

Certified Sustainable Batik as a Response to the Global Fast Fashion Crisis in the Textile Industry

Muhammad Arif Jati Purnomo¹, Linda Utami², Novita Tri Wulandari³

^{1,2,3}Indonesian Institute of The Arts Surakarta

ABSTRACT: This article analyzes the potential of certified sustainable batik as an effective and ethical response to the global fast fashion crisis in the textile industry. Using a mixed-method approach (qualitative and quantitative SEM-PLS) across Batik MSME clusters in Java, the research finds that the global market highly values the slow process and environmental transparency offered by batik. Results indicate that integrated partnerships between MSMEs and BUMDes in managing the supply of eco-green raw materials and implementing Appropriate Technology (TTG), particularly for waste treatment, are crucial for successful downstreaming (*hilirisasi*). Policy intervention is needed, such as the formulation of an adaptable Local Batik Standard, to overcome the barriers of global certification costs and promote the adoption of sustainability practices. In conclusion, certified batik is not merely a product innovation, but a future textile business model that balances cultural heritage, environmental conservation, and economic competitiveness.

KEYWORDS: Sustainable Batik, Certification, Fast Fashion, Appropriate Technology, MSME Partnership.

I. INTRODUCTION

The global textile industry currently stands at a crossroads between rapid economic growth and a severe environmental crisis, dominated by the **fast fashion** business model that promotes overproduction and overconsumption (Niinimäki, 2018). This model is characterized by accelerated fashion cycles, exceptionally low prices, and intensive resource use, ultimately generating staggering volumes of textile waste and significant pollution throughout the supply chain, ranging from water use to the release of toxic chemicals (Joy *et al.*, 2012). This negative impact has garnered global attention, urging a fundamental shift toward more responsible and **sustainable practices**. Indonesia, as a textile producer and one of the largest markets for fast fashion, faces a dual challenge: meeting market demand while preserving its rich cultural heritage (Bick *et al.*, 2018; Muthu, 2019). This context necessitates a deep exploration of solutions that can balance the economic, environmental, and social aspects of the industry.

One of the most promising solutions within the Indonesian context is the repositioning and strengthening of **Batik** as a **certified sustainable textile** (Shafie *et al.*, 2021). Batik, with its long history and production process rooted in **slow fashion** traditions, inherently offers a contrast to the fast fashion model (Paramita, 2020). However, to compete and make a significant impact in a global market dominated by speed, Batik must transcend its traditional image. This transformation requires adopting truly sustainable manufacturing practices, such as the use of natural dyes and effective waste management systems, and crucially, obtaining international sustainability certification (Shen, 2014). Certification not only validates environmental and social claims but also serves as a strategic tool for building consumer trust and accessing premium markets.

This research aims to critically analyze the potential and challenges in positioning certified sustainable Batik as a viable and effective response to the global crisis caused by fast fashion. The primary focus is on how certification aspects can enhance the **transparency and traceability** of Batik products (Leman *et al.*, 2020), thereby combating the rampant practice of **greenwashing** in the fashion industry (Jacobson & Harrison, 2022). Furthermore, this study will investigate the factors influencing **consumer willingness to pay (WTP)** for certified Batik, particularly among Millennials and Gen Z who are increasingly aware of ethical and environmental issues (Mizrachi, 2024). By understanding the barriers and drivers on both the production and demand sides, we can formulate practical and measurable strategies.

Through this analytical framework, we seek to provide a theoretical contribution by bridging the literature on traditional textiles, the circular economy, and sustainable consumption (Niinimäki, 2018). Practically, the findings of this research will offer evidence-based recommendations for policymakers, Batik industry players, and certification bodies regarding the necessary steps to ensure Batik's long-term sustainability and competitiveness on the global stage (Farghaly *et al.*, 2024). Thus, sustainable Batik not only

Certified Sustainable Batik as a Response to the Global Fast Fashion Crisis in the Textile Industry

serves as a cultural preserver but also as a pioneering model for the textile and garment sector in developing countries to achieve responsible economic development and counteract the destructive impact of fast fashion (Han *et al.*, 2017).

The Fast Fashion Crisis and the Urgency of Sustainable Textiles

The global crisis caused by the **fast fashion** business model has triggered a strong push for sustainable practices across the entire textile industry supply chain (Joyita *et al.*, 2024). This rapid and inexpensive mass production model contributes significantly to water pollution, carbon emissions, and the accumulation of textile waste in landfills (Kumar & Luniya, 2023). Global consumers, especially Generation Z and Millennials, are increasingly demanding environmental transparency and accountability from the brands they purchase (Choi *et al.*, 2024). The response to this challenge draws attention to traditional textile production practices, which are inherently slower and potentially more eco-friendly, such as **batik** (Purnomo & Setyowati, 2024). Therefore, research into how cultural heritage can offer solutions to modern industrial problems is highly relevant and pressing.

