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Implementation of Closed Loop on SME (Case Study of Natural Color Batik Siputri Semarang)

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Abstract
This research aims to find out how can the closed loop is implemented at the Natural Color Batik Siputri and what are the benefits possibly obtained. The research is a qualitative. Interviews were conducted with the owner of Siputri Natural Color Batik and was followed with a direct observation at the production site. The research focused on the coloring process. The batik dyeing process produces liquid and wastes which are processed for watering plants. The research results show that SMEs can implement the closed-loop concept. In Natural Color Batik SME, the closed loop can provide benefits for SMEs by guaranteeing the availability of dye raw materials in the expected quality and quantity. Implementing a closed loop can minimize production costs.The implementation of closed-loop on Siputri Natural Color Batik cannot yet be done comprehensively. Three of the five plants used for dying the batik were not cultivated by the firm. This is due to difficulties in finding seeds and the size of the plants which are quite large. Siputri Natural Color Batik is an example of an SME that can implement a closed loop.

Keywords: batik, circular economy, closed loop, natural colors, SMEs.

INTRODUCTION

Population growth accompanied with the increase in human needs causes environmental impacts. The increase in human consumption in especially textile quite possible distresses environmental sustainability in the long-term. The reason is wastes produced by the textile industry can pollute water and soil. Environmental damages due to wastes from the textile industry can affect health and safety of livings including plants, animals, and humans.

Batik is a traditional art from Indonesia. Batik is a cloth that is processed using dyes and wax to create certain patterns or designs. Batik is an important part of Indonesia's cultural

heritage. As an art, batik must be maintained and continuesly developed without eliminating the cultural elements embedded in it. Batik is considered a symbol of national pride and is often used in various events and ceremonies. The production process involves the use of chemicals so the waste produced is not environmentally friendly. The textile or clothing industry produces liquid, solid, and gas wastes that can cause environmental pollution (Mardiana & Primadasa, 2023). Therefore, to maintain environmental sustainability in the long term, the concept of a circular and closed-loop economy is needed.

The Indonesian government, through the Ministry of Industry, continues to encourage the industrial manufacture sector to shift towards sustainable development. One of the efforts made is to implement the circular economy concept. This prioritizes efficiency in the use of raw materials, reuse, environmental sustainability, and sustainability (Siregar et al., 2023). The circular economy is referred to as actions and policies adopted for the management, optimization, and efficiency of resources. The circular economy replaces the inefficient open production cycle (input-output-waste) with a closed cycle (closed loop). The concept of a circular economy and closed loop is important to reduce the negative impact of waste on the environment in the long term (Mishra et al., 2023).

The concept of a circular economy and closed loop in the case of natural batik dyes can be achieved by supporting several points in the SDGs (Sustainable Development Goals). These SDGs goals were set by the United Nations (UN). Several SDGs (sdgs.bappenas.go.id, n.d.) points that support the SDGs goals include ensuring the availability and management of clean water (point 6), clean and affordable energy (point 7), sustainable cities and settlements (point 11), responsible consumption and production (point 12th), as well as protecting the sustainability of land ecosystems (15th point). The circular and closed loop economy provides a positive impact by the SDG's sustainable development goals. Production results are utilized

optimally by changing them into other forms for reuse with economic value (Arista, 2022). Protecting and managing the environment wisely is the key to achieving sustainable development. Responsibility for protecting and caring for the environment is not only the responsibility of the government or state. It requires active participation from the general public, including large and small companies (Wibawa, 2019).

Several large companies have implemented the concept of sustainability. ADIDAS has been recognized as one of the top 50 "green" brands for its commitment to sustainable environmental practices. They focus on developing environmentally friendly materials (Sicoli et al., 2019). Implementing closed-loop systems in small businesses often faces various challenges that make it difficult to implement. Challenges that small businesses often face are limited resources and minimal knowledge about sustainable practices (Kondala et al., 2023). Uvarova et al. (2020) conducted research on rural SMEs in six EU countries in Northern, Central, and Southern Europe, in particular Italy, the Czech Republic, Latvia, Slovenia, Hungary, and Bulgaria. There are several key barriers for rural SMEs to adopt circular business models. SMEs have limited experience, innovation, and skills. SMEs are less able to adapt to rapidly changing market conditions. Thay are lack of qualified workforce.

