Green Productivity Approach to Determine the Productivity and Environmental Performance in Batik Industry

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Abstract. The batik industry in Kampoeng Batik Laweyan drives entrepreneurs to improve company performance for sustainability and competitiveness. SMEs can boost productivity, assessing overall performance and guiding sustainable improvements. Besides economic benefits, batik production poses environmental challenges through waste disposal. Green productivity aims to enhance productivity and environmental performance simultaneously. Research on SMEs like Batik Anugrah Purnama and Batik Tunaruntun shows productivity gains in January 2019: 172% and 610%. Material management strategies, such as reusing leftover wax and switching to gas for the lorod process, contributed to productivity enhancements. Consequently, productivity rose to 206% and 664%. Post-liquid waste treatment, Environmental Performance Indicator (EPI) indices improved from -1.415, -3.285 to 0.032, -0.77.

1 Introduction

Kampoeng Batik Laweyan is one of the batik craft centers in Surakarta. Initially, there were 22 Small and Medium Enterprises (SMEs) producing batik. However, after the establishment of Kampoeng Batik Laweyan, the number of SMEs producing batik increased to 51 units in 2008 [1]. This development necessitated batik entrepreneurs to continually strive for improvement and enhancement of their performance to remain competitive in the industry. One of the essential steps is to measure a company’s productivity level. By measuring the productivity performance of a company as a whole, it can be evaluated and used as a benchmark for continuous improvement [2].

In addition to its positive economic impact, the batik industry also has environmental implications. These environmental impacts are primarily caused by the disposal of waste from the batik production process, which has a negative effect on the environment. Waste management in Kampoeng Batik Laweyan is relatively simple, where liquid waste from production is only directed to a Waste Water Treatment Plant (WWTP) [3]. The presence of WWTP in Kampoeng Batik Laweyan is not fully utilized by the existing SMEs. Not all SMEs use WWTP services, and some dispose of their production waste directly without filtration. This will lead to consequences for several aspects, including the water ecosystem, groundwater contamination exceeding normal limits, and health problems due to the chemical nature of the waste [1]. SMEs’ attention to environmental sustainability is still poor. This is shown by the activities carried out having a greater chance of obtaining maximum profits and ignoring environmental impacts [11]. Addressing these issues requires action to reduce the environmental impact of the waste generated by the batik industry.

From the description above, there are two aspects that need to be aligned, namely increasing productivity and environmental protection efforts. Green productivity is an effort to enhance both a company’s productivity and environmental performance simultaneously within the context of overall development [4]. Batik Anugrah Purnama and Batik Tunaruntun SMEs are members of the Laweyan Batik Village Development Forum. Anugrah Purnama SME has already shifted to using recycled oil as a substitute for firewood, while Batik Tunaruntun SME utilizes natural dye substances in the coloring process. This is expected to have a smaller environmental impact compared to other SMEs. The batik industry is generally able to withstand changes in the external environment because its development is driven not only by the market but also by entrepreneurs [12]. This research conducted with the Green Productivity concept aims to improve the productivity and environmental performance of both these SMEs.

2 Literature Review

2.1 Batik

Batik is inseparable from the life of the community. From childhood to adulthood and even in death, batik has always been a part of traditional rituals and ceremonies. On October 2, 2009, batik was officially designated as one of Indonesia's Cultural Heritage items, recognized as an intangible cultural heritage by the United Nations Educational, Scientific and Cultural Organization (UNESCO). The art of batik involves the creation of drawings on fabric, each with its own philosophical meaning [5].
2.2 Batik Material
1. Fabric
Fabric serves as the medium for the batik process. The fabric typically used in batik is known as 'mori' fabric.

2. Batik Wax
Batik wax or ‘malam’ is a material used to cover specific areas of the fabric, preventing the dyes from mixing and ensuring that the colors remain distinct.

3. Batik Dyes
Batik dyes encompass natural dyes derived from plants, synthetic dyes, and chemical dyes, including remasol and naptol.

2.3 Batik Process
1. Preparation Stage
The preparation stage involves preparing the ‘mori’ fabric, creating the basic pattern for hand-drawn batik, and heating the wax or ‘malam’.

2. Batik Wax Application Stage
In this stage, the patterned ‘mori’ fabric is covered with wax. Batik wax serves the purpose of sealing off specific areas to prevent the colors from blending during the dyeing process.

