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Environmental Impact Evaluation of Sponge Waste Processing in Rattan Seat Making using the Life Cycle Assessment Method

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ABSTRACT: The rapid development of technology in the furniture industry business sector has brought progress, especially in the economic sector, one of which is rattan chair crafts in Cirebon Regency, West Java. Rattan chair crafts are currently one of the businesses that have a fairly high profit value. The increasing demand for rattan chair crafts has made the production of rattan chair crafts continue to grow. The development of this industry not only has a positive impact but also has a negative impact on the environment, both from the emissions generated and energy use. The increase in demand for rattan chair crafts has also increased the need for rattan seat manufacturing, this has caused the waste of sponge residue from the rattan seat manufacturing process to increase due to the increased production of rattan seat manufacturing. This study aims to identify the environmental impacts caused by the production process and the processing of sponge residue waste from the rattan seat manufacturing process, then analyze these environmental impacts, then provide recommendations that are in accordance with the existing problems so that environmental impacts can be minimized. The method used in this study is Life Cycle Assessment (LCA) using simapro 7.1 software in its calculations. Based on the contribution value of environmental impacts generated from the SimaPro 7.1 software, the proposal to process sponges into pillows can be considered as an alternative to processing sponges other than just selling them directly to collectors.

KEYWORDS: emissions, life cycle assessment, waste, environment, sponge

INTRODUCTION

The rapid development of technology in the furniture industry business sector has brought progress, especially in the economic sector, one of which is rattan chair crafts in Cirebon Regency, West Java, which is already known abroad. Rattan chair crafts are currently one of the businesses that have a fairly high profit value. Most rattan chair crafts are exported to the United States, Europe, Asia and Australia. Based on records from the Industry and Trade Service of Cirebon Regency, West Java, the number of rattan craft industry workers has increased every year. This increase is influenced by the increasing demand for rattan chair crafts in Cirebon Regency. The increasing demand for rattan chair crafts has made the production of rattan chair crafts continue to grow and innovate to meet consumer needs, with the increasing demand for rattan chair crafts, the need for rattan seat making has also increased, this has caused the remaining sponge waste from the rattan seat making process to increase due to the increased production of rattan seat making.

Home Industry "Totong Cushion" is one of the businesses that produces rattan seats and is a supplier of several rattan chair factories in Cirebon Regency, with an average of approximately 500 sets of rattan seats consisting of cushions and backrests per year. The processing of sponge waste Home Industry "Totong Cushion" currently only sells it to collectors at a price of Rp. 7000 / kg. The sale of sponges is carried out for a period of 2 months with a distance from Home Industry "Totong Cushion" to the collector's place of 5 km using a pickup truck, the amount of sponge for one sale to collectors with a period of 2 months is 80 kg. In the application of the sustainability manufacturing concept, there are three main strategies that can be applied to waste processing, including reuse, remanufacturing, and recycling. The implementation of the 3R sustainability manufacturing strategy can be applied to the processing of sponge waste in the Home Industry "Totong Cushion", with the implementation of the 3R sustainability manufacturing strategy concept, it is hoped that the sponge waste produced from the rattan seat production process can be recycled and reused by the owner of the Home Industry "Totong Cushion" and become an alternative choice for processing sponge waste, apart from selling it to collectors.

The environment is one of the important factors that is taken into consideration, in various matters amidst the current condition of the earth. This is influenced by the increase in natural resources and the decrease in the earth's carrying capacity for waste. The increasing development in the industrial sector, in addition to having an impact on economic growth, also has an impact on environmental balance. However, concern for the environment is expected

not to be limited to pollution problems in the production process, but the environmental impact throughout the life cycle of products, services and the economy. As an effort to implement the three main concepts of sustainability manufacturing consisting of reuse, remanufacturing, and recycling, it is proposed to process sponge waste into pillow products, and to determine the effects of its environmental impact, an environmental impact evaluation is carried out using the Life Cycle Assessment (LCA) method. Life cycle assessment can be used to determine the potential environmental impacts that will arise, the energy consumption used, and the raw materials needed during the processing of a product. Life cycle assessment can be implemented in a particular process or part of the process.

