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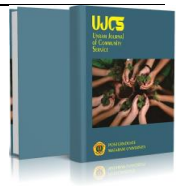

Optimization of the Batik Creative Industry through Technological Innovation to Improve Product Quality, Quantity, and Cost Efficiency in the City of Probolinggo

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Abstract: The Higher Education Community Service Program for Regions (PM-UPUD) aims to optimize the batik creative industry in Probolinggo City through the application of technological innovations. Target partners include Batik Wahyulatri and Poerwa Batik, which face problems such as limited raw material planning, motif and coloring quality, drying technology, and digital marketing strategies. The implementation methods include socialization, training, technology application, mentoring, and evaluation. The technologies applied include Wastewater Treatment Plant (IPAL), infrared dry room machines, Material Requirement Planning (MRP), synthetic coloring techniques, and digital marketing. The program results showed significant improvements: 40% in production capacity, 30% in dyeing quality, 20% in sales turnover for partner 1 and 25% for partner 2, as well as 30% and 36% in profits, respectively. This program supports ASTA CITA number 3 and SDGs number 8 on decent work and sustainable economic growth.

Keywords: Batik, Digital Marketing, Dry Room Infrared, IPAL, MRP, Technological Innovation.

Introduction

The creative industry is one of the sectors that significantly contributes to national economic growth, primarily due to its ability to create high added value and generate new job opportunities. In the modern economic era, the development of the creative industry has become an essential pillar in strengthening regional economic independence. The city of Probolinggo is one of the regions in East Java that has great potential for the development of the creative industry, particularly through the production of hand-drawn batik, which has become an integral part of the local community's cultural and economic identity (BPS, 2024).

Hand-drawn batik from Probolinggo City has its own distinctive characteristics, especially in the use of synthetic dyes that enhance the visual character and appeal of the product. However, despite this great potential, the batik industry in this region still faces various obstacles that hinder improvements in productivity, quality, and product competitiveness. These problems need to be addressed through innovative and collaborative approaches between business actors, the government, and higher education institutions.

Efforts to develop the batik industry in Probolinggo City align with the national priority program outlined in ASTA CITA number 3, which aims

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to increase employment, entrepreneurship, and creative industries, while continuing infrastructure development. Additionally, this program supports the achievement of Sustainable Development Goal (SDG) 8, specifically Decent Work and Economic Growth. This confirms that the optimization of the batik creative industry sector is not only oriented towards improving the local economy, but also forms part of an inclusive and equitable sustainable development agenda (Firdaus & Wibowo, 20244).

In Probolinggo City, two main players in the batik industry are development partners, namely Batik Wahyulatri and Poerwa Batik. Batik Wahyulatri is located on Jalan Panglima Sudirman Gg. PJKA Perum Sentong Blok A1, with a production capacity of 135 pieces per month or around 2,484 pieces per year, and a turnover of IDR 401,500,000 in 2024. Meanwhile, Poerwa Batik, located at Jalan Angguran Jaya No. 1/133, has a production capacity of 200 pieces per month, or approximately 2,400 pieces per year, with a turnover of IDR 480,000,000. These two partners are important representations of the potential and challenges of the local batik industry in Probolinggo City.

Based on the analysis of existing conditions, the main problems faced by both partners can be grouped into three areas: production, marketing, and management. In the production sector, the absence of a Material Requirement Planning (MRP)-based raw material inventory plan has led to an imbalance between material availability and production needs. Additionally, there are still numerous customer complaints regarding the quality of motifs and synthetic coloring. The lack of technological innovation, such as in the drying process during the rainy season and the creation of motifs that are not yet optimal, is also a major obstacle in maintaining product quality (Imanuddin et al., 2021).

In the marketing field, limitations in applying digital marketing strategies pose a particular challenge. Most batik industry players in Probolinggo City have not yet fully utilized the potential of e-commerce and marketplaces as a medium for promoting and selling their products widely. As a result, sales volume remains suboptimal, and market share is limited to specific areas. In fact, with the support of digital technology, local batik products have the potential to reach national and even international markets (Fitria, 2023; Rahayu et al., 2025).

Meanwhile, in the field of management, financial records kept by batik industry players are still simple, limited to sales and expenditure records without a structured accounting system. Additionally, the layout of the production area is not yet efficiently organized, which hinders the smooth operation of work processes and affects the cleanliness and tidiness of the production environment. These problems indicate the need to strengthen managerial capacity and implement a modern production management system (Karsana et al., 2022; Tampubolon et al., 2024).

