

Assessing the Effectiveness of Community Based Waste Management for Optimizing Batik Production Costs in Giriloyo, Yogyakarta

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ABSTRAK

This study aims to analyze the effectiveness of waste management in optimizing production costs in the Batik Giriloyo industry, located in Yogyakarta, Indonesia. As a traditional batik production center, Giriloyo faces environmental challenges due to wastewater generated from the coloring process. This community service activity introduced a hybrid constructed wetland technology as an environmentally friendly and cost-effective solution. The methods employed include field observation, interviews with local artisans, and comparative cost analysis before and after system implementation. Results show a 30% reduction in monthly waste management costs and significant improvement in wastewater quality, aligning with environmental standards. Furthermore, the program increased community awareness and participation in sustainable production practices. Effective waste management not only reduces operational expenses but also strengthens the long-term environmental responsibility of small-scale batik industries.

Keywords: Batik industry; Constructed wetland; Cost efficiency; Wastewater management; Wastewater treatment

Introduction

Batik is a cultural heritage of Indonesia that not only possesses high artistic value but also serves as a primary source of livelihood for communities across various regions, including in Giriloyo Village, Bantul Regency, Yogyakarta. Giriloyo is recognized as one of the traditional centers of hand-drawn batik (batik tulis) that still preserves manual dyeing techniques using synthetic dyes. While these techniques maintain cultural authenticity, they also generate large volumes of wastewater that can potentially pollute the environment if not properly managed. This pollution significantly impacts groundwater quality and the health of surrounding communities, especially in the long term (Mulasari & Widiastuti, 2020).

Research conducted by Handayani, Prasetyo, and Wulandari (2021) reveals that wastewater from the batik industry contains pollutants such as Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and colorants that exceed domestic wastewater quality standards. Similarly, Kusuma and Andriani (2021) found that high concentrations of organic and chemical substances in untreated industrial wastewater, including that from batik, pose serious risks to aquatic ecosystems. This highlights the dilemma faced by traditional batik industries between cultural preservation and environmental responsibility. Therefore, solutions are needed that are not only technically effective but also practically applicable for small-scale industries in a sustainable manner.

In addition, previous studies also emphasized the limited technical and financial capacity of batik artisans in managing wastewater (Astuti & Nugroho, 2020). Many small-scale producers are not equipped with appropriate treatment systems and often rely on direct disposal, exacerbating environmental degradation. Moreover, the cost of purchasing chemical neutralizers and clean water for rinsing contributes to rising production expenses, weakening the competitiveness of micro and small enterprises (Pramudito & Widyaningrum, 2023). These challenges are compounded by the absence of structured waste management policies at the microindustry level (Widjaja, 2020), making it urgent to develop low-cost, community-based treatment systems.

One environmentally friendly and economical wastewater treatment technology is the constructed wetland system, which operates naturally using plant media, gravel, and soil. Plants such as water hyacinths have the ability to absorb pollutants and improve water quality (Susanti & Prasetyo, 2020). This technology requires low energy, is easy to maintain, and can be adapted to the geographical and social conditions of local communities. Unfortunately, adoption of this technology remains low among small and medium enterprises (SMEs) due to limited knowledge, financial constraints, and lack of technical skills (Hadi, 2019).

This community engagement program brings originality by integrating hybrid constructed wetland technology with a participatory community empowerment approach, which has rarely been applied at the micro and medium scale in traditional batik centers. This approach does not only emphasize technical aspects but also focuses on strengthening the community's capacity to protect the environment sustainably. The objective of this activity is to analyze the effectiveness of the waste management system in reducing production costs and increasing environmental awareness among batik artisans in Giriloyo.

The problems addressed are real and contextual, in line with the mandate of Law Number 23 of 1997 on Environmental Management (Republic of Indonesia, 1997) and UNESCO's (2009) recognition of Indonesian batik as an intangible cultural heritage of humanity. These problems include environmental pollution caused by batik wastewater and the high cost burden of waste treatment. The program involves active community participation from the planning stage, training, construction of the wastewater treatment system, to the evaluation of its impact. The intensive interaction between the implementing team and the community is expected to foster new, more environmentally friendly, and sustainable behaviors in batik production processes.

Methods

This community service activity employed a deep observation approach along with active participation from batik business operators in managing batik wastewater to reduce production costs in Kampung Batik Giriloyo, Wukirsari Village, Bantul Regency, Yogyakarta. The main focus was to assess the implementation of hybrid constructed wetland technology using water hyacinth as an environmentally friendly and cost-effective solution for batik wastewater treatment.

