdust waste processing results, various alternatives for sawdust waste processing can be carried out with an analysis of economic feasibility as a determining factor for a clean production program [4], [39], [50].

Sawdust waste produced is not hazardous waste, but there is no effective and efficient utilization. Therefore, appropriate waste treatment is needed as an effective strategy to minimize waste and can reduce production costs so that it will increase efficiency, product quality and good relations with the community and improve environmental quality. The purpose of this research is to identify and analyze alternative opportunities for sawdust waste processing as a source of biomass or conventional alternative fuels. This research needs to be carried out because there has never been a study that specifically discusses the energy and economic potential of using sawdust waste in East Nusa Tenggara. Apart from that, the potential that exists makes this research very important to do. Utilization of this biomass energy source can be further optimized to become an energy source for areas that do not yet have electricity and become a government policy. In addition, the utilization of biomass energy sources has a positive impact on regional income, health, schools, and transportation as well as agriculture [51]–[54].

2. METHOD

This study uses data collection related to the object studied by the method of observation and literature study. Sources of data in this observation come from direct observations in the field through questionnaires and interviews. As for the literature study obtained from previous studies, data from the Ministry of Industry of the Republic of Indonesia. Based on data from the Ministry of Industry of the Republic of Indonesia, it was found that there were 3 logging businesses in East Nusa Tenggara. These companies were then used as models and data sources. From this data collection, the process of utilization and the amount of wood waste that has been carried out so far will be obtained as shown in Figure 1.

In this study using descriptive analysis method for the production process. This analysis explains the production process of wood materials in East Nusa Tenggara. Explanation of this process includes the input, process, output, and impact of the timber company. This analysis also provides a clearer elaboration with root cause analysis, benefit cost ratio, and payback period (PBP) [55], [56]. Root cause analysis is used to see the problems found during observation with a problem tree based on existing conditions. This analysis is carried out by establishing a more structured mindset regarding the causal components related to the problems found. benefit cost ratio analysis is used to determine the feasibility and amount of profit from sawdust waste management. An activity is considered feasible if it provides a benefit-cost ratio (BCR) value > 1. The payback period method is used to measure how long it takes to pay back the investment. The payback period method is used to analyze sawdust waste treatment alternatives that require the costs of providing and modifying production facilities. PBP analysis is carried out with the following stages [45], [57]–[60].

- Determine the value of income and alternative costs of treating sawdust waste.
- Determine the residual value (residual value) and economic life of the tools/machines used in sawdust waste treatment alternatives. Economic life is the age of an asset that ends until the use of the asset is no longer profitable economically even though technically the asset can still be used.
- Calculating the amount of profit obtained from the alternative sawdust waste treatment by reducing the income value with the cost value.
- Calculating the value of depreciation (impairment in the value of assets caused by the useful life and use value that is owned decreases over time). The depreciation value is calculated by the (1).
- Calculating the cash flow value of sawdust waste processing alternatives. The cash flow value is obtained from the value of profit and depreciation.
- Calculating the value of the alternative payback period for sawdust waste processing. The following is the payback period formula if the cash flow per year is the same (2).

$$Depreciation = \frac{Cost\ of\ an\ asset - Residual\ value}{Useful\ life\ of\ an\ asset} \quad (1)$$

$$PBP = \frac{Initial\ investment}{Cash\ flow} \quad (2)$$

Figure 1. Wood waste produced by timber companies

3. RESULTS AND DISCUSSION

3.1. Problem analysis

This problem analysis is used to see the problems found during observations with descriptive explanations based on existing conditions. A chart of the root causes of this problem can be seen in Figure 2. The selection of sawdust waste treatment alternatives that can be applied is adjusted to the existing conditions, identification of production processes and potential problems. Apart from this, the selection of sawdust waste treatment alternatives also refers to previous research. Alternative sawdust waste treatment in this study focuses more on sawdust waste processing so that it can be recycled again and is beneficial to the people of East Nusa Tenggara. Alternative waste from sawdust can be used as sound absorbers, bricks or biomass. The results of this briquette can also support the economy of the sellers of grilled fish and all preparations that use the combustion process which is widely available in East Nusa Tenggara because better combustion results will provide a better selling value. This activity also indirectly supports blue economy activities which have become policies in Indonesia.

The selection of alternative uses of sawdust waste as biomass in this study uses sawdust as an alternative energy source. Utilization of this biomass can be used as an alternative to the use of traditional fuels (fossil fuels). This energy source can be used as a substitute fuel that is environmentally friendly, effective, efficient and accessible to the people of East Nusa Tenggara.