3. Batik Coloring Stage
The coloring stage is where the fabric is dyed to achieve the desired colors. Various types of dyes are used, including natural dyes, synthetic dyes, and chemical dyes.

4. Wax Removal Stage (Lorod)
The wax or ‘malam’ attached to the fabric is removed in this stage. The dyed fabric is boiled in hot water to separate the wax from the fabric.

2.4 Productivity
Productivity is the comparison of output to input materials [6]. Output comprises the results of production, while input in the production process encompasses equipment, costs, energy, and the number of workers. The level of productivity for a company can be calculated using the following equation [1] [7]:

\[ \text{Productivity} = \frac{\text{Output}}{\text{Input}} \times 100\% \]

Increased productivity can be seen in three forms [8]:
1. Increase the amount of production using the same resources.
2. Use fewer resources and produce the same or more production.
3. Large growth in production quantities production quantities with relatively small growth in resource use.

2.5 Environmental Performance Index (EPI)
In this research, the environmental performance of SMEs is assessed using the Environmental Performance Indicator (EPI). The EPI can illustrate the environmental efficiency of the production process. The equation for the EPI Index is presented in equation (2) below:

\[ \text{EPI} = \sum_{i=1}^{k} W_i \cdot P_i \]

Where 'k’ represents the number of waste criteria, and 'Wi’ stands for the weight value of each criterion. These weights are obtained through the administration of questionnaires to experts in environmental chemistry [9]. Meanwhile, 'Pi’ represents the difference between the standard quality of wastewater and the test results of the company’s wastewater. 'Pi’ can be calculated using equation (3) below:

\[ P_i = \frac{\text{standard} - \text{analysis}}{\text{standard}} \times 100\% \]

2.6 Green Productivity
Green productivity is a strategy aimed at enhancing a company's productivity and environmental performance simultaneously within the context of comprehensive socio-economic development. Green productivity is an all-encompassing business strategy, not limited to environmental strategies alone [4] [10]. Implementing Green productivity in a company can lead to increased productivity, waste reduction, and improved production outcomes. The Green Productivity process starts with an analysis of material inputs, processes, and outputs. The four common objectives of Green Productivity when applied to enhance environmental quality and productivity are: Waste Reduction, Material Management, Pollution Prevention, and Product Enhancement.

2.7 Waste Reduction through Filtration
Waste Reduction involves efforts to decrease the presence of hazardous waste, including solid and liquid waste generated from a company's production processes. Filtration is the process of separating a liquid-solid mixture through a filtering medium or filter, with larger solid particles being retained on the filter's surface [1]. In this research, a simple filtering device will be constructed, consisting of zeolite, gravel, quartz sand, palm fiber, and coconut husk. The following is the design of the filtration device used in this study.

![Simple Filtration Design](image)

2.8 Research Methods
The subject of this research comprises producers or small and medium enterprises (SMEs), namely Batik Anugrah.
Purnama and Batik Tumaruntun, involved in batik production and part of the Laweyan Batik Village Development Forum. The research was conducted in Kampoeg Batik Laweyan, located in the Laweyan district. The study took place in January 2019. Both primary and secondary data were utilized. Primary data were gathered through observations, direct interviews with relevant sources. Secondary data, in this study, included journal articles, previous research using related methods, case studies conducted in the batik industry, and wastewater quality standards. The wastewater was collected from the final discharge point just before it entered the communal wastewater channels from each SMEs.

4 Results and Discussion

4.1 Anugrah Purnama SMEs

Based on Table 1, it is known that the total input or production costs incurred by Batik Anugrah Purnama SME for their monthly production activities amount to Rp 58.010.000. Meanwhile, the output or the quantity of products produced is 12.500 meters per month, priced at Rp 8.000 per meter. Consequently, the monthly revenue generated is Rp 100.000.000. The profit earned by Batik Anugrah Purnama SME in a month is Rp 41.990.000. Productivity calculation is obtained through the equation (1).

\[ \text{Profit} = \text{Revenue} - \text{Costs} \]

The inputs consist of raw material costs, energy, and overhead expenses, while the outputs include the total products produced multiplied by the product price per meter. The initial data is as follows:

- Costs of Raw Materials, Energy, Overhead = Rp 58.010.000
- Production Result = Rp 100.000.000

Productivitas = \( \frac{100.000.000}{58.010.000} \times 100\% = 172\% \)

Profit = 100.000.000 – 58.010.000

= Rp 41.990.000/Month

Table 1 represents the result of productivity calculation data processing for Anugrah Purnama SME. After implementing material management, the wax purchasing requirement decreased by 50% to 400 kg per month, resulting in an expense of Rp 10.800.000 for wax purchases. The SMEs also incurred an expense of Rp 1.608.000 for spice purchases. Material management also replaced the fuel for the "lorod" process, previously using used oil with gas. The monthly requirement for used oil was 325 liters, with an expense of Rp 812.500 while the gas usage for the "lorod" process amounted to 96 kg per month, costing Rp 576.000. After implementing material management, the total input costs incurred by the SME in one month decreased to Rp 48.581.500. As a result, the SME's productivity increased by 34% to 206%, compared to the previous 172%.

### Table 1. Productivity Calculation for Anugrah Purnama SMEs

<table>
<thead>
<tr>
<th>Variabel</th>
<th>Unit Price</th>
<th>Requirement Per Month (m, kg, l)</th>
<th>Monthly Expenditures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mori Cloth Candle</td>
<td>0</td>
<td>12500</td>
<td>Rp0.00</td>
</tr>
<tr>
<td>Seasoning ‘malam’</td>
<td>27000</td>
<td>800</td>
<td>Rp21,600,000</td>
</tr>
<tr>
<td>Goiter</td>
<td>24000</td>
<td></td>
<td>48</td>
</tr>
<tr>
<td>Resin</td>
<td>27000</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Micro</td>
<td>37000</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Paraffin</td>
<td>30000</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Kendal</td>
<td>10000</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Dye</td>
<td>200000</td>
<td>37.5</td>
<td>Rp7,500,000</td>
</tr>
<tr>
<td>Sulfurid</td>
<td>6000</td>
<td>104.2</td>
<td>Rp625,000</td>
</tr>
<tr>
<td>Water Sir</td>
<td>27000</td>
<td>4.2</td>
<td>Rp112,500</td>
</tr>
<tr>
<td>Soda As</td>
<td>7000</td>
<td>5</td>
<td>Rp35,000</td>
</tr>
<tr>
<td>Water Glass</td>
<td>6500</td>
<td>150</td>
<td>Rp975,000</td>
</tr>
<tr>
<td>Oil</td>
<td>2500</td>
<td>325</td>
<td>Rp812,500</td>
</tr>
<tr>
<td>Energy</td>
<td>6000</td>
<td>25</td>
<td>Rp150,000</td>
</tr>
<tr>
<td>Labor</td>
<td>1625000</td>
<td>16</td>
<td>Rp26,000,000</td>
</tr>
<tr>
<td>Overhead</td>
<td>200000</td>
<td>1</td>
<td>Rp200,000</td>
</tr>
</tbody>
</table>
### 4.2 Tunaruntum SMEs

The results of the productivity calculation for Tunaruntum SME can be found in Table 2. In its production process, Tunaruntum SME exclusively uses natural or organic dyes, resulting in different input requirements compared to the other two SMEs. They utilize natural dyes, which are more cost-effective. In one month, Tunaruntum SME incurs input production costs of Rp 5,904,000. They produce 180 meters of products per month, priced at Rp 200,000,000 per meter, resulting in total monthly revenue of Rp 36,000,000. The productivity of Tunaruntum SME in one month is 610%, and they earn a profit of Rp 30,096,000. After implementing material management through the reuse of wax, the wax requirement is reduced by 50% to 20 kg. The cost for wax purchases decreases from Rp 1,080,000 to Rp 540,000. Prior to material management, the monthly input costs for Tunaruntum SME amounted to Rp 5,616,000. After implementing material management, the input costs decreased to Rp 5,422,800. This resulted in a 54% increase in Tunaruntum SME’s productivity, rising from the initial 610% to 664%.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Unit Price</th>
<th>Before Material Management</th>
<th>After Material Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production output</td>
<td>12500</td>
<td>8000</td>
<td>8000</td>
</tr>
<tr>
<td>Total Output</td>
<td></td>
<td>100,000,000</td>
<td>100,000,000</td>
</tr>
<tr>
<td>Profit</td>
<td></td>
<td>41,990,000</td>
<td>51,418,500</td>
</tr>
<tr>
<td>Productivity</td>
<td></td>
<td>172%</td>
<td>206%</td>
</tr>
</tbody>
</table>

