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Implementing cleaner production in small and medium batik industry as efforts on environmental management and improving working productivity

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ABSTRACT

Batik recognition as the world's cultural heritage has a positive effect on the national growth of batik industry majority of them are small industries. On the other hand, batik industry activities also affect environment. Those industrial activities that could potentially affect environment come from the production processes such as coloring, wax coating, and dyeing where most of the produced wastes are liquid waste. This research aims in showing that implementing cleaner production through *goodhousekeeping* approach increases productivity, and at the same time conducts environmental management. The data collection used in this study was observations, interviews, and surveys. Data analysis method used is quantitative method including input-output analysis and environmental performance improvement analysis by using the pollution load of discharged wastewater into environment as an approach. The result shows that implementing cleaner production using *goodhousekeeping* to rise up productivity and environmental performance is 117 percent to 118 percent.

Key words : Small and medium batik industries, Goodhousekeeping, Environment, Cleaner production, Productivity.

Introduction

Batik is one of traditional Indonesian fabrics which are worldwidely acknowledged. It is proved by the establishment of Indonesian batik as The World Cultural Heritage by UNESCO (United Nations Educational, Scientific and Cultural Organization) on 2 October 2009. Batik grows into a national industry with tremendous potential.

Almost every region in Indonesia has batik with different motives and characteristics. One of them famously known for its batik centers is the island of Madura. Batik Madura has been able to penetrate the export to Malaysia, Brunei Darussalam, Myanmar, Germany, Belgium, and Italy and with contribution value is 15 percent of total production per year. The remaining 35 percent of production is sold in the local area, while 50 percent goes to national markets, namely Surabaya, Malang, Yogyakarta, Semarang, Bali, Medan, Banjarmasin, and Pontianak. The majority of batik industries in Madura are from small and medium industries. Despite the scales, they can be counted for a significant contribution to the economic growth in East Java, which is 5.01% contributed by 53.4% batik (Purnomo *et al.*, 2013).

The process of batik production cannot be separated from the main raw material such as fabrics and

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supporting materials which contain dangerous chemicals for the environment. Nowadays, consumers' considerations of environmentally friendly products are getting higher, especially in the developed countries such as in Europe, Australia and America which are highly concerned of the environment. Each country has put a standard or regulation that must be fulfilled by international traders to be able to trade their products in those countries. These conditions require the craftsmen in the batik industry to continuously improve its performance in order to survive or even to win the competition against other batik production countries such as China, Malaysia, Singapore, and India.

One of efforts undertaken in improving the performance of batik industry is by increasing productivity. Productivity is very important for long-term competitiveness, profitability and sustainability. Based on the results of the Earth Summit in Rio de Janeiro stated in Agenda 21, developing countries have to heed the production process in economic development based on sustainable development. Thus it is clearly defined that an economy based on natural resources will be stable when entering the state environmental policy. This is what makes the issue of sustainability and environmental issues become one of the most important topics for bisnis strategy, management, manufacture, and product development decisions. The demand makes many industries adopting a variety of programs in producing green products and reducing the impact of production on the environment (Bulent and Sibel, 2013).

Industries begin to race to produce green products by applying clean technologies. They realize that clean technology is one of important factors for economic growth and industrial development as well as plays a major role for achieving sustainable development (Nowosielski *et al.,* 2007). Strategy which increases productivity while simultaneously improves the environmental performance creating a total socio-economy development as in order to achieve continuous improvement in the quality of human life is green production. Green production is a combined application of appropriate productivities, environmental management equipment and technologies in order to reduce the environmental impact of production while increasing profitability and competitive advantages. Implementing green production allows eco-efficiency which will ultimately lead to the sustainable development. Cleaner production is pollution prevention strategies in an integrated environment for processes, products and services that are continuously implemented due to increase efficiencies and to reduce risks for both human beings and the environment (UNEP, 1998). It aims to minimize the use of resources, energy, emissions and wastes, as well as to maximize products' output by analyzing the flow of materials and energy in the clean system. Implementing cleaner production gives several benefits such as reducing emissions, waste reduction and cost savings from energy, the efficiency in using production resources, and waste management system (Vincenzo *et al.,* 2009). Apart from the environmental benefits, it also offers financial benefits for the company through various efficiency measures (Basappaji and Nagesha, 2014).