This study addresses implementation of circular economy in SMEs in a developing country that is still relatively limited and still in its early stages (Nindiya & Kusumastuti, 2024). It studies on how Siputri Natural Color Batik as one of the SMEs implements circular economic system. Circular economy is a broad concept aiming to achieve environmental sustainability. One implication of the circular economic model is closed loop. It supports the principles of circular economy in terms of reducing, reusing, and recycling materials to create a sustainable cycle without relying on the use of new resources continuously. Closed loop

focuses on maintaining the overall capital stock and is very different from the 'open' industrial economy that relies on the use of materials from the past (Kara et al., 2022).

Closed-loop system in Siputri Natural Color Batik can be an interesting discussion since wastewater resulted from dying process often contains organic compounds that are difficult to decompose naturally. As a result, waste can pollute the environment, especially water sources. Polluted water sources can damage the health of living creatures, including humans (Sirait, 2018). Efforts to minimize waste in the batik industry are to implement a clean production strategy in the production process (Akbari et al., 2022).

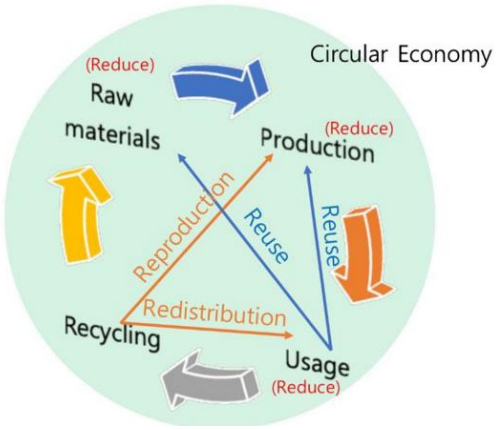
This research aims to know how the process of applying a closed loop is implemented on the Siputri Natural Color Batik. Can the whole concept of closed loop (100%) be applied and what are the obstacles and benefits of applying the closed loop to Siputri Natural Color Batik?

LITERATURE REVIEW

Circular Economy

A circular economy is a model that focuses on the efficient use of resources. Utilizing wastes to produce long-lasting products aims to increase social and economic benefits that are environmentally friendly (Fadhillah & Fahreza, 2023). Circular economy refers to an economic system where the business model changes linear concepts to circular or circular ones. A linear economy moves in a straight line. Meanwhile, the circular economy moves in a circle. Some ways to implement a circular economy include reducing, reusing, recycling, and recovering materials from production, distribution, and consumption processes. This system operates at various levels, starting from the micro scale such as products, consumers, and companies. Up to the meso level such as eco-industrial parks, and even down to the macro level such as cities,

regions, countries, and surrounding areas. The goal is to achieve sustainable development. The impact on environmental quality, economic prosperity, and social justice, for the benefit of both current and future generations (Kirchherr et al., 2017).



Source: *Circular Economy and Sustainability of the Clothing and Textile Industry* (Chen et al., 2021)
Figure 1Circular Economy Process

From the picture above regarding the circular economy, it can be seen that the processes that occur move in a circle or circle. The circular economy concept is also balanced with the main principles of 3R, namely Reduce, Reuse, and Recycle. Starting with the use of raw materials or materials that are produced into finished goods. This process involves the reduce principle or in other words making reductions. Reducing raw materials to be processed will also reduce consumer use. Items that have been used can be reused. Or it can be recycled, which turns items that should be waste or rubbish into useful materials (Chen et al., 2021). Reproduction and redistribution are also carried out. This rotation system continues, creating the concept of zero waste. Zero waste is a waste management principle that seeks to minimize the amount of waste that ends up in final disposal sites (Nusamuda Pratama, 2023).