In view of these various problems, a targeted development strategy is needed through the application of technological innovation and optimization of the production process. This approach is expected to enhance the quality and quantity of batik products while efficiently reducing production costs. Thus, the optimization of the creative batik industry in Probolinggo City will not only strengthen the competitiveness of local businesses but also contribute to sustainable, inclusive, and environmentally-friendly regional economic growth.

Method

The PM-UPUD program is implemented through five stages:

1. Socialization
   Coordination of program implementation between the proposing team and target partners, determination of the implementation schedule, and explanation of the technological innovations to be applied.
2. Training
   Training is conducted to improve the knowledge and skills of partners in various aspects:
   a. Accounting-Based Bookkeeping
      1) Time: Monday, October 20, 2025
      2) Participants: 30 people per group
      3) Speaker: Dr. Dra. Fedianty Augustinah, MM
      4) Material: Creation of journals, ledgers, balance sheets, and income statements
   b. Material Requirement Planning (MRP)
      1) Time: Wednesday, October 22, 2025
      2) Participants: 30 people per group
      3) Speaker: Bambang Sutejo, ST., MT
      4) Material: Key components of MRP, calculation mechanisms, practices, and evaluation
   c. Marketing Mix and Digital Marketing
      1) Time: Saturday, October 25, 2025
      2) Participants: 30 people per group
      3) Speaker: Dr. Dra. Fedianty Augustinah, MM
      4) Material: Marketing mix fundamentals (4Ps), digital transformation, content creation practices
   d. Motif Creation and Synthetic Coloring Techniques
      1) Time: Wednesday, October 29, 2025
      2) Participants: 30 people per group
      3) Speakers: Dr. Nensy Megawati Simanjuntak, S.Pd., M.Pd., and Dr. Dra. Liosten R.R. Ully T, MM

4) Material: Introduction to synthetic coloring, modern motif creation techniques, quality control

e. IPAL Operation and Maintenance
   1) Time: Saturday, November 1, 2025
   2) Participants: 30 people per group
   3) Speakers: Bambang Sutejo, ST., MT., and Amirullah ST, MT
   4) Material: Application of TTG IPAL, operation, and maintenance

f. Operation of Infrared Dry Room Machines
   1) Time: Monday, November 3, 2025
   2) Participants: 30 people per group
   3) Speakers: Bambang Sutejo, ST., MT
   4) Material: Basics of infrared dry rooms, operating SOPs, and preventive maintenance

3. Technology Application and TTG Production
   a. Wastewater Treatment Plant (IPAL) - Target Partner 1
      1) Total capacity: 15.24 m^3
      2) Components: Settling tank (6.72 m^3), coagulation tank (1.80 m^3), absorption tank (5.04 m^3), control tank (1.68 m^3)
   b. Infrared Dry Room Machine - Target Partner 2
      1) Size: 3 x 3 m^2
      2) Capacity: 16 pieces of batik cloth
      3) Drying time: 15 minutes
   c. Material Requirement Planning (MRP) System**
      Raw material planning documents for both partners
4. Assistance and Evaluation
   Ongoing assistance in operating the technology and evaluating the results of the program's implementation.
5. Program Sustainability
   Sustainability plan for the following year to maximize the program's impact.

Result and Discussion

The application of technology and innovation is a key strategy in improving the competitiveness of the batik creative industry in Probolinggo City. Through this program, several innovations have been implemented to address various issues faced by partners, such as low productivity, inconsistent product quality, and low-cost efficiency. The application of technology was carried out at two main partners, namely Batik Wahyulatri and Poerwa Batik, by adjusting to the specific needs of each.

Wastewater Treatment Plant (IPAL)

The Wastewater Treatment Plant (IPAL) technology was implemented at Target Partner 1 – Batik Wahyulatri to treat liquid waste from the synthetic dyeing process. This IPAL consists of four main tanks, namely a settling tank, a coagulation tank, an absorption tank, and a control tank, with a total capacity of 15.24 m^3. The main objectives of implementing IPAL are to reduce environmental pollution caused by the disposal of untreated dyeing waste and to protect the health of the craftsmen.

Figure 1. Wastewater Treatment Plant at Batik Wahyulatri

Figure 2. Wastewater Treatment Plant at Batik Wahyulatri

The benefits of implementing IPAL include: creating a green economy or green industry, reducing the risk of water and soil pollution, and reducing the potential for skin, lung, and cancer diseases caused by exposure to dye chemicals. The treated water can be reused in the production process, thereby increasing the efficiency of water resource use. The implementation of IPAL has also been proven to improve the quality of batik products by up to 50%, while reflecting the partners' commitment to preserving the environment and supporting the principles of sustainable development.