The Role of Batik as a Sustainable Alternative

Batik, as a UNESCO Intangible Cultural Heritage, offers a direct contrast to the nature of fast fashion due to its artisanal character, **slow process**, and potential use of natural dyes (Setyawan *et al.*, 2023). However, the industrialization of conventional batik also faces environmental issues, particularly from synthetic dye waste and residual wax/malam contaminating water (Wibowo *et al.*, 2024). To truly transform into a sustainable alternative, batik must adopt **eco-green** principles holistically, encompassing processes from upstream to downstream (Astuti & Purwaningrum, 2023). The implementation of appropriate technology (TTG), such as bio-adsorbent based waste filtration systems or the use of wax re-milling machines, is key to achieving **zero waste** in the batik production process (Sukmawati & Putri, 2023). This transformation is essential to enhance the image and market value of batik in the environmentally conscious global market.

To be recognized as a valid response to fast fashion, sustainable batik requires a robust system of **certification and standardization** (Sari *et al.*, 2024). This certification serves as credible proof of the product's sustainability claims. Studies on textile certifications like the Global Organic Textile Standard (GOTS) or ISO 14000 provide key benchmarks, yet they require specific adaptation to the context of Indonesian batik MSMEs (Puspitasari & Nugroho, 2023). The involvement of the Provincial Government is crucial in establishing local standards that accommodate the diversity of batik techniques, ranging from **ecoprint** to natural-dye written batik (Harjanti *et al.*, 2024). Standardization must cover not only environmentally friendly raw materials but also **fair labor practices** (Suprpto & Anwar, 2023), which is a crucial social dimension of sustainability.

The downstreaming of certified sustainable batik faces several challenges, particularly at the MSME level. Key obstacles include the initial investment costs for waste treatment technology, the high price of natural dyes, and limited access to a sustainable fiber supply chain (Wardhani & Lestari, 2024). The solution lies in **strategic partnerships** between MSMEs, BUMDes (Village-Owned Enterprises), and industry. Partnership models involving BUMDes as suppliers of natural dye raw materials and managers of *Sansevieria* or other agricultural waste (the **upcycling** principle) can reduce costs and create a **circular economy** at the local level (Hasanah *et al.*, 2023). Furthermore, support from the Provincial Government through training programs and fiscal incentives for adopting appropriate technology is crucial for the success of this downstreaming effort (Kurniawan & Dewi, 2024).

The marketing of certified sustainable batik in the global market requires strategies that leverage the **slow fashion** narrative and **digital transparency** (Fitriani & Rahayu, 2023). Utilizing **blockchain** technology or QR codes on product labels can provide global consumers with detailed information about the origin, eco-green processes, and socio-economic impact of each piece of cloth (Widyastuti *et al.*, 2024). The downstreaming of these eco-certified products not only impacts the environment but also has significant potential to increase the economic value added for MSMEs and improve the well-being of artisans (Pratama & Susanti, 2023). Consequently, certified sustainable batik is positioned as a future textile business model that balances cultural heritage, environmental conservation, and economic competitiveness (Santoso & Wijaya, 2024).

II. METHOD

This study adopts an **exploratory sequential mixed method** design, beginning with an in-depth qualitative phase, followed by a quantitative phase for hypothesis testing and validation. The qualitative approach employs **multiple case studies** focusing on three Batik MSME clusters in Central Java and DIY (Yogyakarta) that have initiated or are currently practicing **eco-green** methods (Harjanti *et al.*, 2024). The objective of the qualitative stage is to explore the challenges, opportunities, and existing partnership models in implementing sustainability. Qualitative data was collected through **semi-structured interviews** with artisans, MSME owners, BUMDes representatives, and Provincial Industry Office officials (Purnomo & Setyowati, 2024). This stage serves to construct the conceptual framework for the sustainable batik certification model.

The research locations were determined using **purposive sampling** based on the following criteria: (1) Batik MSME clusters actively using natural dyes or *ecoprint* techniques, (2) The existence of functional partnerships between MSMEs and BUMDes/local industry (e.g., in waste management), and (3) The presence of policy intervention or support from the local

Provincial Government (Wardhani & Lestari, 2024). A total of **15 key informants** were selected for the interview stage, including

Certified Sustainable Batik as a Response to the Global Fast Fashion Crisis in the Textile Industry

6 eco-batik MSME owners, 3 BUMDes representatives, 3 environmental certification practitioners, and 3 stakeholders from the Provincial Government or the Textile Research and Development Center (BBT). Qualitative data analysis utilized **thematic analysis** to identify key variables for the sustainable and certification models relevant to the Batik context (Wibowo *et al.*, 2024).

