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Waste Reduction in Green Productivity in Small and Medium-Sized Enterprises of Kampoeng Batik Laweyan

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ABSTRACT

This study aims to provide recommendations for reducing the concentration of chemicals in liquid waste. The method used is waste reduction, which is one of the goals in Green Productivity (GP). Waste parameters used for testing are COD (Chemical Oxygen Demand), BOD (Biological Oxygen Demand), TSS (Total Solid Suspended), pH, total chromium, and phenol. Waste reduction applied is by filtering technique, which uses natural materials such as palm fiber, sand, activated charcoal, zeolites, and gravel. This simple filtration can safely be used at home and larger scale batik SMEs. Waste samples were taken from different SMEs, which are SME A with large scale production capacity and SME B with a small scale. The liquid waste tested was pure waste before filtration and waste after filtration. Waste testing was performed in a laboratory and the results show that the concentration of the tested parameter decreased. The decrease in concentration was significant. The results of SME A show that COD, BOD, and TSS decreased by 85.8153%, 77.09251%, and 90.65744% respectively. While the pH increased 15%, total chromium was still within safe limitation and phenol decreased by 86.56255%. Whereas, SME B had a decreased concentration of waste by 66.67%, 41.22%, 72.34%, and 5.55% respectively. The pH had increased by 5.55%, total chrome was found in a safe perimeter. The results of the two SMEs show that the waste reduction effort with filtration can reduce the concentration and increase the pH of the liquid waste before filtration. This is expected to reduce the negative impact of batik liquid waste on the environment.

Key words: batik waste, environmental impact, Filtration, Green Productivity, Waste Reduction

1. INTRODUCTION

Batik is a commodity produced by Small and Medium-Sized Enterprises (SMEs). Nowadays, batik has been produced traditionally due to the limitations of SMEs. The environmental impact caused by the batik production process has not been carefully considered which results in waste discharged into rivers or residential sewage. Liquid waste containing dyes derived from chemicals will bring an impact on the environment.

Batik has been pronounced as an intangible cultural heritage of Indonesian Cultural Heritage by the United Nations Educational Scientific and Cultural Organization (UNESCO) on October 2, 2009 [1]. Laweyan is one of the oldest and most well-known batik centers in Solo city. This area is established on approximately 24.83 hectares with 2500 residents, the majority livelihood of residents are as batik crafters and merchants. Initially, there were 22 Small Medium Enterprises (SMEs) producing batik, but after Kampoeng Batik Laweyan was established the number of SMEs producing batik increased by 29 units and in 2008 totaled in 51 units [2].

Initially, the government promoted the kampoeng batik Laweyan as a preserved cultural heritage site. Kampoeng Batik Laweyan is in the western part of Solo city and is the largest batik production center in Indonesia. This location is very strategic and is the best asset for trade and industry [3]. This development requires batik entrepreneurs to always create improvements and betterment in performance so they can compete with other industry players. Surely, the batik industry has a good impact on the surrounding community because it can improve their standard of living, yet it is undeniable that batik also harms the environment [4]. For instance, SMEs that have a close relationship with environmental pollution is batik industry because besides producing batik, the process of making batik also produces solid and liquid waste that can pollute the environment due to the use of synthetic dyes [5].

Batik SMEs in Laweyan mostly conduct a very simple production process. The number of workers is still very small, roughly 1-5 workers. The attention of SMEs towards environmental sustainability is still poor. This is shown by the activities carried out more likely to gain maximum profits and neglect the environmental impacts. This also occurs in other countries, in practice environmental management, SMEs focus more on manufacturing activities rather than the environment-related [6]. SMEs also have constraints in terms of a workforce that understands matters relating to cleaner

production systems, such as energy-efficient and environmentally friendly technologies. Besides the lack of time and availability of capital, which are also as obstacles, the batik industry is currently in a competitive market so there is not much time to consider energy efficiency and cleaner production systems. They spend more time marketing products, fulfilling orders, negotiating prices, and maintaining delivery schedules [7]. Previous research has explained that one of the obstacles encountered by small industries when dealing with environmental problems is the cost factor [8] as the investment costs to achieve an environmentally friendly industry are considered unprofitable.

