



Digital Transformation and Appropriate Technology Application to Improve the Competitiveness of Singosari Batik

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Abstract: This community service program strengthens the competitiveness of the Singosari Batik Association through digital transformation and appropriate technology. The association consists of around 30 artisans, mostly women, but faces constraints in wastewater management, limited use of natural dyes, and weak digital marketing. Using a descriptive qualitative approach with participatory action research, the program applied participatory observation, in-depth interviews, focus group discussions, and documentation of production, waste management, and marketing activities. Interventions were designed and implemented in three areas: RO+ wastewater treatment technology, plant-based natural dye technology, and digital marketing for batik promotion and sales. The RO+ system combines multistage pretreatment, sedimentation, and reverse osmosis to reduce pollutant loads in batik wastewater before discharge. Natural dye training introduced plant-based dye sources, extraction and dyeing techniques, and fixation using ferrous sulfate (tunjung) to improve color fastness. Digital marketing interventions included training on content creation, branding, social media management, marketplace use, and TikTok Live-based selling. The results show increased awareness and capacity for environmentally friendly production, supported by RO+ technology and standard operating procedures for wastewater management. The adoption of natural dyes expanded product variety and strengthened the identity of "environmentally friendly Singosari batik." The use of TikTok and other digital platforms improved promotion consistency, audience reach, and sales volume. Overall, the integrated application of appropriate technology and digital marketing enhanced the association's productivity, environmental responsibility, and market competitiveness, and was welcomed by artisans.

Keywords: Appropriate Technology, Digital Marketing, Digital Transformation, Singosari Batik, Wastewater Treatment.

Introduction

Singosari District in Malang Regency, East Java, is widely known not only as the former center of the Singhasari Kingdom, but also as an area with significant historical heritage, including the 13th-century Singosari Temple, a 13th-century site built to commemorate the kingdom's last king (Disporapar Malang, 2015). Amid this historical context, the Singosari Batik Association has developed a community of batik artisans comprising around 30 members, the majority of whom are women

of productive age between 20 and 45 years old. About 20% of the members are skilled in batik making, while the others are still learning. This community can produce 50–100 batik fabrics per month at prices of IDR 300,000–IDR 3,000,000 per piece, depending on the motif, technique, and fabric quality. However, limited digital marketing capabilities, skill disparities, and equipment constraints mean that marketing still relies on local markets, and product quality is not yet fully consistent (Indrowaty et al., 2025).

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Singosari batik has significant cultural and economic potential because its motifs are inspired by royal symbols, flora, fauna, and historical reliefs that are integral to the region's identity. These motifs are not only aesthetically valuable but also contain historical narratives that can strengthen the region's image as a center of cultural heritage (Indrowaty et al., 2025). With proper guidance, Singosari batik has the opportunity to become a leading regional product, a medium for cultural preservation, and an instrument for community economic empowerment. However, this potential has not been fully realized due to the lack of a digital transformation strategy and the application of appropriately designed, systematic technologies to strengthen the community's competitiveness.

The current condition of the Singosari Batik Community shows that out of 30 members, only 12 people are actively making batik regularly. Of these, seven people already have their own batik brands, while the rest are still in the learning stage and rely on the support of other members and mentors. The capacity-building process is carried out through regular training and independent practice at home, with results shared at regular meetings for joint review. This mechanism helps with gradual skill development, but a structured production and management system, including the use of digital technology for design, documentation, and marketing, does not yet support it. Without more comprehensive intervention, the association risks stagnation and difficulty competing with batik producers from other regions that are better technologically and managerially prepared.

From an environmental perspective, only two of the seven independent batik producers have their own wastewater treatment plants (IPALs) with planting systems. Other artisans still rely on wastewater filtration facilities owned by certain members. Liquid waste from the dyeing process, which contains chemicals, can pollute the environment if not properly treated. On the other hand, artisans' knowledge of natural dyes is still minimal, even though they can be an important alternative to reduce dependence on synthetic dyes, which produce hazardous waste and are expensive to process. This condition shows the need to apply appropriate technology, such as a simple IPAL system based on a combination of pre-treatment and filtration stages, as well as innovations in the use of natural dyes from local resources to support environmentally friendly production practices (Imanuddin et al., 2021; Levi et al., 2020).