The circular economy concept offers opportunities to reduce waste and extend the life of products. The basic concept of a circular economy involves reducing waste and pollution, extending the lifespan of products and materials, and regenerating natural systems. A circular

economy applies practices of efficient use of resources, recycling products/materials, and wise waste management. By applying these principles, optimal results can achieved. More efficient use of resources can minimize negative impacts on the environment. Recycling goods and materials creates jobs, saves energy, and reduces resource consumption and waste (Circular Economy, 2016). The circular economy perspective is more directed at a broader dimension through the concept of a closed loop that aims to reduce the use of limited resources (Camilleri, 2019).

Closed Loop

Closed Loop (CL) is a closed supply chain cycle that includes two main flows, namely forward flow and reverse flow. In a closed cycle, waste is transformed and reused into input. This system supports the circular economy concept to create zero waste (Mishra et al., 2023). Closed loop starts from raw materials processing and ends with products. The process produces wastes. However, the wastes are recycled and reused as raw materials by other units (Leksono & Abidin, 2021). According to Asif et al. (2012), closed loop supply chain management is defined as the design, control, and management of systems to optimize value creation throughout the life cycle of a product.

The main characteristic of a closed loop design is that the finished products or the wastes are back to the initial supply chain to be repaired, remanufactured or recycled (Tapia et al., 2021). This is to increase efficiency of the resources use to support environmental sustainability in the long term. Thus, wastes are minimized and nothing is wasted. Closed loop can be done by recycling or reusing materials. This system is carried out continuously to form a circular and closed flow system. The term "closing the resource cycle" was introduced by Triguero et al. (2022) to describe this. Here, the company seeks to close the cycle between the post-use and production stages to create a circular flow of resources.

A research in Khmelnytskyi, Ukraine, shows that textile waste creates a significant problem. Only 30 of more than 600 sewing companies in Khmelnytskyi are able to recycle their 800 tons of textile waste every year. The application of textile waste recycling technology can improve environmental conditions and reduce the amount of waste. Zero waste design aims to use resources efficiently throughout the product life cycle by maximizing material utilization, encouraging reuse, recycling and recovery, and designing products that are easy to modify or reuse (Bukhantsova et al., 2024).

METHODS

The research used a qualitative method. The techniques to collect data were interview the owner of Siputri Natural Color Batik and observation the production process especially the dying process in the location. The analysis uses the closed loop concept which focuses on the coloring process to see how Batik Warna Alam Siputri implements a circular economy. Observing the whole production process was used to understand the supply chain. The production stages are grouped orderly: collection of dye plants, dying process, waste disposal, liquid and solid wastes management process, and watering dye plants using the wastes.

RESULTS AND DISCUSSION

Siputri Natural Color Batik established in 2017is an ecofashion brand from Semarang. It is committed to preserving culture and the environment through the production of natural dye batik. Its vision is to benefit society and the environment. To use natural dyes and not the synthetic ones is the mission to achieve this vision, (Untari, 2021). Siputri Natural Color Batik producing natural dye batik fabrics, ecoprint fabrics, men's and women's cloths, and

accessories such as hair ties and necklaces has won several awards. It has shipped the products to foreign countries.

Production Process of Siputri Natural Color Batik

The initial production process is the purchase of the main raw material, namely cloth. The fabric is processed by mordant to clean the fabric from factory chemicals. The cloth cleaning process was carried out for 3 days and used the services of another party. Once the fabric is clean and ready to proceed to the next stage, a pattern is made using a pencil. Next is the cutting process, where the finished pattern is then overwritten using wax or wax on the fabric according to the pattern that has been made. After painting, the cloth is dipped in dye liquid. The cloth that has been dipped in dye is then drained. Re-coloring is carried out at least 7 times or until the resulting color matches your wishes. The coloring process is carried out manually using a brush in parts that require color emphasis. Then, the fabric is dried and ready to be sewn.