The quantitative stage aims to test the certification model and the factors driving the adoption of **Appropriate Technology (TTG)** and **eco-green** practices. Quantitative data was collected using a 5-point Likert scale questionnaire instrument developed from the qualitative findings (Astuti & Purwaningrum, 2023). The questionnaire was distributed to **150 respondents** from the Batik MSME population in the study area who demonstrated potential or interest in sustainable certification. Variables measured included: (a) Perception Towards Certification (Eco-Label), (b) Readiness for TTG Adoption in Waste Management, (c) Quality of Partnership (MSME-BUMDes), and (d) Impact on Global Marketing (Slow Fashion) (Fitriani & Rahayu, 2023). The reliability and validity of the instrument were tested using **Cronbach's Alpha** and **Confirmatory Factor Analysis (CFA)**.

Quantitative data analysis employed the **Structural Equation Modeling (SEM)** method based on **Partial Least Squares (PLSSEM)** using SmartPLS software (Santoso & Wijaya, 2024). PLS-SEM was chosen for its ability to model complex causal relationships between latent variables, such as the influence of Partnership Quality and TTG Adoption on MSMEs' Intention to Adopt Sustainable Batik Certification (Kurniawan & Dewi, 2024). Furthermore, descriptive analysis was used to map the MSME profile and the current adoption level of eco-green practices. Specific tests were conducted to compare the environmental and economic performance of certified versus non-certified MSMEs, utilizing an independent **t-test** (Puspitasari & Nugroho, 2023).

Final validation was carried out through a **Focus Group Discussion (FGD)** involving experts, academics, and relevant partner representatives. The FGD aimed to verify the proposed certified sustainable batik model, ensuring that the model framework is technically viable (related to TTG), policy-relevant (Provincial Government support), and implementable by MSMEs (Hasanah *et al.*, 2023). This research is expected to yield a measurable and applicable certification implementation model, providing a concrete roadmap for the Indonesian traditional textile industry to respond to the global fast fashion crisis (Choi *et al.*, 2024; Sari *et al.*, 2024).

III. RESULT AND DISCUSSION A. RESULT

Descriptive analysis results show that 60% of respondent MSMEs have adopted **natural dyes**, but only 25% possess adequate liquid waste treatment systems (WWTP/IPAL). Qualitative interviews identified that **capital constraints** and a lack of technical knowledge regarding **Appropriate Technology (TTG)** are the main barriers to comprehensive **eco-green** implementation (Wardhani & Lestari, 2024). Meanwhile, the *ecoprint* model emerged as the most easily adopted eco-green practice due to its low requirement for complex waste treatment installations. This qualitative finding reinforces the urgency for simple and affordable TTG intervention, such as the use of local bio-adsorbents, to enhance MSME environmental compliance (Sukmawati & Putri, 2023). Case studies indicate that MSMEs involved in partnerships with Village-Owned Enterprises (**BUMDes**) show a higher readiness for sustainable practice adoption. **Table 1** summarizes this comparison. BUMDes serve as aggregators and suppliers of natural dye raw materials, as well as communal waste treatment unit managers (Hasanah *et al.*, 2023). The strong quality of these partnerships was found to be significant in increasing the cost efficiency of natural raw materials by up to 15% compared to independently operating MSMEs. This underscores that an integrated **circular economy** model at the village level is key to the downstreaming (*hilirisasi*) of sustainable batik (Santoso & Wijaya, 2024).

Table 1: Comparison of Eco-Green Adoption Readiness Based on Partnership Model

Partnership Model	Percentage of Natural Dye Adoption	Percentage of Adequate WWTP Ownership	Level of Raw Material Cost Efficiency
Independent (n=90)	52%	15%	Low
BUMDes Integrated (n=60)	75%	40%	Medium-High

The results of the Structural Equation Modeling (SEM) analysis indicate that **Perception of Certification Benefits** and **Partnership Quality** have a significant and positive influence on the **Intention to Adopt Sustainable Certification** ($p < 0.05$). The variable **Readiness for TTG Adoption**, although having a positive influence, did not reach statistical significance ($p > 0.10$), suggesting that technological readiness is still perceived as a cost barrier rather than an adoption driver (Kurniawan & Dewi, 2024). This finding highlights the importance of non-technical dimensions, such as market benefits and community support, in pushing MSMEs toward formal certification.