From a marketing perspective, the challenges are no less significant. Branding and digital marketing strategies are still weak. Product promotion relies primarily on exhibitions organized by relevant agencies, which occur only once or twice a year and are not

regular. The underutilization of professional websites, marketplaces (such as Shopee and TikTok Shop), and social media means the market reach of Singosari batik products remains narrow and highly dependent on event momentum. In fact, in the digital economy era, the competitiveness of handicraft products is primarily determined by visibility on online platforms, consistency of brand identity, and the ability to manage digital sales channels. This gap makes digital transformation a strategic necessity, not just an option.

The community service team that conducted field visits to the Singosari Batik Association found several key problems: inefficient production processes, minimal use of batik design applications, dependence on manual methods, the lack of an adequate waste management system for all craftsmen, low use of natural dyes, weak branding, and limited access to digital markets and business capital. In response, several solutions were formulated, including the development of and training in the use of batik design applications to accelerate the motif design process, the application of RO+ and simple pre-treatment-based liquid waste processing technology, the gradual substitution of synthetic dyes with natural dyes, and the development of a professional website and marketplace account integrated with digital marketing training. These solutions were designed as a form of appropriate technology applications and digital transformations relevant to partners' real needs.

Efforts to strengthen Batik Singosari are also closely related to the Sustainable Development Agenda. The use of environmentally friendly dyes, waste treatment that meets quality standards, and efficient production processes align with SDG 12 (responsible consumption and production) and SDG 13 (climate action). Meanwhile, the development of a creative economy based on batik as a value-added local product supports SDG 8 (decent work and economic growth). From the perspective of higher education, the involvement of lecturers and students in this empowerment program contributes to the achievement of IKU 2, IKU 3, and IKU 5 through the involvement of students outside the campus, collaboration with partners, and the commercialization of applied research results in the form of empowerment models and batik design technologies that community groups can directly adopt.

Although various training and mentoring initiatives have been carried out, studies that specifically and systematically analyze how digital transformation (including design, branding, and online marketing), combined with the application of appropriate technology (waste management, natural dyes, and design and production efficiency), can increase the competitiveness of Singosari Batik are still limited. There

has been little research that captures the interrelationships among cultural, technological, environmental, and marketing aspects within a comprehensive creative economic empowerment framework in the context of Singosari.

This research is expected to provide an in-depth understanding of how technological intervention and digitalization can increase production capacity, strengthen environmentally friendly production practices, expand market access, and ultimately improve the competitiveness and economic sustainability of the Singosari Batik Association (Disperpusip Jawa Timur, 2016). This study aims to design and implement a digital transformation model using batik design applications, professional websites, and marketplaces to strengthen branding and expand markets.

Method

This study uses a descriptive-qualitative approach with a participatory action research (PAR) design integrated into a community service program at the Singosari Batik Association, Malang Regency. The research subjects were all members of the association, with a focus on 12 active batik artisans, including seven artisans who already had their own batik brands and two artisans who already had simple wastewater treatment plants. Primary data were obtained through participatory observation of the production process, waste management, and marketing activities; in-depth interviews with association administrators and key artisans; and focus group discussions (FGD) to explore partners' needs, perceptions, and experiences regarding the application of technology and digital marketing. Secondary data was collected from community documents, production and sales records, social media content and insights (Instagram, TikTok), and documentation of training and mentoring activities (Darmadi et al., 2019; Eryanto, 2025).