The proposed process of processing sponge waste into pillows is carried out through several stages of the process, namely the fabric cutting process, the sewing process, the pillow filling process, and the pillow packaging process. Identification of environmental impact assessments using the Life Cycle Assessment method is carried out on sponge processing by selling to collectors and the proposed processing of sponges into pillows is used to determine how much environmental impact is generated and can be used as a comparison of better and more environmentally friendly sponge waste processing processes.

MATERIALS AND RESEARCH METHODS

Energy data used by the Home Industry "Totong Cushion" in the process of selling sponges directly to collectors is the fuel oil of pickup cars, while the energy data used in the proposal to process sponges into pillows is the use of electrical energy needed to process sponges into pillows. Raw material data used in the process of selling sponges directly to collectors is the need for plastic to pack sponges, while in the proposal to process sponges into pillows is the need for raw materials for fabric, sewing thread and plastic used to pack pillows. The data processing carried out is as follows:

Life cycle Assessment (LCA)

LCA is a method used to estimate energy or material flow related to the life cycle of a product that affects the impact on the environment. According to ISO 14040 LCA is a technique used to assess the environmental impacts associated with a product. LCA is based on cradle to grave (analysis of the entire cycle from the production process to waste processing) which is used to determine the amount of energy and environmental impact caused by the stages of the product life cycle starting from the time the raw materials are taken until the product is finished being used by consumers. Each LCA step is described in international standards (ISO 14040, ISO14041). LCA includes several stages, including:

Figure 1. Life Cycle Assessment Work Steps

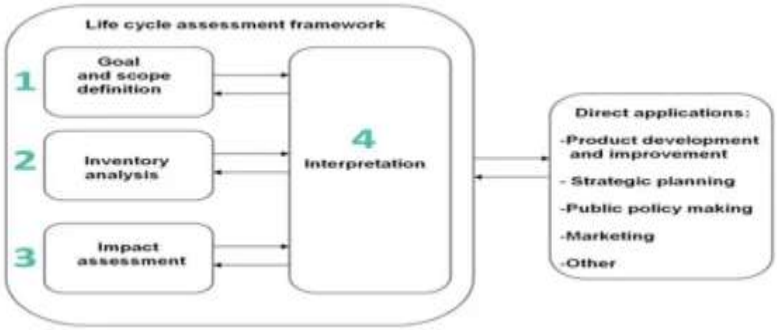

Figure 1. Life Cycle Assessment Work Steps

Determining Goal and Scope

The purpose of this study is to identify and compare the environmental impacts resulting from the process of selling sponges directly to collectors with the proposed processing of sponges into pillows based on energy requirements and the type of raw materials used using the LCA method with the limitations of the Cradle to gate system.

Inputting Life Cycle Inventory (LCI) data

All data on the use of raw materials and energy from the process of selling sponges directly to collectors and the proposed processing of sponges into pillows are input into the software.

Inputting Life Cycle Impact Assessment data

Input LCIA data based on the eco-indicator 99 (I) approach where, there are ten categories of environmental impacts contained in the eco-indicator 99 (I), namely carcinogens, respiratory organics, respiratory. inorganics, climate change, radiation, and ozone layer. The impact assessment results consist of 4 outputs, namely based on characterization, normalization, weighting and single score.

Characterization

At this stage, an assessment of the magnitude of the environmental impacts that contribute from the two sponge processing to each impact category is carried out.

Normalization

At this stage, all impact category units are standardized by dividing the characterization value by the normalization factor value, to compare between impact categories.

Weighting

At this stage, weighting is carried out so that the results obtained will be in accordance with the level of importance, by multiplying by the weight value where the weight value for Human Health is 55%, Ecosystem Quality is 25% and Resources is 20%.