The textile industry is inseparable from liquid waste including batik cloth. Batik has a serious problem with waste management since batik liquid waste has a high concentration [9]. The high concentration of waste results in the underwater ecosystem problems, a lack of attention from SME owners regarding these problems adds fuel to the fire.

According to the Surakarta City Environmental Agency (BLH) report in 2006, Laweyan batik cluster produced 110-150m cubic of liquid waste per day from 20 business operators [10]. Obviously, the liquid waste produced by SMEs brought impacts to its surrounding, for example, the decline in the aquatic biota ecosystem in the river which is used as a final disposal site after entering the WWTP (Wastewater Treatment Plant) and cannot be longer repaired. Batik circulates pollution because in the production process it uses materials that contain chemicals for the coloring process [5].

The environmental impact is very closely related to the production process. The material used in the production process will become liquid and solid waste that will be released into the environment. Research on environmental impacts is essential to analyze the batik production process and its impact on the environment. Inefficient use of the material is also connected to the environmental impacts that occur. The dyeing process of batik is a process that requires large amounts of water and produces a lot of waste and is hazardous, as shown by traditional batik industries [11]. Therefore, entrepreneurs, crafters, and batik makers must carefully consider environmental aspects in every production process to create harmony with the surrounding environment [12].

Batik A SME produces printed batik on a large scale that uses synthetic dyes in the production process. The liquid waste is discharged directly into the river. This triggers various problems, namely, the river water ecosystem is affected by liquid waste. The general condition of this SME is a simple production process and only considers the quantity of production and the benefits over the environmental impact caused by the batik production process. Generally, SMEs are thoughtless to consider whether the waste is dangerous or not. They also do not perform any treatment for liquid waste, such as precipitated, filtered, or other treatments, but release those chemicals into the river or residential sewage. Kampoeng Batik Laweyan has already provided WWTP (Waste Water Treatment Plant) but only part of SMEs taking benefit from it. This occurs due to the unsupportive geographic position for channeling waste to the WWTP. This study aims to provide recommendations for SMEs to be able to process their waste simply and independently before disposal. The method used is a waste reduction with filtration.

2. WASTE REDUCTION

Waste reduction is one of the stages of Green Productivity. Green productivity aims to ensure environmental protection by conducting profitable business through a multidisciplinary, systematic, and holistic approach [13]. Green Productivity strives for a business to continue to gain profits and high productivity while still paying attention to the environmental impacts it may cause. Within green productivity, there are four objectives, one of which is waste reduction.

Waste reduction is a method used to reduce the amount of solid or liquid waste of companies. The waste reduction includes the reaction of waste sources and recycling. The application of waste reduction can use a variety of techniques. Filtration, for instance, with the mechanism of solid or liquid waste that is discharged into the flow system will go through a filter serving to decipher the concentration of waste. Materials used for liquid waste treatment using filtration include palm fibers, sand, gravel, activated charcoal, and zeolites [14]. Filtration media is shown in Figure 1 and the design of filtration equipment [14] is presented in Figure 2.

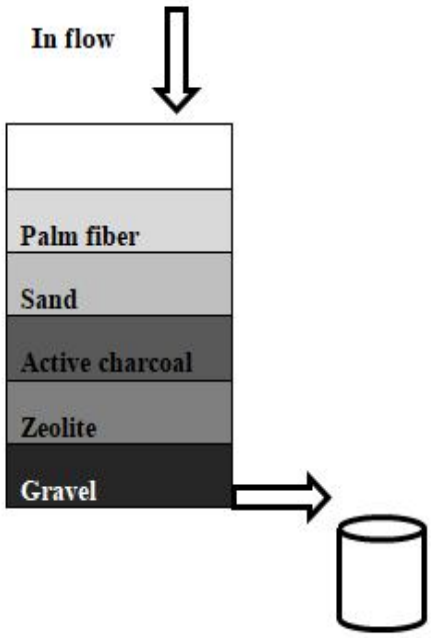

Figure 1: Filtration Media

Figure 2: Design of Filtration Tool

The research method of this research is descriptive analytic. Descriptive analytic is research that identifies SMEs' problems, takes several data, and then analyzes them based on objective explanations and the available facts. Batik A and Batik B SMEs are the two objects used in this study including members of Kampoeng Batik Laweyan Development Forum (FPKBL) located in Kampoeng Batik Laweyan, Laweyan Surakarta. This study compares wastewater before and after filtration using 2 liters of the waste sample. Filtration tool used was made from a water pipeline that contains materials such as palm fiber, sand, zeolite, activated charcoal, and gravel arranged in sequence as shown in Figure 2. Then the liquid waste sample was discharged into it and the filtration results were tested in the laboratory.