The research procedure was carried out in several stages: (1) preliminary study and problem mapping to obtain an overview of the existing conditions of waste management, dye use, and marketing patterns; (2) intervention design in the form of implementing IPAL RO+ Appropriate Technology (TTG), training on the use of natural dyes and color fixation, as well as training and digital marketing assistance (content creation, marketplace management, and TikTok Live); (3) gradual implementation of technology and training; and (4) monitoring and evaluation of the impact by comparing conditions before and after the intervention. Data analysis was conducted descriptively and qualitatively by organizing and interpreting field findings, supported by simple descriptive and quantitative analysis of performance indicators such as sales volume, promotion

frequency, audience reach, adoption of natural dyes, and the existence of waste management SOPs. Data validity was maintained through source and technique triangulation, as well as confirmation of results (member check) with community partners.

Result and Discussion

Digital Marketing

This community service activity was carried out to help batik artisans in the Singosari Batik Community in Malang Regency understand how to use digital media to market their products. Through this activity, the artisans are expected not only to understand the functions and benefits of online media but also to apply it independently to expand the reach of batik product promotion to a broader audience. The use of digital technology is considered important for addressing the challenges of the current creative industry era, where online marketing is a significant factor in increasing product competitiveness and sales.

The activity began with an intensive socialization and mentoring session on the use of TikTok and Shopee as promotional and sales media. The mentoring was conducted privately and gradually so that the artisans could more easily understand and practice using the applications directly. This approach was considered adequate because it allowed participants to receive guidance according to their level of understanding and ability.



Figure 1. Partner Training and Mentoring Activities



Figure 2. Partner Training and Mentoring Activities



Figure 3. Promotional Activities by Tiktok FEB Unidha Malang



Figure 4. Promotional Activities by Tiktok FEB Unidha Malang

In addition, considering that most members of the Singosari Batik Community do not yet have their own online stores, the community service team facilitated the promotion of their products through the official TikTok account of FEB Unidha Malang as a pilot media. This step introduces digital marketing strategies and demonstrates how using social media can increase

product visibility and sales. Over time, the community is expected to manage its own sales accounts and make digital marketing an integral part of batik business development, thereby creating independence and improving the welfare of the artisans.

Table 1. Comparison of Online Marketing Activities of the Singosari Batik Community in Malang Regency before and After Using TikTok

| No | Marketing Aspects | Before Using TikTok | After Using TikTok | Impact |
|----|-------------------------------------|--|--|--|
| 1 | Marketing Platform | Only used social media such as Facebook and Instagram with limited reach | Actively used TikTok as the leading platform with engaging short video content | Audience reach increased across cities and provinces |
| 2 | Promotion Frequency | Promotions were unscheduled, averaging 1-2 times a week | Promotions were carried out regularly every day with a regular upload schedule | Promotion consistency increased and had an impact on brand awareness |
| 3 | Content Type | Only displayed product photos without engaging narratives | Uses videos of the batik-making process, storytelling, and customer testimonials | Content is more interactive and able to attract potential buyers |
| 4 | Interaction with Consumers | Slow response to comments and messages from potential buyers | Faster and more active interaction through comments and live streaming features | Closer relationships with customers |
| 5 | Number of Sales (average per month) | 100 batik products sold by 20 community members | 140 batik products sold by 20 community members. | 140 batik products sold by 20 community members. |
| 6 | Product Image and Popularity | Product Image and Popularity | Product Image and Popularity | Product Image and Popularity |
| 7 | Community Member Income | Community Member Income | Community Member Income | Community Member Income |

Wastewater Treatment Technology for Batik Waste

The technology applied to the Singosari Batik Community partners is RO+ technology, which is an advancement of *Reverse Osmosis* (RO) technology commonly used for drinking water treatment. This innovation is specifically designed to meet the needs of batik artisans and reduce the impact of liquid waste generated during production. RO+ technology not only functions as a filter, but also as a more comprehensive waste treatment system, so that it is safe before being discharged into the environment.