Cleaner production is an effective way for improving environmental performance in some industries such as dairy processing, poultry slaughterhouses, and fish processing (Khuriyati *et al.,* 2015). The efforts in implementing cleaner production are by conducting management of water use, replacement of equipment, and chemicals management, as well as reusing and recycling products, although these efforts often encounter many obstacles due to lack lack of initiation, as well as limited knowledge and finance. *Goodhousekeeping* (GHK) is one of cleaner production methods which its approach is practical, and simple, without requiring big investment. This research aims to implement cleaner production in small batik industry using *Goodhousekeeping* as the strategy by measuring the productivity escalations before and after the implementation.

Materials and Methods

Data collection method is conducted through observation, in-depth interviews as well as field surveys to obtain accurate and comprehensive information. An observation method is carried out by measuring and directly observing the production processes and the use of materials, water, and energy in the field. Observations conducted over two years, where the first year was observation before implementing clean production and secon year was the observation after implementing clean production. The amount of materials, water and energy were 1 year averaged use. The material use was the number and types of raw materials and supporting materials which were used in the production process. The use of energy and water was obtained from the total use of energy and water used in the production process. The fuel use was the types and amount used in the production process.

Sampling method of industrial waste water effluent is obtained from the location of the object studied, using the method of instantaneous samples taken directly from the sewer when the production normally takes place. The analysis conducted on pH parameter, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Total Suspended Solid (TSS) as an indicator of environmental performance as a key parameter for getting wastewater quality, and analyzing the heavy metals (Zn, Pb, Cu, Cr, Cd), as an indication of the environmental pollution that would endanger the health and life of humans, animals and plants.

Data analysis method used is principles of scientific writing by quantitative methods. Data field observations taken in the form of figures showing the amount of energy consumption (electricity and fuel), water, raw materials and auxiliary materials. The analysis used include: 1) input-output analysis is performed to determine the possibility of efficiency at each stage of the process. Furthermore, it can show the total input-output on how much energy, water, raw materials and supporting materials were used and the amount of production (batik) produced; 2) Analysis of the environmental performance improvement approach using pollution load of discharged wastewater into the environment. The Ministry of the Environment Decree No. Kep-51/MENLH/10/1995 and East Java Governor Regulation No. 72 Year 2013 on Wastewater Quality Standard for Industrial and/or other business activities review that waste discharge indicator is seen based on the maximum and maximum pollution load.

Results

Batik production process produces liquid waste at most. Wastewater is generated in the process boiling, dyeing, waxing, and cleansing. Boiling proces produces discharged wastewater averagely of 95 m^3/month, the dyeing process produces discharged wastewater averagely of 100 m^3/month, waxing discharged wastewater averagely of 15 m^3/month, and cleansing process produces discharged wastewater averagely of 650 m^3/month. Cleansing process needs water at most due to repeatation in removing wax attached to the fabric before it is dried up resulting batik cloth that is ready to be marketed.

Table 1 obtained by the analysis of the content of pollutants contained in wastewater of batik production. The analysis carried out on the parameters BOD, COD, TSS, Zn, Pb, Cu, Cr, Cduntuk then compared to the quality standard of industrial wastewater and other activities as stated in east Java Governor Regulation No. 72 / 2013. The result indicates that the parameters BOD, COD and TSS have above the allowable threshold as required at the East Java Governor Regulation No. 72/2013, while the parameters of heavy metals (Zn, Pb, Cu, Cr, Cd) are still below the required threshold.

The analysis shows that the actual pollution load (BPA) per month for all three parameters (BOD, COD and TSS) is above the maximum allowable pollution load (BPM). It also occured in the actual maximum pollution load per day (BPAi) whiche is above the permitted maximum pollution load per day (BPMI). This condition certainly worries marine environment around the batik production house because of no treatment for discharged wastewater. It needs an effctive and economical environmental management since the majority of batik industries are undertaken by small and medium enterprises with limited capital and knowledge.

Batik industry seeks a way in implementing cleaner production in order to improve environmental condition. The adopted strategy is by applying materials and energy efficiency as well as simple waste treatment unit wherewith to give an added value to the products and to strengthen the markets (Nowosielski *et al.*, 2007). Cleaner production undertaken by the batik industry has not fully solved the contradiction between economic development and environmental protection. In this condition, government has to control and regulate the implementation of cleaner production in industry (Duan Ning, 2009).

Discussion and Conclusion

Pollution load produced by the batik industry which is above the threshold requires proper environmental management strategies to get production efficiency and to minimize discharged liquid waste into the environment. The productivity of the small industry batik before implementing clean production using *Goodhousekeeping* approach is showed in Table 2.