Single Score

At this stage, the aim is to obtain a single value for the environmental impacts resulting from each production process

Interpretation

This stage aims to determine and evaluate the LCI and LCIA stages that have the potential for environmental impacts on each production process to achieve the objectives in the goal and scope stage. At this stage, the results of the environmental impact assessment of the product with the process and materials used are explained, as well as the proposals that can be given based on the results

The results of the data collection have been obtained, then the data is calculated and processed using the Simapro 7.1 software. Simapro software is a software used to calculate or perform LCA analysis. Simapro software can help in the process of analyzing aspects related to the environment of a product being produced. Simapro software is one of the most widely used software for analyzing LCA. The data entered into the Simapro software is determined based on the system description consisting of raw materials, production processes, and distribution of the final product. Simapro has an extensive international LCI database with many LCIA methods such as Impact 2002 +, EDIP 1997 and 2003, CML 2001, Eco-indicator 99, IPCC 2007 and others.

The eco indicator 99 method is a method that is widely used in life cycle analysis, this method can display the results of the single score value of the environmental impact of each activity unit. The impact category on the indicator is evaluated using a weighting basis according to the structural hierarchy perspective. This impact category is grouped into four categories of damage including Human health, Ecosystem quality and Resources.

RESULTS AND DISCUSSION

Network Analysis

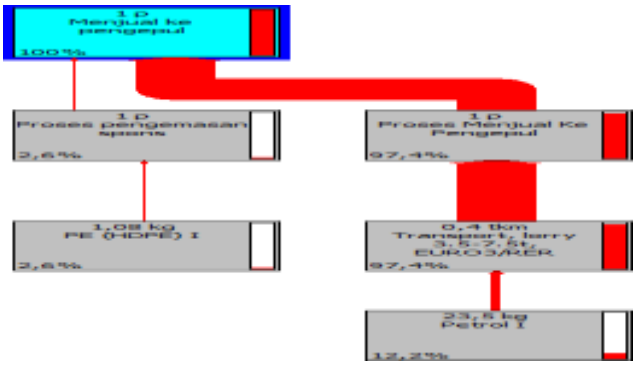

Figure 2. Network Process of Selling Sponges Directly to Collectors

In Figure 2, the contribution of environmental impact resulting from selling sponges directly to collectors using a pickup truck over a distance of 5 km and a transport load of 80 kg is 97.4% and the contribution of environmental impact from the need to use 1.08 kg of plastic to package the sponge pieces is 2.6%.

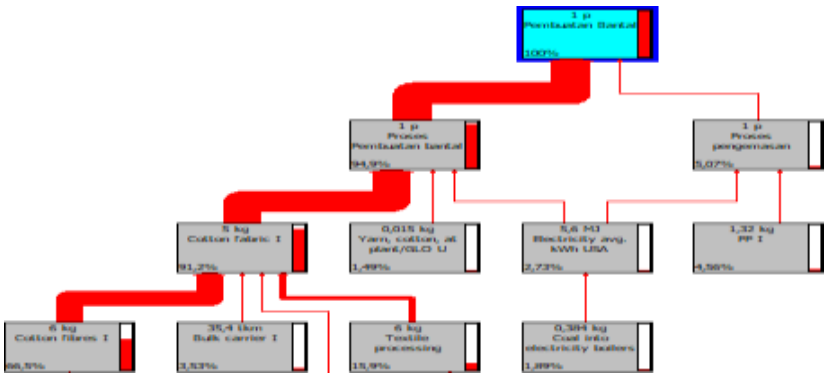

Figure 3. Proposed Network for Processing Sponges into Pillows

In Figure 3, the contribution of environmental impact resulting from the use of 5 kg of calico (cotton fabric) to make 80 pillows is 91.2%, the need for sewing thread (yarn cotton) of 0.015 kg is 1.49%, the use of electrical energy (Electricity, medium voltage) of 1.55 kWh is 2.73% and the use of plastic wrapping (PP I) of 1.32 kg is 4.56%.

