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Implementation of Green Manufacturing in Traditional Batik SME to Reduce Waste of Raw Materials and Waste Water

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***Abstract*-** UNESCO recognizes Indonesian batik as one of the Intangible Cultural Heritages of Humanity. As generally in Indonesia, batik industry is currently still classified as small and medium enterprises (SMEs). One of quite popular in Indonesia is the traditional batik of Jetis Sidoarjo village. The case of our study on batik SMEs in Jetis village (Sidoarjo). This study is the implementation of the green manufacturing method. We define and analyze: 1) What kind of an inefficiency at every stage of traditional batik production process. 2) How is the opportunity of application of green manufacturing at every stage of traditional batik production process? We have identified the root causes of problems that lead to waste of raw materials, resources, energy, and waste that burden environmental performance. The wastewater of traditional batik production still exceeds the high pH, BOD and COD (especially BOD and COD) values far exceeding the quality standard. Besides the high pH, BOD and COD values, the wastewater samples also still contain dangerous heavy metals, such as Zn, Cd, Cu, Cr, and Pb. We also state some proposed improvement that available to green manufacturing team to decide and choose it and then implemented.

***Keywords*-** *Indonesian Batik, Green Manufacturing, Green Productivity, SMEs, Sidoarjo*

I. INTRODUCTION

Small and medium-sized enterprises (SMEs) are very important for developing economies in the Southeast Asian countries, including Indonesia. SMEs play an important role as the backbone of the national economy. In the midst of the global economic downturn, SMEs are virtually unaffected and their growth relatively stable. Out of 100 business in Indonesia, 99% of them are SMEs, which contribute greatly to the revenues [1]. This is more than 50% of Indonesia's total GDP and also absorbed up to 97% workers [1]. Ironically, Indonesian SMEs products are facing strong competition over imported products, even in their own country. Opening the free trade agreement, the Indonesian market is flooded with foreign products where customers can easily select and customize the product [1]. Countries whose their economies are mostly driven by SMEs have been implementing many kind strategies to improve the competitiveness of their SMEs. Globalization and emerging technologies are having a big impact to the SMEs.

Currently, environmentally friendly production has become a strategic issue in developing economy countries. SMEs are critical to all economies but also have a significant negative impact on the environment. Their collective footprint equates to 60% of industrial pollution [9]. The concept of green manufacturing has been known worldwide as a key strategy for sustainable development model for manufacturing companies [10]. This concept combines principles of environmental protection and energy conservation into production activities and services to reduce the industrial waste, save energy and scarce resources, and minimize pollution to the natural environment while achieving a production economy. Increasing environmental awareness and concerns are the driving force which pushes manufacturers worldwide to adopt green manufacturing practices.

II. LITERATURE REVIEW

A. Definition of SMEs

According to [2] small and medium size enterprises (SMEs) in Indonesia growth for several reasons, such as their potential to create employment and to generate foreign currencies through export, and their potential to grow into larger enterprises. According to the Ministry of Cooperatives and Small and Medium Enterprises of Indonesia, the meaning of Small Enterprise is a business entity having a net worth of IDR 200 million excluding land and business premises, and has annual sales of at most IDR 1,000 million.

B. Indonesian Batik Industries and Their Problems

The United Nations Educational, Scientific and Cultural Organization (UNESCO) recognizes Indonesian batik as one of the Intangible Cultural Heritage of Humanity. As generally in Indonesia, batik industry is currently still classified as small and medium enterprises (SMEs). One of quite popular in Indonesia is the traditional batik of Jetis Sidoarjo village.

The strategies position of batik industries is contradictory with the capacity of their production and management.There are many problems faced by SMEs in batik industry, such as limitation of capital, limitation of equipment, limitation of

natural dyes sourcing, limitation of advertising, limitation of relationship with higher education, the private sector, and government [3]. The external threat to the batik industry is coming from China. Nowadays, the textile product from China flooded batik markets in Indonesia with cheaper. Textile batik from China can be produced quickly by machine and China also capable to keep an eye with the worldwide design patterns. Whereas the Indonesian traditional batik takes a longer time to produce and Indonesian traditional batik only produces based on local designs.