At every stage of the production and use of energy, water and materials, there are significant inef-

Table 1. The results of the analysis of batik wastewater content and maximum pollution load and the actual pollution load

Parameter	Analysis Method	Industrial waste water quality standards and/other activities (East Java Governor Regulation No. 72/2013)	Results of analysis				The maximum pollution load per unit of product (kg)					BPM (kg/ton)	BPA (kg/ton)	BPMi (kg/ton)	BPAi (kg/ton)
			Prepa-ring (Q= 95 m^3)	Colou-ration (Q= 100 m^3)	Dyeing (Q=15 m^3)	Wax cleasing (Q=650 m^3)	Prepa-ring	Coloura-tion	Dyeing	Wax cleasing	Total				
Biological Oxygen Demand (BOD_5)	Winkler Methods	150	2720	530	320	290	258.4	53	4.8	188.5	504.7	5.047	103.36	0.5047	10.336
Chemical Oxygen Demand (COD)	Refluks Titration	300	3680	670	460	380	349.6	67	6.9	247	670.5	6.705	139.84	0.6705	13.984
Total Suspended Solid (TSS)	Gravimetri	400	530	500	580	640	50.35	18	1.65	39	109	1.09	20.14	0.109	2.014
pH	pH meter	7-10	9.8	3.4	7.1	7.5	0.931	0.34	0.1065	4.875	6.2525	0.062525	0.3724	0.0062525	0.03724
Cr total	Atomic Adsorption Spectrofotometre	1	0.58	0.3	0.2	0.1	0.0551	0.03	0.003	0.065	0.1531	0.001531	0.02204	0.0001531	0.002204
Cd	Atomic Adsorption Spectrofotometre	0.1	0.004	0.004	0.0005	0.03	0.00038	0.0004	0.0000075	0.019	0.0202875	0.000202875	0.000152	2.02875E-05	0.000015
Cu	Atomic Adsorption Spectrofotometre	3	0.01	0.01	0.01	0.01	0.00095	0.001	0.0001	0.006	0.0086	0.000086	0.00038	0.000008	0.000038
Pb	Atomic Adsorption Spectrofotometre	1	0.01	0.01	0.01	0.01	0.00095	0.001	0.0001	0.006	0.0086	0.000086	0.00038	0.000008	0.000038

Sources: Primary data (2013)

ficiencies on the use of wax (paraffin), dying materials, water and raw materials. These inefficiencies affect to the high production cost and aggravate environmental performance due to high waste produced as a non-product output (NPO). This NPO will definitely cause externalities costs beared by the company, and it will add to the production cost. Controling liquid waste from batik production process requires cleaner production implementation by applying efficiency from the use of energy, water, materials raw and supporting materials. As for alternative treatment or improvement in implementing cleaner production as follows:

Cloth handling

The alternative way in handling raw material (cloth) can be administered by planning the materials' needs, and cutting fabric precisely. These steps require precision and discipline of the workers. Furthermore, it can be done by reusing the remaining cloth as handicraft, such as napkins, handkerchiefs and other trinkets. This activity possibly saves more raw materials, lessens waste cloth, and adds economic values.

Wax (paraffin) handling

The alternative ways in handling waxes (paraffin) is by recovering the wax taken from *lorod* (cleansing) process and reusing it as mixture of batik paraffin. The process in collecting wax from *lorod* and washing process can be performed by using two stages of wax bath. *Lorod* residual water mixed with batik wax poured into tubs trap consists of two tubs connecting each other it works by using principle of equal trap tub with a system of connecting vessels. The wax will be seperated from water and float on the surface, so it can be easily collected. In addition, locations where the work is carried out can be constructed with ceramic for the floor, so it is easier to clean the wax remnants. Thus the rest of wax is clean and does not mix with dirts (soil or sand). The process of handling wax can improve the recovery rate to 60%.