Figure 3. Wastewater Treatment Plant at Batik Wahyulatri

Figure 4. Wastewater Treatment Plant at Batik Wahyulatri

Infrared Dry Room Machine

The second technology implemented is the Infrared Dry Room Machine at Target Partner 2 – Poerwa Batik. This machine measures 3 x 3 square meters and can accommodate up to 16 pieces of batik fabric in one drying cycle in just 15 minutes. Previously, the drying process was done traditionally and was highly dependent on weather conditions, so production was often hampered during the rainy season.

Figure 5. Infrared Dry Room at Poerwa Batik

Figure 6. Infrared Dry Room at Poerwa Batik

The impact of implementing this machine is quite significant. Production capacity increased from 3,115 pieces to 4,411 pieces per year, or an increase of 40%. In addition, product quality also increased by 50% because the drying process became more even and did not cause stains. This technology enables partners to fulfill orders on time and overcome drying space limitations. Thus, Dry Room Infrared is an effective solution to weather constraints and production infrastructure limitations.

Figure 7. Infrared Dry Room at Poerwa Batik

Figure 8. Infrared Dry Room at Poerwa Batik

Material Requirement Planning (MRP)

Material Requirement Planning (MRP) was implemented to improve efficiency in controlling raw material inventory. Previously, both partners often experienced material surpluses or shortages due to the lack of a structured planning system.

Figure 9. Implementation of MRP

Through MRP, material requirements can be calculated accurately based on production schedules and order volumes. This system helps ensure that materials arrive on time, avoids costly excess stock, and prevents material shortages (stock-outs) that can hamper production. Procurement cost efficiency has increased, and orders can be fulfilled on schedule, thereby increasing customer satisfaction.

Figure 10. Implementation of MRP

After two months of implementing the program, the partners' knowledge and skills in applying MRP increased by 30%, demonstrating the effectiveness of this system in improving business operational efficiency.

Synthetic Dyeing Techniques and Motif Creation

Training in synthetic dyeing techniques and motif creation was provided to both partners to improve product quality and appeal in line with market trends. Current trends show consumer preference for softer motifs with dark shades, while still maintaining the distinctive characteristics of Probolinggo batik. The results of the training showed a 60% increase in the quality of motifs and coloring, a 50% increase in knowledge and skills, and a significant decrease in customer complaints. Batik products have become more competitive and in demand in the market due to the combination of design innovation and consistent coloring. This training plays an important role in enhancing the aesthetic value and differentiation of products in the market (Fahma et al., 2019).

Figure 11. Synthetic Dyeing Techniques and Motif Creation

Figure 12. Synthetic Dyeing Techniques and Motif Creation

Digital Marketing and Marketing Mix

In facing modern market competition, the application of Digital Marketing and Marketing Mix (4P) is an important step. This training focuses on the use of social media such as YouTube, Instagram, and TikTok, as well as the use of e-commerce platforms to expand market reach.