The internal problem with the process of making batik is inefficiency because of material-usage. This inefficiency can lead to high cost of production and increase the volume of the waste that generated from the raw materials, and the production process. Furthermore, the increase in the volume of waste will also cause economic loss and a negative effect on the environment. [3] Reported that the portion of wax and dyestuff cost dominate the total production cost. Unreusable wax reached 60%, dyestuff losses from 0.07% a year until 54.58% a year, and water inefficiency approximately reached 80% a year. The increase in the volume of waste will also cause economic loss and a negative effect on the environment. [3] Assesses the relative efficiency of the production process of making stamped-batik from 16 SMEs which is located in Pekalongan, Solo, and Yogyakarta.

The traditional batik processing consists of several stages of the process: 1)“Ngloyor”, the process of cleaning cloth from the factory that usually still contains kanji, using hot water mixed with straw. 2) “Ngemplong”, the more cloth in the hammer to smooth the fabric layer for easy in batik. 3)”Memola”, that is making a pattern on the fabric using a pencil. 4) “Batik”, which is to attach wax to the pattern that has been drawn using "canthing". 5) “Nembok”, which is closing the cloth that will be left white with wax. 6) The coloring is to give color to some batik cloth, in this way it can be obtained various colors in a piece of fine cloth. 7) Drying the colored cloth. 8) “Mbironi”, ie to cover the piece of cloth to be left white and the cloth part there are dots. 9) Dyeing cloth with naphtol dye. 10) Drying the colored cloth. 11) Dyeing cloth with Vatsol dye. 12) “Nglorod”, which is the process of removing candles with boiling water. 13)Drying the batik cloth.

C. Green Manufacturing Practices

[4] States that environmental and green attempts in manufacturing should move from being an environmental management approach to an environmental strategy. This will create a win-win situation by which manufacturers can improve their environmental performance while achieving economic gains. In addition, the clean production program adopted by the United States promotes that green manufacturing will result in increased productivity, efficiency, and corporate competitiveness. Green manufacturing deals with maintaining environmental, economic and social objectives in the manufacturing field. Reducing hazardous emissions, eliminating waste of resources consumption and recycling are examples of sustainable green manufacturing activities.

Green manufacturing is an approach to the design system operation to reduce environmental impact. Green manufacturing aims to the integration of environmental improvements of industrial processes to minimize or prevent pollution to water, air, and land. Also to reduce waste at source; and to minimize risks to humans and other species [5].

The implementation of green manufacturing on SMEs including batik SMEs has attracted the interest of researchers [6] report the drivers and barriers faced by SMEs in implementing green manufacturing methods, study case in Malaysia. The environmental performance of SMEs is mostly driven by the intention of the company owners [6]. [7] applicated green energy for the production process of batik. The production process is still using kerosene stoves, while the use fossil fuels that produce environmental pollution. The use of the solar home system and batik electric stoves is more practical and economical [7]. The efficiency in the production process of making stamped-batik can be enhanced through the adequate allocation of resources in the production process, in the study case of SMEs batik in Laweyan Center-Solo, and SMEs batik in Yogyakarta [3]. [8] Implemented the cleaner production in a natural dye batik industry SMEs. [8] State that cleaner production solution, specifically material substitution and process modification could be increased biodegradability.

Based on previous discussed problems, it is interesting to research more about the phenomenon. Our study is interested to define and analyze: 1) What kind of an inefficiency at every stage of traditional batik production process. 2) How is the opportunity of application of green manufacturing at every stage of traditional batik production process.

III. RESEARCH METHODOLOGY

The methodology used in this research is the implementation of the green manufacturing method. Implementation stages are as follows: 1) Getting started, carry out the process of collecting various basic information and the process of identifying the scope of the problem in traditional batik production process. At this stage the collection of information, analysis, the operation of traditional batik production process from raw materials to finished goods. Then, determine the balance of material in traditional batik production process. It serves as the process of quantitative evaluation of input and output materials. 2) Planning, at this stage, conducted identification of the problem and the cause, where the data obtained from the survey on traditional batik production process is used to identify the problems and causes. 3) Generation, preparing alternative suggestions for improvement to reduce the waste of raw materials and wastewater in traditional batik production process.