Dyes and supporting materials handling

The alternative way in handling dyes and other supporting materials begin by calculating the dye composition accurately, wieghing accuracy, weighing equipment maintenance to keep the well-functioned, and organizing materials storages. In dyeing prosess, implementing clean production can be undertaken before the waste is formed including setting in the dyeing process, changing product or input material, changing process and modification tools, *Goodhousekeeping*, and applying occupational work and safety, as well as recycling. From clean production measured, it is briefly described as follows: a) planning the dyeing process including cal-

Table 2. The productivity of small batik industry before implementing cleaner production

Total product per day (m)	Total Product per year (300 working days) (m)	Total Product per year (300 working days) (yard)	Total product per year (1 kg product equivalen with 8 yard product) (ton)	Total (Rp/year)
Total production				
735	220,500	241,220	30.15	
Total sale per year (output)				55,125,000,000
Worker				720,000,000
Cloth				22,500,000,000
Wax (paraffin)				6,900,000,000
Coloring				7,650,000,000
Chemicals				5,610,000,000
Supporting materials				3,390,000,000
Over Head Cost				241,200,000
Total cost per year (input)				47,011,200,000
Profit per year				8,113,800,000
Profit per month				676,150,000
Productivity = output/input (%)				117

culating the balance between amount of dye solution and fabrics; calculating the accuracy needs of dyestuffs and other adjuvants; and how to stain. The benefits is to reduce the risk of defective cloth and to save the dyes; minimize liquid waste, and add more work efficiently; b) measuring changes in product and input materials including the use of cloths, using high-quality dye, using natural dyes to replace synthetic colors or combine synthetic colors and natural dyes; c) In addition, for the safety factor considering to use gloves as protection and avoid direct contact to the dye; d) measuring the changes in process and customization tools by managing operations of dyeing process by differentiating tools used in light and dark colors. *Goodhousekeeping* actions is including maintaing/setting up/storaging and tidying in order to extend the duration of tools used in productions, thereby it saves equipment purchase. Organizing storage cloths to be dyed in order to reduce the risk of incompatibility qualities, such as spots, shadow cap, and color inclusion which unneeded in batik waxing. The recycling can also be done by re-using the remaining dye solution, such as re-using dye that has been used for dyeing dark colors, black, brown, dark blue, and so on.

Water use handling

Handling the use of water used in the dyeing process including in coloring, washing, and cleansing can be carefully carried out by managing water use. The efforts can be carried out by providing coloring and rinsing tubs adjoining and adjacenting to the water source. Water distribution from the water source to the tanks where the process of staining, washing and cleansing is taken leads to waste because the water continues to flow from the hose. Overcoming the condition, it needs to use a stop valve fit at the end of the hose. The use of flow meter can control the flow of water as well as monitor water consumption. Besides, it can be conducted by re-using the used water in staining and washing process and avoiding leaks and spills of water from faucet or hose. It also can be treated by separating waste to dilute concentrated. Those actions save 70

Table 3. The productivity of small batik industry after implementing cleaner production

	Total product per day (m)	Total Product per year (300 working days) (m)	Total Product per year (300 working days) (yard)	Total product per year (1 kg product equivalen with 8 yard product) (ton)	Total (Rp/year)
Total production	735	220,500	241,220	30.15	
Total sales per year (output)					55,125,000,000
Worker					720,000,000
Cloth					22,500,000,000
Wax (paraffin)					6,900,000,000
Coloring					7,650,000,000
Chemicals					5,610,000,000
Supporting materials					3,390,000,000
Over Head Cost					
Kerosene					30,000,000
Diesel					10,500,000
Water					36,000,000
Electricity					18,000,000
Liquid Waste Processing	Limestone				9,000,000
	Alum				11,400,000
	Charcoal				3,000,000
					117,900,000
Total cost per year (input)					46,770,000,000
Profit per year					8,355,000,000
Profit per month					696,250,000
Productivity = output/input (%)					**118**

percent of the total cost of water usage.

Energy use handling

On energy use, the treatment can be carried out in the use of electricity, kerosene and firewood as follows: a) electricity use should be separated between industrial and household uses, so it can be controlled. In addition to the process of water filling, the investment required water tank or water tower in order to pump water does not flow throughout the day. For efficiency firewood used in cleansing process (*lorod*), it is recommended to use a closed heating furnace to get faster heat. Furthermore, extinguish the embers once the process is completed. This is to prevent fire spread continuously and use up the remaining firewood. Implementing cleaner production in the batik production process over 1 year showed the increase of 117 percent to 118 percent productivity as shown in Table 3.

The conclusion derived from the results and analysis in an effort to minimize the waste, to reduce matter and energy in the batik production process does not directly show the reduction of the environmental pollution. It becomes the initiation of long-term projects achieved by implementing cleaner production productivity by using *goodhousekeeping* methods. The productivity uplift after implementing cleaner production strategy in small batik industry was 1 percent, from 117 percent to 118 percent.

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