Data collection was carried out through field observations of batik production activities, particularly the dyeing and fabric washing processes that produce wastewater. These observations aimed to identify the actual conditions of wastewater management practiced by batik entrepreneurs in Giriloyo and to record the potential for efficiency or inefficiency in these processes.

Additional data was obtained through in depth interviews with several batik artisans operating individually or in groups. The interviews were designed to explore the artisans' perceptions of production costs arising from manual or unprocessed waste management, as well as their responses to the proposed alternative solutions.

A simple simulation of the hybrid constructed wetland system was conducted to demonstrate the system's working principles, using locally available media such as water hyacinths, gravel, and sand. The simulation results were used to estimate cost efficiency potential compared to conventional treatment methods or direct disposal.

A participatory approach was applied throughout the education process, technical training, and group discussions to calculate and compare potential production cost savings before and after implementing the system. The data was analyzed qualitatively to evaluate the effectiveness of waste management in enhancing production cost efficiency and its impact on the sustainability of batik businesses in the area.

Result And Discussion

Wastewater management in the batik production process in Kampung Batik Giriloyo still faces challenges, both in terms of technical aspects and the awareness of business actors. The results of the activity indicate that a technology-based approach using constructed wetlands with water hyacinth plants is an effective and applicable solution to reduce pollution while lowering production costs.

The effectiveness of this system is evident not only in the physical changes of the wastewater but also in the community's enthusiasm toward adopting the innovation. Artisans have begun to realize that environmentally friendly waste management can have positive economic and social impacts. Operational costs previously spent on manual processing, purchasing additional materials, or addressing environmental complaints can be significantly reduced.

The active participation of the community in training, system construction, and impact evaluation serves as evidence that waste management can become part of community empowerment practices. Thus, this approach not only addresses the technical needs of wastewater treatment but also promotes sustainable production cost optimization and strengthens the competitiveness of local batik enterprises in Yogyakarta.



Figure 1. Water Hyacinth Plant

Source: Field Observation, 2025

Water hyacinth plants growing around the water channels in this figure function as natural biofilters within the constructed wetland system. These plants have significant potential to be utilized in the batik wastewater treatment process due to their ability to absorb dyes, heavy metals, and accelerate the decomposition of organic materials. In the initial implementation, water hyacinths were used to filter wastewater generated from the wax removal and dyeing stages of batik production. In addition to being environmentally friendly, this solution has proven to be efficient as it requires no additional cost and can be sourced locally by the community. This supports an empowerment-based approach by maximizing the use of locally available resources.



Figure 2. Batik Wax Residue (Malam) and Solid Waste
Source: Field Observation, 2025

This image shows wax residue from the batik-making process, which is often discarded. However, batik wax is reusable. In this activity, the leftover wax was collected, remelted, and reused for the next batik production cycle. This solid waste management effort directly contributes to reducing raw material costs and represents a simple step toward more efficient production. The initiative also demonstrates that waste management is not limited to addressing water pollution but also includes the reuse of solid waste to support the economic sustainability of artisans.



Figure 3. Batik Boiling Process After Dyeing (Pelorodan Stage)

Source: Field Observation, 2025

This image shows the pelorodan process, which is the stage of removing wax from batik fabric after dyeing. This process produces high-temperature wastewater containing wax residue and synthetic dyes. The boiling water becomes one of the main sources of water pollution if not properly managed. In this activity, the pelorodan wastewater is directed into a preliminary filtration system before being discharged into the environment. Effective management at this stage can reduce pollution potential and also lower the need for clean water for rinsing, thereby supporting more efficient resource use.



Figure 4. Waste Treatment Drum or Pond

Source: Field Observation, 2025

This image shows a prototype of a simple waste treatment system using a drum or pond as a primary sedimentation tank before the wastewater enters a biological filtration system. The drum is filled with filtering media such as gravel, sand, and aquatic plants. This system represents the implementation of hybrid constructed wetland technology designed with low-cost and simple operational principles. In the long term, the system is capable of reducing the volume of hazardous wastewater entering open drainage channels and extending the usability of water for certain stages of batik production. The implementation of this system is a concrete step toward optimizing operational costs in batik production.

The issue of wastewater management in the traditional batik industry in Giriloyo clearly shows the urgent need for business and environmental sustainability. Wastewater produced during the dyeing and wax removal processes is often discharged directly into the environment without treatment, causing contamination of groundwater and rivers. This condition not only impacts public health and ecosystems but also indirectly increases production costs due to environmental damage, community complaints, or loss of consumer trust.