Figure 13. Instagram Account of Batik Wahyulatri

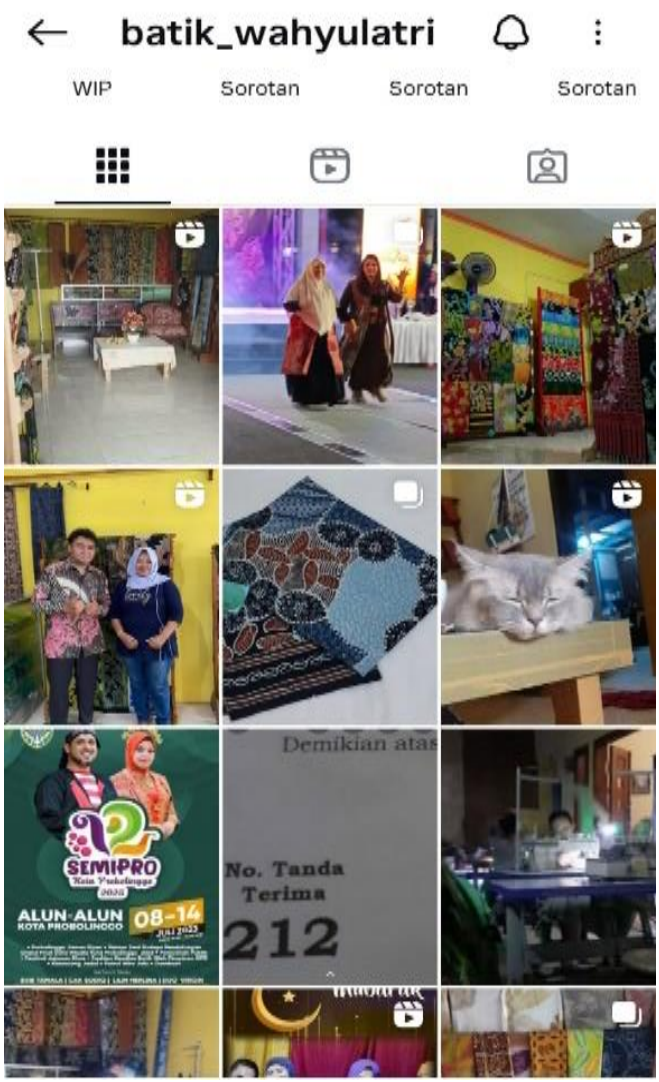

Figure 14. Instagram Account of Batik Wahyulatri

The results of implementing this digital strategy have been very positive. Batik Wahyulatri's turnover increased from IDR 401,500,000 to IDR 461,725,000, or a 20% increase, while Poerwa Batik's turnover increased from IDR 480,000,000 to IDR 600,000,000, or a 25% increase. In addition, the net profits of each partner increased by 30% and 36%, respectively, with market segments expanding beyond the Probolinggo area. The implementation of digital marketing has proven to increase brand visibility, strengthen customer loyalty, and open up new market opportunities (Ustazah et al., 2025).

Accounting-Based Bookkeeping

Training in accounting-based bookkeeping was provided to improve the partners' ability to manage their finances professionally and transparently. Before the training, partners' financial records were still simple, consisting only of sales and expenditure summaries without a clear accounting structure. After the training, partners were able to use a modern application-based recording system called Siapik, which includes journal entries, ledgers, balance sheets, and income statements. Partners' knowledge and skills increased by 50%, and the financial system became more accurate to support business decision-making. The implementation of this system strengthened the governance and transparency aspects of the business, which are important foundations for the development of a sustainable creative industry (Subekti et al., 2020).

Figure 15. Accounting Bookkeeping Using Siapik

Figure 16. Community Service Activities

Evaluation of Program Implementation Results

The program implementation evaluation was conducted over two months (September–November 2025) by assessing key performance indicators such as productivity, product quality, cost efficiency, and management capacity improvement.

Table 1. Evaluation of Program Implementation Results

No	Description	Before PM-UPUD	After PM-UPUD	Improvement
1	Improvement in production water quality at target partner 1	-	50%	50%
2	Increase in production capacity (dry room infrared) at target partner 2	3115 sheets per year	4411 sheets per year	1296 sheets (40%)
3	Increase in sales turnover at target partner 1	Rp. 401.500.000	Rp. 461.725.000	Rp. 60.225.000 (20%)
4	Increase in sales turnover at target partner 2	Rp. 480.000.000	Rp. 600.000.000	Rp. 120.000.000 (25%)
5	Improvement in product quality at target partners 1 and 2	-	60%	60%
6	Improvement of accounting-based bookkeeping skills and knowledge in target partners 1 and 2	-	50%	50%
7	Increased profits due to the marketing mix and digital training in the target partner 1	-	30%	30%
8	Increased profits due to the marketing mix and digital training in the target partner 2	-	36%	36%
9	Improvement of batik-making skills and knowledge in target partners 1 and 2	-	50%	50%
10	Improvement of MRP manufacturing skills and knowledge at target partners 1 and 2	-	30%	30%

The evaluation results show that all the technologies and training implemented had a significant positive impact on improving the performance of partners. Production capacity increased by an average of 40%, product quality improved by up to 60%, and production cost efficiency improved thanks to the implementation of MRP and the reuse of treated wastewater from IPAL. On the other hand, the significant increase in turnover and profits demonstrates the success of integrating technology with digital marketing strategies (Munawir et al., 2024).

Overall, this program has succeeded in optimizing the potential of the batik creative industry in Probolinggo City through the application of sustainable, environmentally friendly, and competitiveness-oriented technological innovations (Friadi et al., 2024).

Relevance and Community Participation

The program to optimize the batik creative industry through technological innovation is highly relevant to the needs of the batik craft community in Probolinggo City. The main problems faced by artisans, such as limited drying land, inefficient procurement of raw materials, limited motif variations, and a lack of digital marketing strategies, are directly addressed through a series of technology applications and training. Thus, this program is not only applicable but also appropriate to the social, economic, and cultural context of the local community (Khristiana et al., 2024).