In this research involves: (i) the selection of samples of research, and (ii) the selection of variables inputs and outputs. Participant of this study consist of six owners of SMEs batik in Jetis village (Sidoarjo). This research conducted in-depth interviews and observations of six SMEs to investigate the resources used as inputs in the production process of batik making and also to explore the resulting output.

IV. Results and Discussions

We examine the possibility of wastewater in traditional batik production process. Batik waste is classified as 1)solid waste such as patchwork and melt batik wax. 2) Liquid wastes such as wastewater from the staining and wastewater process of the washing process.

The primary data is collected through survey and test of wastewater quality. The collection of primary data is using direct observation in case study location, interview with the SMEs staff and testing of wastewater characteristics. In the first test of wastewater characteristics, sampling is conducted through composite sampling where the samples are collected by mixing the samples of wastewater produced from traditional batik production process, while the sampling for wastewater from each process is collected using sampling method which represents the condition of wastewater from each stage of traditional batik production process. The total samples for sampling and implementation are 45 samples. Whereas the dependent variables of wastewater characteristics are pH, Cu, Zn, Cr, Cd, Pb, BOD and COD.

Then the wastewater samples were tested in TAKI laboratory at Chemical Engineering Institut Teknologi Sepuluh November. The wastewater test performed is adjusted to the Governor regulation of East Java Province of Indonesia number forty-five the year 2002. The averages of wastewater test results are shown in Table 1.

As shown Table 1 that the waste-water of traditional batik production still exceeds the high pH, BOD and COD (especially BOD and COD) values far exceeding the quality standard. Besides the high pH, BOD and COD values, the wastewater samples also still contain dangerous heavy metals, such as Zn, Cd, Cu, Cr, and Pb. Habits of small traditional batik industry in general that exist in Jetis village Sidoarjo do not have unit Installation of Wastewater Treatment. The waste of residual water is discharged directly into the sewer to the surrounding river, without waste water treatment. While the wastewater that is not accommodated in the sewer will flood the soil around the location of SMEs. Then it will seep into the soil. This condition can cause an adverse impact on the environment and also burden the environmental performance. These elements are very damaging to the life of water biota and harmful to human health. The influence of heavy metals is accumulative. In the long run can damage the kidneys, liver, and brain of humans.

Next, we examine the possibility of inefficiency in traditional batik production process. Based on our observations on the production process stages in six batik SMEs, we found there are inefficiencies of energy use, water, materials, and additives. The inefficiency will affect the high cost of production and burden the environmental performance due to high waste as non-product output. The first step is to identify the balance of the batik making process on the production floor. Material balance in traditional batik making process is shown in Table 2.

TABLE I. Laboratory Test Result of Waste-water from Traditional Batik Production

Parameter	Quality standard (mg/liter)	Average of sample (mg/liter)	Method
pH	6 - 9	0.131	pH-Metry
Cu	2	0.061	Atomic Absorption Spectro-Metry
Zn	10	0.062	Atomic Absorption Spectro-Metry
Cr	0,5	0.007	Atomic Absorption Spectro-Metry
Cd	0,05	0.05	Atomic Absorption Spectro-Metry
Pb	0,5	930	Atomic Absorption Spectro-Metry
BOD	50	1540	DO-Metry
COD	100	131	Reflux