Research two SMEs under the study was conducted in September 2019. The data used is data samples of waste taken directly from SMEs and information regarding the maximum liquid waste levels obtained during interviews with the laboratory of the Center for Environmental Health Engineering and Disease Control Yogyakarta. Other supporting data were obtained from reference books, journals, and relevant previous studies. Some references can be considered for further multi disciplinary studies [15]-[16]

3. RESULTS AND DISCUSSION

3.1 Batik A SME

The effort to reduce waste is through the filtration process, which is the process of physical water treatment, the process of separating solid and liquid objects through media containing pores to eliminate as many fine grains of solids suspended within the liquid [18]. Batik A SME produces printed batik with the once dyeing process. Samples of batik production process waste were taken directly and tested in the laboratory. Likewise, waste samples that had been through the filtration process. The results of laboratory tests on liquid waste after the batik production process especially boiling process before and after going through the filtration as shown in Table 1 through laboratory testing, the results before the filtration or initial condition of liquid waste as shown in Table 1. Based on the six parameters used, which are COD (Chemical Oxygen Demand), BOD (Biological Oxygen Demand), TSS (Total Solid Suspended), pH, total chromium and phenol each having laboratory test results of 3465 mg/L, 1135 mg/L, 289 mg/L, 6.3 mg/L, <0.0213 mg/L and 0.16 mg/L. The reduction in the content of the 6 parameters occurred significantly after wastewater had been through Waste Reduction (WR) with filtration. The parameters were 491 mg/L, 260 mg/L, 27 mg/L, 7.3 mg/L, 0.0213 mg/L, and 0.0215 mg/L respectively.

From the laboratory results before and after filtration, it was found a significant decrease in the value of waste concentrations in COD, BOD, and TSS. Conversely, the pH increased significantly. The difference in concentration before and after waste reduction is also seen in Figure 3. It shows that the filtration process has a positive impact on the reduction concentration of waste. Thus, when liquid waste is discharged into the river, it will reduce the impact it may cause.

Table 1: Laboratory Test Results of Batik A SME Waste

No	Parameter	Unit	Before WR	After WR	Change in %
1	COD	mg/L	3465.0	491.5	85,81529
2	BOD	mg/L	1135.0	260.0	77.09251
3	TSS	mg/L	289,0	27.0	90.65743
4	pH	-	6.3	7.3	15.87301
5	Total chromium (Cr)	mg/L	<0.,0213	0.0213	-
6	Phenol	mg/L	0.16	0.0215	86.56250