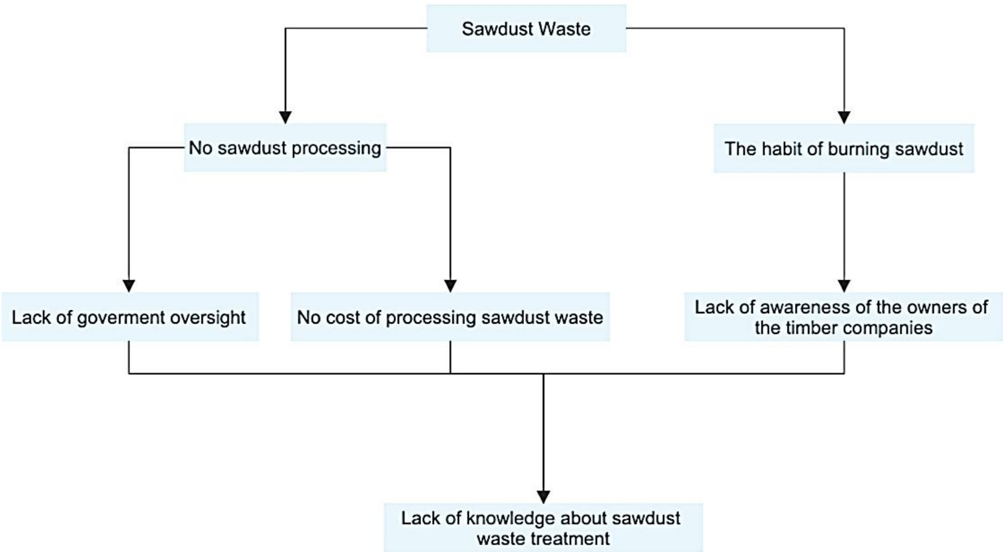

Figure 2. Problem analysis of sawdust waste

3.2. Benefit cost ratio analysis

Timber business waste in the form of sawdust can be used as an alternative energy source that is environmentally friendly (Figure 3). The BCR value of sawdust processing as an alternative energy source is 2.13. This value is based on a benefit value of 8,137,004,146 and a cost value of 3,811,403,609. Based on the BCR value, the utilization of biomass from sawdust is considered feasible and profitable because BCR > 1.

Figure 3. Sawdust briquette

Based on the results of the analysis it was found that sawdust waste processing as biomass can reduce energy use. The electricity price for biomass is IDR 1,150 per kWh, while the price for conventional electricity in the 900 VA class is IDR 1,552 per kWh. This proves that by using electricity from biomass, savings of IDR

402 per kWh can be made compared to conventional electricity used today. Apart from sawdust, if this energy is combined with other sources such as coconut dregs, rice husks, corn, and cassava, it is estimated that this energy can produce 212 MW of electricity. There is still a lot of potential for waste from these materials in East Nusa Tenggara, and it is possible to make further use of it by combining some of this waste into briquettes. Utilization of this energy also provides a good calorific value compared to ordinary charcoal. Therefore, if it is used by the people in East Nusa Tenggara as fuel for burning fish, it will be very profitable because it gives better results of burning.

3.3. Payback period analysis

Calculation of PBP from the utilization of sawdust is needed to determine the return-on-investment costs of sawdust waste management. The calculation of the PBP value from the utilization of sawdust obtained a value of 0.82 years or 9.84 months. This value comes from an investment cost of IDR 4,030,559,316 and a cast flow of IDR 4,918,517,843. The use of sawdust waste can be used by industries in East Nusa Tenggara as an alternative fuel source and also a source of electrical energy to replace conventional electricity. Utilization of this energy can reduce industrial players' expenses because the cost of biomass electricity is cheaper, and also the energy produced is more environmentally friendly because it is the result of recycling sawdust waste while reducing sawdust waste produced in East Nusa Tenggara.

3.4. Development of local economic potential

The availability of production factors such as natural resources, labor capital, and technology determines the comparative advantage of a region. The potential of production factors owned by a region will affect the efficiency of economic values that are developed based on these potentials. To realize an increase in the quality of East Nusa Tenggara's economic growth, the government needs to optimize regional comparative advantage. This is intended to develop economic activities based on local resources. Thus, the product or service that is developed will be more efficient so that it has competitiveness and competitive advantage both at the regional and national levels.

To achieve economic competitiveness and competitive advantage, all development elements must be conceptualized in the Regional Medium Term Development Plan. Therefore, efficiency is needed in all elements of development which include Natural Resources, Human Resources, and Infrastructure. However, there are not a few obstacles faced to optimize these elements. One of them is the imbalance of development between regions. Inequality in development between regions is an aspect that often occurs in regions in Indonesia.

One of the strategic efforts that can be carried out by the government to overcome development disparities between regions is the concept of development with regional dimensions. This needs to be directed at realizing a stronger regional economy based on the people's economy, the potential for regional superior sectors in agribusiness, agroindustry, tourism, and competitive industries. Therefore, the concept of development is also directed at realizing the availability and equity of basic service facilities and infrastructure in the framework of increasing economic and non-economic accessibility and mobility, regional development, and reducing disparities between regions. To realize development that has a regional dimension, optimizing regional potential is a must.

Each region has superior commodities that will be integrated with economic activities to produce more efficient and competitive products. Based on comparative advantage, it can be analogized that a region that has a comparative advantage is based on the low opportunity cost of producing a product. If a production process uses raw materials from the area concerned, it will be very efficient and reduce the opportunity cost. Thus, these products will be easier to compete in both the domestic and global markets. Therefore, measuring the economic potential in a region is the first step to producing products that can compete and at the same time increase state and community income. This of course will be a good opportunity with the briquettes from sawdust as one of the energy commodities in East Nusa Tenggara. Utilization of this biomass energy source can be further optimized as an energy source for areas that do not yet have electricity and become one of the government policies. In addition, the utilization of this biomass energy source can have a positive impact on regional income, health, schools, and transportation as well as agriculture.

4. CONCLUSION

The resulting sawdust waste can reach 20-60 kg per day and can be used as another form of energy, namely biomass. This energy can be used as a source of electrical energy to replace conventional energy which is less environmentally friendly and fuel for burning fishery products in East Nusa Tenggara. Based on the value of the BCR and Payback Period, good results were obtained with a value of 2.13 with a return on investment of 0.82 years. The generated electric biomass can be a substitute for conventional electrical energy and provides cost savings of 19.2% per kWh. Utilization of this biomass energy source can be further optimized as an energy source for areas that do not yet have electricity and become one of the government policies. In addition, the utilization of this biomass energy source can have a positive impact on regional income, health, schools, and transportation as well as agriculture.

ACKNOWLEDGEMENTS

Thanks to the Marine and Fisheries Polytechnic of Kupang and the Institute of Business and Technology Indonesia for all the help that has been given.

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