Characterization analysis

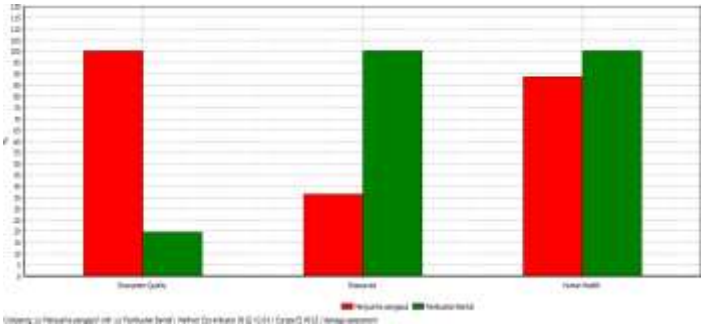

Figure 4. Comparison of Characterization of the Two Sponge Processing Methods

In Figure 4, it can be seen that the environmental impact of both sponge processing on Human health, Ecosystem quality color is the proposed processing of sponges into pillows. and Resources. The red color is the process of selling sponges directly to collectors and the green

Normalization Analysis

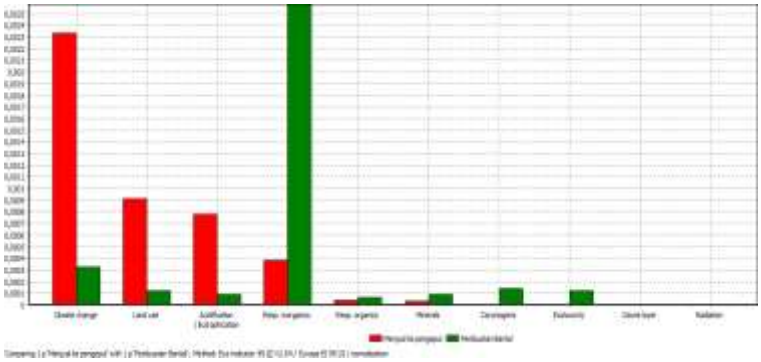

Figure 5. Normalization Comparison Bar Diagram

In Figure 5, there is a significant impact category among the other impact categories, namely respiratory inorganics. Of the two sponge processing processes, the proposed processing of sponges into pillows has the greatest impact compared to processing sponges by selling them to collectors. The respiratory inorganics value in the proposed processing of sponges into pillows is 0.00258. Respiratory inorganics are the effects of respiratory disorders caused by emissions of dust, SO2 (Sulfur Dioxide) and NO2 (Nitrogen Dioxide) into the air. The use of electrical energy can be a cause of respiratory disorders because the source of electrical energy produced in Indonesia currently still uses coal so that the effects arising from the combustion of coal can be emissions of SO2 and NO2 which can cause respiratory disorders.