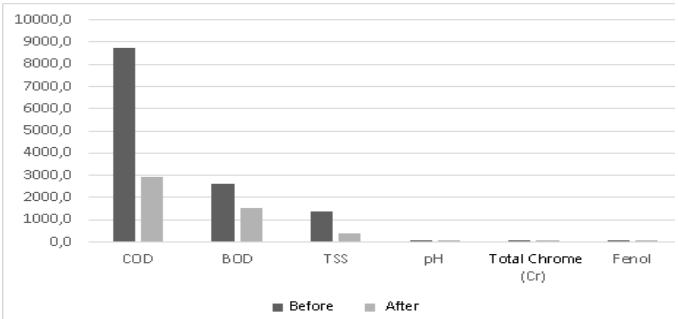

Figure 3: Graph of Laboratory Test Results of Batik A SME Waste

3.2 Batik B SME

The results of the laboratory tests of liquid waste generated in the process of batik production, especially in the boiling process of Batik B SME is presented in the table below. The results show differences from Batik A SME because of Batik B SME's results from the main product of written batik, which is identical to the thickness of the dye materials used. The dyeing process was carried out twice to maintain color quality. Based on the six parameters used, which are COD (Chemical Oxygen Demand), BOD (Biological Oxygen Demand), TSS (Total Solid Suspended), pH, total chromium, and phenol, each has laboratory test results as shown in Table 2; 8725 mg/L, 2620 mg/L, 1396 mg/L, 10.8 mg/L, <0.0213 mg/L and 0.0215 mg/L, respectively. A visible decrease in liquid waste content was found after going through Waste Reduction (WR) with filtration with the test results for each parameter sequentially is 2903 mg/L, 1540 mg/L, 386 mg/L, 10.2 mg/L, 0.0213 mg/L, and 0.0215 mg/L. The percentage change in the parameter content was also quite high. The difference in concentration before and after waste reduction is detailed in Figure 4.

Table 2: Laboratory Test Results of Batik B SME Waste

No	Parameter	Unit	Before WR	After WR	Change in %
1	COD	mg/L	8725.0	2907.5	66.67621
2	BOD	mg/L	2620.0	1540.0	41.22137
3	TSS	mg/L	1396.0	386.0	72.34957
4	pH	-	10.8	10.2	5.555555
5	Total chromium (Cr)	mg/L	0.0213	0.0213	0
6	Phenol	mg/L	0.0215	0.0215	0

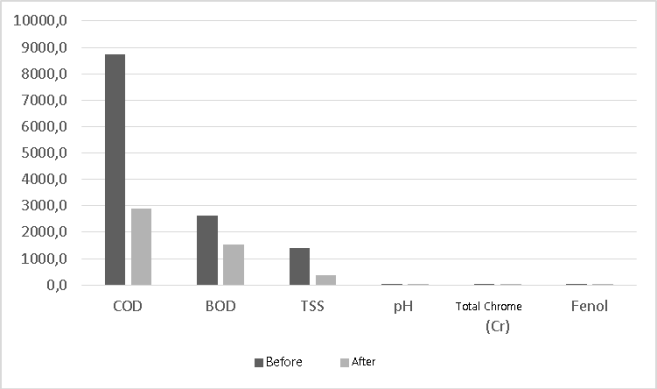

Figure 4: Graph of Laboratory Test Results of Batik B SME Waste

Table 3: Recapitulation of Laboratory Tests Before and After Waste Reduction

No	Indicator	Batik A SME		Batik B SME	
		Before	After	Before	After
1	COD	3465.0	491.5	8725.0	2907.5
2	BOD	1135.0	260.0	2620.0	1540.0
3	TSS	289.0	27.0	1396.0	386.0
4	pH	6.3	7.3	10.8	10.2
5	Total chromium (Cr)	<0.0213	0.0213	0.0213	0.0213
6	Fenol	0.16	0.0215	0.0215	0.0215

The recapitulation results as described in Table 3 show the results of laboratory tests from the two SMEs. In general, the waste content produced by Batik A SME is lower than Batik B SME. The results might due to several things, the difference in the product of both SMEs, for instance. Batik A SME produces printed batik with once dyeing, while Batik B produces batik twice dyeing. In Batik B SME, painting and dyeing were done twice, the first dyeing was conducted after the batik being painted, then dyeing was locked with water glass, and after that was painted and dyed again in the second stage. Then, the dyeing was locked again, the wax removed, washed, and dried. Whereas, in Batik A SME, dyeing was only performed once, only after the stamping process. The production process was mostly similar, the difference was the type of batik produced and the dyeing processes carried out.
Based on two Batik SMEs, Waste Reduction by filtration can reduce the concentration of 6 parameters contained in batik waste. This is expected to minimize the impact caused by batik waste. Decreasing the concentration of the parameters tested can eliminate negative impacts on the environment such as rivers [19]. The Waste Reduction process with filtration is a simple method that can be used by batik SMEs and at an affordable cost because it only uses daily and easy to find materials.

4. CONCLUSION

a. The application of green productivity with waste reduction through filtration techniques using materials such as gravel, zeolites, activated charcoal, and palm fibers can reduce the concentration of batik liquid waste, which will affect reducing the environmental impact.
b. Filtration technique is a simple method that is easily applied in SMEs, both on a small scale and large production capacity.

c. The difference in the concentration of waste from the two SMEs is due to the different products and requirements for the dyeing process.

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