**Table 2. Productivity Calculation for Tunaruntum SMEs**
4.3 Environmental Performance Indicator (EPI)

Based on the results of laboratory tests and Environmental Performance Indicator (EPI) calculations which can be seen in table 3 and table 4, the environmental performance of UKM Anugrah Purnama and UKM Tunaruntum is: -1.415 and -3.285. In EPI calculations, a negative index value means that the environmental performance of SMEs is still not good. Laboratory test results show that the BOD and COD values of the two SMEs are still above the maximum quality standard values. The high chemical content in wastewater has a negative impact on the environment. High BOD and COD content causes reduced oxygen content in the air. In the long term, hazardous waste can damage waters, groundwater and disrupt aquatic ecosystems. Efforts to reduce waste are carried out through a filtration process. After carrying out the filtration process, the environmental performance of the third SME increased to: -0.032 and -0.77. Even though it still has a negative value, filtration can reduce the chemical content of liquid waste. A comparison of the EPI index values is in table 5.

Table 3. Calculation EPI for Anugrah Purnama SMEs

<table>
<thead>
<tr>
<th>No</th>
<th>Parameter</th>
<th>Weight</th>
<th>Maximum Level (Mg/L)</th>
<th>Test Result</th>
<th>Pi = Deviation (x100%)</th>
<th>Index EPI (Wi x Pi)</th>
<th>EPI Index Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BOD</td>
<td>0.25</td>
<td>60</td>
<td>279</td>
<td>-3.65</td>
<td>-0.9125</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>COD</td>
<td>0.25</td>
<td>150</td>
<td>516.9</td>
<td>2.44</td>
<td>-0.6115</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>TSS</td>
<td>0.2</td>
<td>50</td>
<td>44</td>
<td>0.12</td>
<td>0.024</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>pH</td>
<td>0.3</td>
<td>6-9</td>
<td>7.7</td>
<td>0.28</td>
<td>0.085</td>
<td></td>
</tr>
</tbody>
</table>

EPI Index Value -1.415

Table 4. Calculation EPI for Tunaruntum SMEs

<table>
<thead>
<tr>
<th>No</th>
<th>Parameter</th>
<th>Weight</th>
<th>Maximum Level (Mg/L)</th>
<th>Test Result</th>
<th>Pi = Deviation (x100%)</th>
<th>Index EPI (Wi x Pi)</th>
<th>EPI Index Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BOD</td>
<td>0.2</td>
<td>60</td>
<td>302.5</td>
<td>-4.041666</td>
<td>-1.01041</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>COD</td>
<td>0.2</td>
<td>150</td>
<td>1116.9</td>
<td>-6.446</td>
<td>-1.6115</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>TSS</td>
<td>0.2</td>
<td>50</td>
<td>236</td>
<td>-3.72</td>
<td>-0.744</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>pH</td>
<td>0.3</td>
<td>6-9</td>
<td>7.6</td>
<td>0.26666666</td>
<td>0.08</td>
<td></td>
</tr>
</tbody>
</table>

EPI Index Value 3.285911667

5 Conclusion

a. Based on research conducted on UKM Batik Anugrah Purnama and UKM Batik Tunaruntum, it was found that the productivity of the two UKM in January 2019 was: 172% and 610%. Tunaruntum SMEs have higher productivity due to the use of input materials in the form of natural dyes which have cheaper prices and both natural dyes have higher selling prices.

b. Based on the results of laboratory tests and Environmental Performance Indicator (EPI) calculations, the environmental performance of the two SMEs was found to be: -1,415 and -3,285, which means the environmental performance of the SMEs is still not good.

c. To increase productivity, SMEs can implement material management in the form of reusing wax candles and replacing fuel for the lori process with gas. Based on productivity calculations, it was found that the productivity of the two SMEs increased to 206% and 664%.

d. Waste reduction efforts are carried out through a filtration process. Based on EPI calculations, it was found that the environmental performance of SMEs after filtration increased to: -0.032 and -0.77.

References