Weighting Analysis

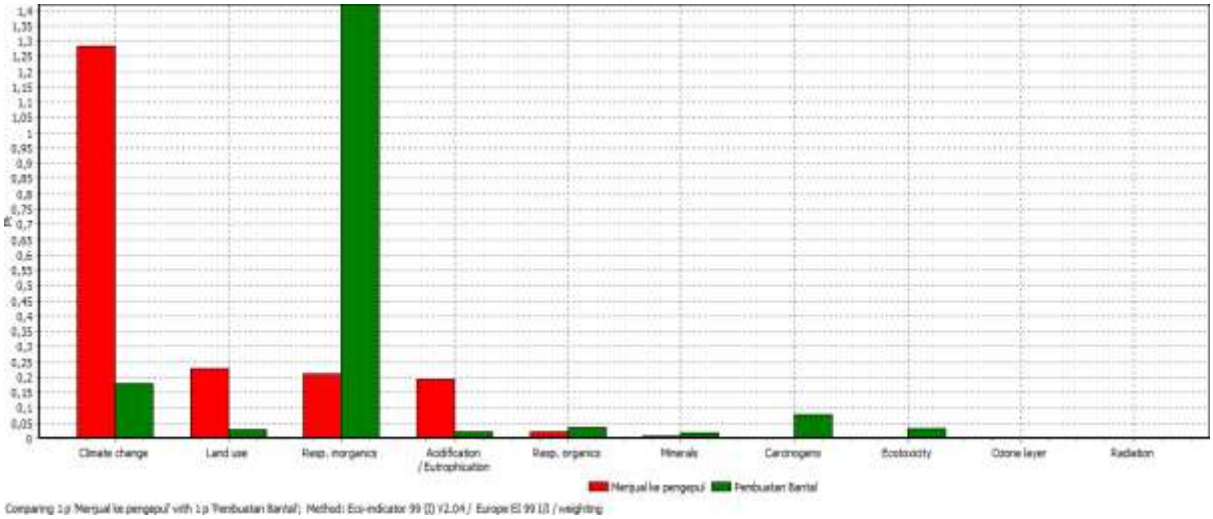

Figure 6. Weighting Comparison Bar Diagram

The process of selling sponges to collectors has the most dominant influence on climate change. The climate change value in the process of selling sponges directly to collectors is 1.28 pt so that the average environmental burden on climate change per year resulting from the process of selling sponges directly to collectors is 0.00128. The process of selling sponges to collectors has the most dominant influence on land use. The land use value in the process of selling sponges directly to collectors is 0.228 pt so that the average environmental burden on land use per year resulting from the process of selling sponges directly to collectors is 0.000228. The proposal to process sponges into pillows has the most dominant influence on respiratory inorganics. The respiratory inorganics value in the proposal to process sponges into pillows is 1.42 pt so that the average environmental burden on respiratory inorganics per year from the proposal to process sponges into pillows is 0.00142. The process of selling sponges directly to collectors has the most dominant influence on adification/eutrophication. The adification/eutrophication value in the process of selling sponges directly to collectors is 0.194 pt, so the average environmental burden on adification/eutrophication per year from the process of selling sponges directly to collectors is 0.000194. The proposal to process sponges into pillows has the most dominant influence on respiratory organics. The respiratory organics value in the proposal to process sponges into pillows is 0.0352 pt so that the average environmental load on respiratory organics per year from the proposal to process sponges into pillows per year is 0.0000352. The proposal to process sponges into pillows has the most dominant influence on minerals. The minerals value in the proposal to process sponges into pillows is 0.0182 pt so that the average environmental load on minerals per year from the proposal to process sponges into pillows is 0.0000182. The proposal to process sponges into pillows has the most dominant influence on carcinogens. The carcinogens value in the proposal to process sponges into pillows is 0.0768 pt so that the average environmental load on carcinogens per year from the proposal to process sponges into pillows is 0.0000768. The proposal to process sponges into pillows has the most dominant influence on ecotoxicity. The ecotoxicity value of the proposed processing of sponges into pillows is 0.0311 pt, so the average environmental burden on ecotoxicity per year from the proposed processing of sponges into pillows is 0.0000311.

Single score analysis

Single score is a stage of environmental impact assessment based on the total single value obtained from both sponge processing, the value is obtained by adding up all impact category values after weighting. The single score bar chart comparing the two sponge processing can be seen in Figure 7 single score bar chart comparing the two sponge processing