TABLE II. Material Balance in Traditional Batik Making Process

No.	Process	Input	Output	
			Product output	Non-product output
1	Cutting	sheets of "mori" cloth	pieces of" mori" cloth	patchwork
2	Sewing edges of "mori" cloth	sewing edges of the "mori" cloth	-	-
3	Washing	stitching of "mori" cloth, caustic soda, peanut oil	wet mori cloth	Waste-water
4	Drying	wet "mori" cloth	dry mori cloth	-
5	"Ngemplong	dry "mori" cloth	dry "mori" cloth	-
6	Make a pattern	the "mori" cloth, pencil	pattern on the "mori" cloth	-
7	"Mbatik"	pattern on the "mori" cloth, wax, kerosene	batik cloth	emissions, CO, CO2, SO2, melt wax
8	"Nembok"	batik cloth, wax, kerosene	batik cloth with wax	emissions, CO, CO2, SO2, melt wax
9	"Nyoled"	batik cloth with wax, pigment.	batik cloth with colour	solid waste
10	Drying	batik cloth with colour	dry batik cloth with colour	-
11	"Mbironi"	dry batik cloth with colour	dry batik cloth with "mbironi"	emissions, CO, CO2, SO2, melt wax
12	Dyeing	batik cloth with "mbironi" colour, Napthol dye, water	wet batik cloth with "mbironi" and one colour	liquid waste
13	Drying	wet batik cloth with "mbironi" and one colour	dry batik cloth with "mbironi" and one colour	-
14	Dyeing	batik cloth with "mbironi" and one colour, Vatsol dye	wet batik cloth with "mbironi" and two colour	liquid waste
15	"Nglorod"	wet batik cloth with "mbironi" and two colour	batik cloth with "mbironi" and two colour	steam, liquid waste, chemical compound odor
16	Drying	batik cloth with "mbironi" and two colour	batik cloth that has been finished process	-

Based on data presented in table 2 above, we identified the problem and its root cause by using cause effect diagram tools. Cause and effect diagrams are structured approaches to find the causes of a problem. Summary of the root cause and proposed improvements for problems that occur in the production process of traditional batik SMEs in Jetis village (Sidoarjo) is presented in table 3.

TABLE III. PROBLEM, ROOT CAUSE, AND PROPOSED IMPROVEMENT

No	Problem	Root cause	Proposed improvement
1	Unused patchwork pieces	inaccurate "mori" material cutting,	• Accuracy and discipline of worker • Reuse mori cloth pieces as handicrafts, such as napkins, handkerchiefs and other trinkets
2	Batik wax waste is scattered around the workplace	Batik wax dropped on the floor around the workplace	reuse the batik wax taken from the "lorod" process, as a mixture of batik wax by: • Making a batik wax trap. • Use the base around to the work floor so that the batik wax was littering the workplace can be collected.
3	The remaining chemical dyes litter on the floor and containers in the work area	chemical dyes are weighed inaccurately	• A good weighing procedure • Making shelves to place and store chemical dye supplies • Organize the operation of the dyeing process, for example, first do the dyeing process for brighter colors then do the dyeing process for the darker colors • Separating between concentrated wastewater and wastewater. • Installation of Waste Water Treatment unit
4	Waste-water	use of large amount water in the process of making traditional batik	• Organize the operation of the dyeing process, for example, first do the dyeing process for brighter colors then do the dyeing process for the darker colors • Separating between concentrated wastewater and wastewater. • Installation of Waste Water Treatment unit
5	Concentrated wastewater	use of large amount water and chemical dye in the process of making traditional batik	• Use natural dye • Wastewater treatment plants use a combination of physical and chemical processes
6	Waste of electrical energy	high frequency in the use of water pumps	• Installation of water tower • Installation of home solar cell system to distribute electric current to storage batteries as a source of electrical energy for lighting in the batik production room
7	Emissions, CO, CO2,	use of a large amount of kerosene	Installation of home solar cell system to distribute electric current to electric stoves

V. CONCLUSION

In this study, we have identified the root causes of problems that lead to waste of raw materials, resources, and energy and waste that burden environmental performance. We also state some proposed improvement that available to Green Manufacturing team to decide and choose it and then implemented. Once the root of the problem and the cause is known, the next step is to determine the goals and objectives to be achieved by SMEs.

This is a guideline for the Green Manufacturing Team to choose which alternatives are possible to implement in SMEs of traditional batik in the Jetis village-Sidoarjo. The implementation of Green Manufacturing in SMEs will require some adjustments. The following guidelines can provide useful insights for practitioners as well as researchers: (1) The goals should be based on the identified problem. (2) Goals may generate more than one target. (3) The desired target should be in accordance with the needs of SMEs. (3)There should be an indicator used to know the achievement of targets and goals in units of time.

Finally, for further research, we focus on generating, selecting, implementing, and evaluating alternatives to Green Manufacturing. This step is crucial and requires high creativity to find possible and appropriate methods to increase green productivity for SMEs of the traditional batik.

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