Community participation in the program's implementation was very active and comprehensive at every stage of the activity. Craftsmen were directly involved in testing and implementing infrared dry room technology, which replaced the traditional drying system. In addition, they played an active role in implementing the Material Requirement Planning (MRP) system for raw material management, motif development, and synthetic coloring, as well as providing accounting-based bookkeeping training that improved managerial professionalism (Wibowo et al., 2021).

This participation was also evident in the implementation of a digital marketing mix strategy, which involved promoting products through social media and marketplaces, as well as in the construction and management of a Wastewater Treatment Plant (WTP) as a commitment to environmental sustainability.

The active involvement of the community in this program had a broad positive impact, both economically and socially. Economically, artisans experienced increased income, improved production cost efficiency, and expanded market reach. Meanwhile, from a social perspective, this activity promotes business independence, enhances cooperation between artisans, and cultivates a spirit of innovation in creating high-value-added products. Thus, this program not only strengthens the economic resilience of the community but also builds a sustainable and participatory batik creative industry ecosystem.

Impact on Usefulness and Productivity

The implementation of the program has had a significant impact on environmental usefulness, increased productivity, product quality, business management, and market expansion. From an environmental perspective, the implementation of IPAL has created a cleaner and healthier production environment. Liquid waste from synthetic dyeing,

which was previously discharged into rivers, can now be reprocessed into usable water. This reduces the risk of skin diseases and respiratory disorders for craftsmen and the surrounding community. Thus, a business ecosystem is formed that supports the principles of green industry and sustainable development (Suhrowardi et al., 2024).

In terms of business productivity, the application of dry room infrared technology increases drying process efficiency by up to 80% and increases production capacity by 40%. The MRP system also contributes significantly to more efficient raw material management, resulting in a more stable production flow and minimizing the risk of production delays. This efficiency has a direct impact on the partners' ability to meet market demand promptly (Siradjuddin et al., 2018).

In terms of product quality and innovation, training in synthetic dyeing techniques and motif creation has successfully enhanced the artisans' creativity in producing more modern designs without losing the local character of Probolinggo batik. The resulting products feature softer colors, are more durable, and align with contemporary market preferences. This makes the partners' batik products more competitive and able to reach new market segments at the national level (Handayani et al., 2025).

Management and financial aspects have also seen significant improvements through the implementation of accounting-based bookkeeping. Financial records have become more transparent, structured, and easy to audit. Partners can now compile financial reports independently, including journals, ledgers, balance sheets, and income statements. These improvements have made financial management more professional and supported accurate business decision-making, thereby reducing the risk of losses and making business planning more measurable and effective (Levi et al., 2020).

Ultimately, the implementation of digital marketing strategies has had a tangible impact on increasing sales and enhancing the economic value of the region. Promotion through social media such as YouTube, Instagram, and TikTok has proven effective in expanding market reach and introducing Probolinggo batik products to a broader audience. Sales through e-commerce platforms have also increased significantly, ultimately contributing to increased turnover and local economic growth (Wardoyo & Abdullah, 2018).

Overall, the application of technology and innovation in this program has not only increased business productivity and efficiency but also strengthened the position of the Probolinggo batik industry as part of a resilient, sustainable, and environmentally-oriented creative economic ecosystem. This success demonstrates that collaboration between technological innovation and community participation can lead to meaningful change in enhancing regional welfare and economic competitiveness.

Conclusion

The PM-UPUD Program for Optimizing the Batik Creative Industry through Technological Innovation in Probolinggo City has successfully had a significant impact on increasing productivity, product quality, and the welfare of partners. The application of IPAL technology, infrared dry room machines, MRP systems, modern synthetic dyeing techniques, and digital marketing strategies has proven effective in overcoming the problems faced by batik craftsmen.

Evaluation results show a 40% increase in production capacity, a 60% increase in dyeing quality, a 20-25% increase in sales turnover, and a 30-36% increase in profits. This program also contributes to the creation of a green industry and increases the competitiveness of Probolinggo batik products in the national market.

The program's sustainability needs to be continued in the second and third years to maximize the impact of empowerment, strengthen partners' capabilities in accounting (target 90%), MRP (target 70%), and product diversification. This program proves that the integration of technology and innovation in traditional industries can increase competitiveness while preserving the nation's cultural heritage.

Acknowledgments

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