Before the waste is fed into the RO+ machine, the wastewater undergoes a pretreatment process comprising seven filtration stages. Each stage is designed to reduce suspended solids, wax residue, dye particles, and other chemicals commonly found in batik wastewater. In addition to the seven filtration stages, the wastewater must undergo a sedimentation for approximately 3 days. This sedimentation process aims to separate heavy materials and residues that cannot be processed directly by the RO system, allowing the machine to operate more efficiently and have a longer service life.



Figure 5. Handover of TTG IPAL RO + to Partners

RO+ technology is expected to minimize the negative impact of textile industry waste, especially batik. With the application of this technology, wastewater quality can be significantly improved, bringing it to a safer level for the environment. This is important because batik activities generate waste that can pollute soil and water sources if not correctly managed.

The application of RO+ technology also provides a sense of security for artisans. They no longer need to worry that their batik production activities will hurt the

surrounding community. In addition to raising environmental awareness, this technology also encourages more responsible and sustainable production practices. Thus, RO+ technology not only serves as a technical solution but also as a strategic step to support the sustainability of the local batik industry.

TTG Natural Dyes

In the natural dyeing process, it is necessary to use a fixing agent, such as ferrous sulfate (FeSO_4), to bind the dye to the fabric fibers. Ferrous sulfate is particularly effective for plant-based dyes that are rich in tannins, such as mahogany, jolawe, ketapang, and various types of bark. This material helps deepen the color, stabilize its intensity, and increase its resistance to washing and light exposure. Technically, fixation is carried out at the final stage, after the fabric has been dipped in a natural dye solution. The fabric is then soaked in a low-concentration tunjung solution of about 1-3 grams per liter of water so as not to make the fabric texture hard. This process produces a more intense, long-lasting color with the distinctive character of natural batik.



Figure 6. Natural Dye Adhesive (Tunjung)



Figure 7. Natural Materials for Good Fabric Dyeing



Figure 8. Training and Assistance Activities for Partners of the Singosari Batik Association

In applying appropriate technology (TTG) for natural plant-based dyes, the activity implementation team provided comprehensive training to partners of the Singosari Batik Association. This training covered an introduction to various types of natural dyes, how to process them from raw materials, and alternatives for obtaining finished materials that are now available on the marketplace. Thus, the artisans had two choices: to process the dye materials themselves as needed or to purchase ready-to-use products and then learn the techniques for applying them correctly to batik fabrics.

Through this training, it was discovered that some partners were actually familiar with natural dyes, but did not continue using them due to a lack of understanding of the application techniques and limited market. Natural dyes tend to produce softer colors than textile dyes, requiring branding strategies and consumer education. To that end, the team will continue its assistance in the form of branding development, digital promotion, and online marketing so that natural dye batik products can be more widely accepted and have competitive selling value.

Community service activities carried out in collaboration with the Singosari Batik Association have resulted in three appropriate technology (AT) products developed to meet partners' needs. These products include both physical technology (complex technology) and soft technology (knowledge- and skill-based technology). All of these products are designed to improve the quality of batik production, strengthen

environmental sustainability, and expand partners' marketing reach. The TTG produced are as follows:

1. RO+ Technology for Batik Liquid Waste Treatment (Hard Technology)

RO+ technology is an adaptation of the membrane system (Reverse Osmosis) modified for the context of batik industrial waste. Generally, batik waste requires a series of filtration, sedimentation, and membrane treatment stages to reduce COD, solids, and dyes before discharge into the environment. Membrane approaches, including ultrafiltration, nanofiltration, and RO, have been proven effective in reducing textile pollutants when applied in an integrated process (Kiswanto et al., 2019; Rokhmania et al., 2023). Therefore, modifications to "RO+" (a seven-stage pretreatment followed by RO) can reduce pollutant loads and help artisans without independent wastewater treatment plants meet discharge standards and adopt responsible production practices (Amalia et al., 2023).