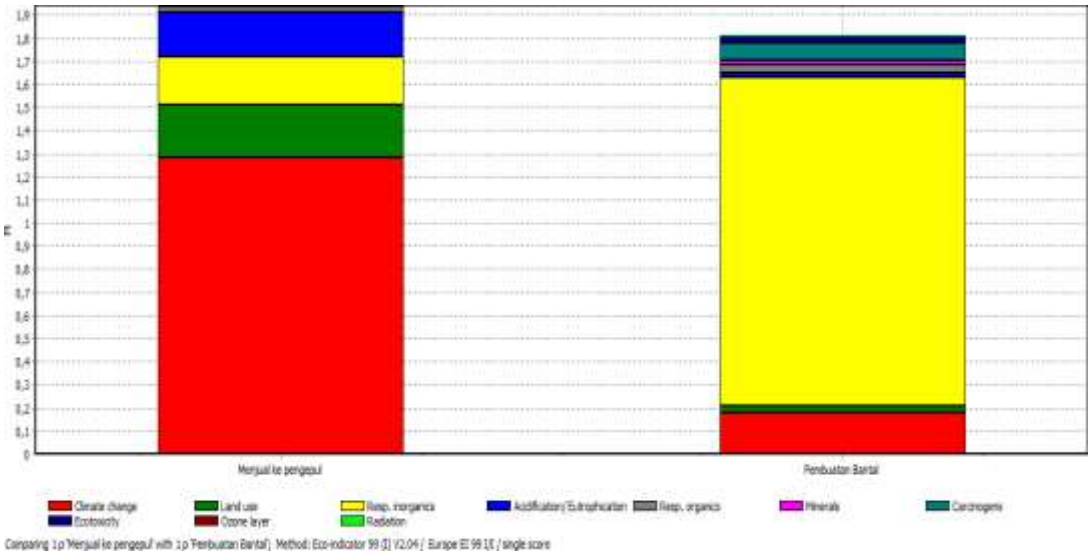

Figure 7. Comparison single score bar chart

Sponge processing by selling to collectors

The total value of environmental impact contribution in sponge processing by selling to collectors is 1.94 pt with the highest impact category influence occurring in climate change of 1.28 pt. The cause of climate change is the use of pickup trucks as a means of transportation to sell sponges to collectors because the pollution produced from the use of vehicles such as CO (carbon monoxide) can cause global warming.

Proposed processing of sponges into pillows

The total value of environmental impact contribution in the proposed processing of sponges into pillows is 1.81 pt with the highest impact category influence occurring in respiratory inorganics of 1.41 pt. The use of electrical energy can cause respiratory problems because the source of electrical energy produced in Indonesia currently still uses coal so that the effects arising from the combustion of coal can be SO2 and NO2 emissions which can cause respiratory problems.

Interpretation is the last stage of LCA which aims to identify and evaluate the results of LCI and LCA to reach conclusions and recommendations in accordance with the goal and scope definition. Based on the analysis that has been carried out on the process of selling sponges directly to collectors and the proposal to process sponges into pillows, it is known that the process of processing sponges by selling to collectors has a higher total environmental impact contribution value compared to the proposal to process sponges into pillows, this is influenced by several factors including the use of transportation, energy use and the use of raw materials. Based on the value of the contribution to the environmental impact generated from the SimaPro 7.1 software, the proposal to process sponges into pillows can be considered as an alternative to processing sponges other than just selling them directly to collectors.

CONCLUSION

1. The results of the evaluation of the most dominant environmental impact category from the process of selling sponges directly to collectors are climate change with a contribution value of 1.28 pt so that the average environmental burden per year from the process of selling sponges directly to collectors on climate change from each process of selling 80 kg of sponges to collectors is 0.00128.
2. The results of the evaluation of the most dominant environmental impact category from the proposal to process sponges into pillows are respiratory inorganics with a contribution value of 1.41 pt so that the average environmental burden per year on respiratory inorganics for each process of processing 80 kg of sponges into 80 pillows is 0.00141. 3. In the processing of sponges by selling to collectors, the contribution of environmental impact from the use of plastic to pack sponges of 1.08 kg is 2.6% and the use of pickup cars as a means of transportation to sell sponges of 400 kgkm is 97.4%, while in the proposal to process sponges into pillows, the contribution of environmental impact is given from the use of calico cloth of 5 kg is 91.2%, the use of sewing thread of 0.015 kg is 1.49%, the use of plastic to pack pillows.
4. Based on the total value of the single score comparison between the process of selling sponges directly to collectors and the proposal to process sponges into pillows using SimaPro 7.1 software, the proposal to process sponges into pillows has a better and more environmentally friendly value compared to selling sponges directly to collectors which is currently being done by the Home Industry "Totong Cushion" so that the proposal to process sponges into pillows can be considered by the Home Industry "Totong Cushion" in

terms of processing sponge waste from rattan seat production.

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