Siputri Natural Color Batik uses several plants as natural dyes. Mahogany (*Swietenia mahagoni*) is used for the skin of the fruit as a pale green color. Tegeran (*Cudrania javanensis Trécul*) uses part of its woody stem as a yellow color. Tingi (*Ceriops candolleana arnwarna*) is used for the woody part of the stem as a brown color. Ketapang (*Terminalia catappa*) uses the leaves as a brownish-yellow-green color. Jalawe (*Terminalia bellirica*) uses the skin of the fruit as a brownish-yellow color. Some of these plants come from self-planting around the yard, given to them by other people, and bought from other parties. Tingi (*Ceriops candolleana arnwarna*), jalawe (*Terminalia bellirica*), and mahogany (*Swietenia mahagoni*) are not planted on their yard. The material is boiled for 1 - 1 and a half hours until it boils. 1 kilogram of material mixed with 11 liters of water will produce 9 liters of dye. The boiled water is cooled first before the cloth is dipped.

Closed Loop Process of Siputri Batik Coloring

Figure 2 is a schematic of the application of closed loop in the dying process of Siputri Natural Color Batik.

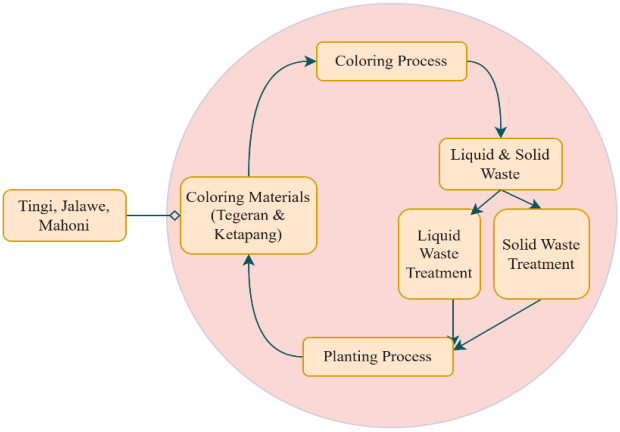


Figure 2. Application of Closed Loop in Siputri Natural Color Batik

The Closed loop concept is implemented in batik dye materials as in the picture above. Tegeran (*Cudrania javanensis Trécul*) and Ketapang (*Terminalia catappa*) were taken from their yard. Tingi (*Ceriops candolleana arnwarna*), Jalawe (*Terminia bellirica*), and Mahogany (*Swietenia mahagoni*) were obtained from other parties. The necessary parts of the plant are taken and boiled until boiling. The boiled product is used as a batik dye. The dyeing process produces liquid and solid waste. Liquid waste consists of remaining boiled water. Solid waste in the form of leftover boiled sediment.

Liquid waste is collected in the first tank (figure 3). In the first tank, there are husks, river stones, and sandstone to filter the waste to make it cleaner. Then it is filtered into the second tank (figure 4) which is no longer too cloudy. Then there is a large tank (figure 4) for a mixture of household wastewater and filtered production waste. Water resulting from liquid waste in large tanks will be absorbed into the ground. Waste can be used to water plants. Solid waste in the form of wood is dried and used as mulch. Mulch is placed on the soil surface over

plants to reduce evaporation. Solid waste in the form of leaf deposits and fruit peels is used as fertilizer for plants. In this way, liquid and solid waste are processed for the planting process.

This waste does not pollute the environment, there are even plants around the reservoir that grow well. The waste from boiling the leaves is thrown onto the ground where over time it will rot and decompose into soil.

Figure 3. The First Tank, Second Tank, And Final Reservoir

It is not only liquid and solid waste from natural dyes that companies use. Production waste such as thread and leftover fabric (rags) is used for accessories (tote bags, earrings, necklaces, hair ties, etc).