2. Application of Plant-Based Natural Dyes (Soft-Hard Technology)

The use of natural dyes for batik combines the technical aspects of dye extraction and processing (hard) with applied knowledge of dyeing techniques and fixation processes (soft). Experimental research on natural dyes, the use of ketapang, mahogany, or mango seed extracts, shows that a combination of multiple dyeing processes and the use of fixatives such as tunjung (ferrous sulfate, FeSO_4) or lime can increase color fastness to washing and light (Pujilestari, 2017; Widowati et al., 2023). With training in the application of natural dyes and fixation techniques, artisans can produce more stable and environmentally friendly colors while strengthening the characteristics of local culture (Purwaningrum et al., 2023).

3. Digital Marketing for Batik Marketing (Soft Technology)

Digital marketing assistance for batik MSMEs includes content creation, branding, social media account management, and marketplace utilization. Case studies on the application of digital marketing in batik MSMEs show that digital marketing training and visual/descriptive content coaching can expand market reach, increase product visibility, and reduce dependence on physical exhibitions (Fitria, 2023; Subekti et al., 2020). By strengthening their digital capabilities, batik artisans can increase their competitiveness in an increasingly digitized creative economy ecosystem (Wibowo et al., 2023).

4. Application of Technology and Innovation to the Community

The application of technology and innovation to the Singosari Batik Association was carried out

through training, direct assistance, and demonstrations on how to use the tools. RO+ technology was introduced by explaining the waste filtration process, maintenance procedures, and daily operations so that partners could practice it independently. On the natural dye side, training focused on plant-based material processing techniques, dyeing processes, and the use of fixing agents such as tunjung to improve color fastness. Meanwhile, digital marketing technology was applied through guidance on creating marketplace accounts, social media management, product photography techniques, and branding strategies. Overall, the application of technology was carried out in stages so that it could be understood and adopted sustainably (Khristiana et al., 2024).

5. Relevance and Community Participation

The technology applied is highly relevant to the needs of Singosari batik artisans, particularly in production, environmental sustainability, and marketing. The main issues faced by partners related to liquid waste, low understanding of natural dyes, and limited access to digital sales can be addressed through the three TTGs developed. Community participation in this activity is very active; community members are fully involved in discussions, hands-on practice, evaluation of results, and sharing experiences among artisans. They also provide input on the technology's suitability for field conditions, so the assistance process can be adjusted accordingly. This involvement shows that the community feels they need and benefit from the technology provided, while also strengthening the sustainability of the activity (Handayani et al., 2025; Siradjuddin et al., 2018).

6. Impact (Benefit and Productivity)

The application of technology and innovation has had a real impact on improving production quality and on artisans' independence. RO+ technology helps reduce environmental pollution while providing artisans with a sense of security in managing waste. The use of natural dyes increases product variety and strengthens the identity of Singosari batik as an environmentally friendly product. Digital marketing training increases partners' ability to market products online, broadening sales potential and reducing dependence on annual exhibitions. The combination of these three technologies increases productivity, improves the quality of batik products, and opens up new economic opportunities for community members. The long-term impact is the formation of an independent, adaptive, and highly competitive batik community.

Conclusion

The implementation of community service at the Singosari Batik Association shows that partners still face several major obstacles, particularly in managing batik wastewater, limited understanding of natural dyes, and weak branding and digital marketing capabilities. Of the 30 association members, only a few are actively involved in batik-making and have simple wastewater treatment facilities, so technological and business management improvements are urgently needed to support the sustainability of an environmentally friendly batik industry.

Through this program, three appropriate technologies were successfully implemented, namely RO+ technology for waste management, natural dye technology to improve quality and environmental friendliness, and digital marketing to expand the market. As a result, the partners' ability to manage waste, understand the natural dyeing process, and improve product appearance and marketing has begun to improve. Continued assistance is still needed to maintain consistency in implementation, including strengthening digital marketing through Instagram and TikTok account management and implementing more professional online sales strategies so that the association can develop into a productive, competitive, and sustainable community.

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