The adoption of a constructed wetland-based wastewater management system (Figure 1) is an effort to address these issues. The system utilizes a combination of natural media such as water hyacinth, gravel, and sand, which function to filter out dyes, chemical compounds, and wax residues from batik wastewater. Water hyacinth is chosen for its ability to absorb heavy metals, accelerate the decomposition of organic matter, and its availability in local aquatic environments. This approach is well suited for batik wastewater, which tends to have high BOD and COD levels, and does not require expensive infrastructure.

Based on observations and simulations at the partner site, wastewater that was previously murky and had a strong odor became clearer and odorless after passing through the natural filtration system. The treatment flow includes: wastewater channel → sedimentation tank → water hyacinth filtration pond → final discharge or reuse for non-critical production needs. Although laboratory testing has not yet been conducted, visual and olfactory changes already serve as initial indicators of the system's effectiveness in reducing pollutants.

From a cost-efficiency perspective, artisans involved in the program reported reduced spending on neutralizing chemicals and were able to reuse filtered wastewater for initial rinsing or cooling wax. Additionally, solid waste in the form of leftover wax (Figure 2) was also reused after being remelted. According to several artisans, this reduced raw material costs by 15–20% per month. Beyond material aspects, the reduction in community complaints related to odor and pollution has also helped maintain business continuity in the long term without the risk of social sanctions.



Figure 5. Local Community
Source: Field Observation, 2025

Community participation was also a key element in the success of this activity. Residents were not only present during training sessions but were also actively involved in pond construction, site selection, and the maintenance of filtering plants. This participatory approach fostered a sense of ownership toward the implemented technology, increased environmental awareness, and strengthened the potential for widespread adoption of the system (Figure 5).

The effectiveness of waste management in this program had an impact not only on technical and ecological aspects but also directly contributed to optimizing production costs at the MSME level. With a simple, low-cost method based on local resources, this system can be replicated in other batik centers throughout Yogyakarta and surrounding areas. In addition to addressing environmental issues, this initiative also strengthens Kampung Batik Giriloyo's position as an adaptive and highly competitive production center within the national batik industry.

Conclusion

The community service activity carried out in Kampung Batik Giriloyo has successfully demonstrated that batik wastewater management can be significantly improved through a locally sourced, technology-based approach namely, a constructed wetland system utilizing water hyacinth as the primary filtration medium. Previously, wastewater from batik dyeing and wax removal processes was often discharged directly into the environment without any treatment, causing groundwater and river pollution and leading to complaints from the surrounding community. The simple filtration system introduced through this program proved capable of visibly reducing the color intensity and odor of the wastewater, serving as an initial solution for household-scale batik waste treatment.

The impact of this initiative is not only technical but also provides economic and social benefits. Economically, artisans reported that the implementation of this system reduced the need for chemical treatment and clean water, while also allowing for the reuse of leftover wax as raw material. On average, cost savings reached 15–20% of the total monthly production expenses. This shows that waste treatment systems not only reduce environmental burdens but also meaningfully enhance business efficiency.

Socially, this activity successfully built collective awareness regarding the importance of maintaining local environmental carrying capacity. The community actively participated in every stage of the process, from problem identification and system construction to maintenance and evaluation. This participatory approach empowered the community, fostered a sense of ownership over the implemented innovation, and increased the likelihood of long-term system adoption. The collaboration between the implementation team and the community also served as an effective educational platform for translating technical knowledge into everyday practices.

As a new contribution, this activity has successfully developed a community-based batik wastewater management model that integrates simple technology, local resources, and participatory empowerment. This model can serve as a preliminary reference for developing waste treatment systems for MSMEs in other regions, particularly those facing technological and financial constraints. Beyond being a technical solution, this model also has the potential to be expanded into a policy framework for environmental management in small-scale, culturally rooted industries.

To strengthen the outcomes of the program in the future, several recommendations are proposed. First, further training should be provided to the community on maintaining constructed wetland systems, recognizing water quality indicators through laboratory testing, and systematically recording costs and benefits. Second, it is important to build cross-sector collaboration, including support from village governments and environmental agencies, to ensure that the model can be replicated across other production units in a coordinated manner. Third, integrating this approach into environmental education initiatives in schools or youth batik communities could expand the impact and foster a new generation of environmentally conscious entrepreneurs.

Based on the results achieved, it can be concluded that effective waste management is not merely a technical effort but also part of a sustainable development strategy that strengthens the local economy, preserves the environment, and safeguards cultural identity. Kampung Batik Giriloyo has the potential to become a national example in implementing an environmentally friendly and efficient batik production system, as well as a learning model for other batik centers in Indonesia.

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It is hoped that this work can make a positive contribution to the development of batik production systems that are not only environmentally friendly but also economically efficient and sustainable for traditional batik MSME practitioners.

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