Discussion

Closed loop can be applied to the dying process of Natural Color Batik Siputri. The closed loop system related to supply chain management ensures the availability of dyes quantitatively and qualitatively. Dyes nurtured and planted near by the production facility guarantee the quality of color as they can be used directly right after taken from the plants which can result in consistent color. No shipping dyes also reduces carbon emissions. This supply chain ensures that the process from upstream to downstream does not damage the environment.

The application of *closed-loop* in Natural Color Batik Siputri coloring is not yet comprehensive. Three dye plants are not included in the closed loop system of Natural Color

Batik Siputri, namely tingi (*Ceriops candolleana arnwarna*), jalawe (*Terminalia bellirica*), and mahogany (*Swietenia mahagoni*). This is because no one is selling these plant seeds. In addition, some of these plants are forest plants that are difficult to plant yourself. This is due to the fairly large size of the plant. The waiting time for plants to grow until they are ready to be used is quite long.

A closed-loop system related to supply chain management guarantees the supply of coloring materials in both quantity and quality in Batik Warna Alam Siputri. Coloring materials taken from plants grown in one place guarantee the quality of the freshness and consistency of the color produced. The quality of the color is guaranteed because it is planted with the same soil nutrients. The collection of dyes is taken from plants. Some of the plants come from the yard. The quality of raw materials grown by yourself is better maintained because they are used directly. The dye raw materials that are grown themselves do not go through a shipping process, thereby reducing carbon emissions. An effective supply chain ensures processes from upstream to downstream do not damage the environment.

Natural Color Batik Siputri proves that the *closed-loop concept* can be applied to small businesses. Implementing *a closed loop* does not always require high technology and high costs. The application of *closed-loop* in Batik Siputri minimizes production costs. The waste produced does not pollute the environment. The waste produced makes the soil fertile. There are plants around the shelter that grow well. Some of the raw materials for batik dye are picked directly from the yard. The dye raw materials used are fresher because they can be used immediately. Not like in di six EU countries in Northern Europe, Natural Color Batik Siputri No experience limitations experience, innovation, and skills. However, Siputri Color Batik experiences limitations in land for planting 3 big plants. Thus, this does not disrupt the production process because can buy from the other party even often get material for free.

CONCLUSION AND IMPLICATIONS

Conclusion

Natural Color Batik Siputri can do a closed loop in the coloring section by processing the waste. This proves that SMEs can carry out a closed loop. A closed loop can provide benefits for SMEs by guaranteeing availability in quality and quantity. Implementing a closed loop can minimize production costs. No need to incur raw material and transportation costs.

This research proofs that SMEs can implement circular economy and apply closed loops. Awareness and knowledge enable SMEs to do these. Closed loops provides benefits for SMEs. Although Natural Color Batik Siputri has not been able to supply dyes independently from the plants it nurtures and processes in a sustainable manner (can be replanted). The application of closed loop can minimize production costs since it does need to spend money on raw materials and transportation.

Recommendations

The results show evidence that SMEs can implement closed loop and circular economy. The implementation of closed loops must be disseminated to other SMEs and thus training and socialization are needed. The dissemination must emphasizes advantages or benefits SMEs possibly gain from implementation of closed loops in especially in availability of raw materials. SMEs can support the success of circular economy implementation.

SMEs that have implemented closed loop must continue to strive to make better implementation.The implementation of closed loop in Batik Siputri is not yet comprehensive and thus it may implement closed loop totally. It may grow all dye plants. It is possible to expand the land for planting dye plants. Companies need to look for information regarding seed availability. Companies need to learn planting techniques for tall (*Ceriops candolleana*

arnwarna), jalawe (*Terminalia bellirica*), and mahogany (*Swietenia mahagoni*) so they can be planted in the yard. Companies need to increase public education about sustainable practices. Other SMEs need to implement *a closed loop* to maintain environmental sustainability.

This research is a case on one company and one process stage (dying process). Therefore, further research can study more comprehensively by coevring more businesses.

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