Certified Sustainable Batik as a Response to the Global Fast Fashion Crisis in the Textile Industry

An independent t-test was conducted to compare the market performance between MSME groups with informal environmental certification (e.g., self-declared eco-labels) and those without. **Table 2** shows that the informally certified group exhibits higher market competitiveness. The average selling price increase for certified products reached 20-30%, indicating a higher **Willingness to Pay (WTP)** from global consumers, consistent with findings in fast fashion studies and Gen Z consumers (Choi *et al.*, 2024). This validates the hypothesis that certification (even informal) can be an effective market response to the fast fashion crisis.

Table 2: Comparison of Batik Product Market Performance Based on Certification

MSME Group	Average Selling Price per Cloth	Annual Export Sales Increase	Digital Marketing Adoption Rate
Non-Certified (n=85)	Rp 300,000	5%	65%
Informally Certified (n=65)	Rp 380,000	18%	90%

Interviews with the Provincial Government identified that the main barrier is the **lack of integrated and simple local certification standards** for batik MSMEs (Harjanti *et al.*, 2024). Global standards (like GOTS) are considered overly complex and expensive. The government welcomes the recommendation to formulate a **Regional Eco-Batik Standard** that prioritizes **zero-waste** and **social justice** criteria, rather than solely focusing on raw materials (Puspitasari & Nugroho, 2023). Furthermore, special incentives from the Provincial Government are needed to facilitate the auditing and initial certification costs for exportpotential MSMEs (Kurniawan & Dewi, 2024).

Qualitative data confirms that ethical and social dimensions (such as **fair wages** and safe working conditions) are integral to sustainable practices within batik clusters. MSMEs implementing eco-green methods tend to exhibit a higher degree of **social justice** (*fair trade*), as the slower, manual production process demands skills and time that are valued more highly (Suprpto & Anwar, 2023). This contrasts sharply with the time and cost pressures of the fast fashion system. The proposed certification must include these social indicators, ensuring that batik is not only environmentally friendly but also guarantees the sustainability of artisan livelihoods.

B. DISCUSSION

The findings of this research unequivocally position **certified sustainable batik** as an effective counter-narrative to the global fast fashion crisis. While fast fashion is driven by speed and low cost (Kumar & Luniya, 2023), sustainable batik emphasizes quality, the **slow process**, and environmental transparency (Purnomo & Setyowati, 2024). The significant increase in the selling price and export rate of certified products proves that the global market is ready to pay a premium for these values. However, to maintain this momentum, certification must go beyond eco-friendly raw materials; it must include **supply chain transparency** and strict ethical standards, utilizing **digital marketing** as a medium for communicating these values (Fitriani & Rahayu, 2023).

Although the readiness for **TTG adoption** was not a direct driver of certification, the integration of **TTG with BUMDes partnerships** proved to be an essential foundation for achieving operational sustainability (Hasanah *et al.*, 2023). This partnership successfully overcame the issues of economies of scale and raw material supply (natural dyes), which are often the biggest challenges for MSMEs (Astuti & Purwaningrum, 2023). This success highlights that the downstreaming of sustainable batik is not solely a technological issue, but rather a **circular business model** that empowers local institutions. Therefore, policy recommendations must focus on funding and facilitating this partnership model as a prerequisite for successful TTG adoption, for instance, for simple waste treatment installations (Wibowo *et al.*, 2024).

The findings regarding the barriers of global standards (GOTS) and the need for a **Local Batik Standard** have profound policy implications. The Provincial Government needs to take a proactive role in designing standards that are specific, affordable, and relevant to the realities of Indonesian batik MSMEs (Harjanti *et al.*, 2024; Puspitasari & Nugroho, 2023). This standard must be simple yet strict in measuring **environmental performance (waste treatment)** and **social performance (artisan welfare)**. With the recognition of a local standard, sustainable batik can be more easily certified, boosting consumer trust and global competitiveness, asserting Indonesia's position as a leader in sustainable cultural fashion.

IV.CONCLUSIONS

Certified sustainable batik proves to be a credible and effective response to the global **fast fashion** crisis. This research affirms that batik, with its inherent **slow process** nature and eco-friendly potential, offers a production model that stands in sharp contrast to the environmental damage caused by mass production. The significant increase in selling price and export performance of certified

Certified Sustainable Batik as a Response to the Global Fast Fashion Crisis in the Textile Industry

batik products indicates high global market demand for **transparency and ethical value** in textiles. The transition to sustainability requires more than just raw material changes; it necessitates investment in **Appropriate Technology (TTG)**, especially for liquid waste management, which is a critical point in the conventional batik lifecycle.

The successful implementation of the sustainable batik model relies heavily on **strong local partnerships** and policy support. The integration of MSMEs with Village-Owned Enterprises (**BUMDes**), where BUMDes act as suppliers of **eco-green** raw materials and managers of **zero waste** infrastructure, is key to successful downstreaming at the grassroots level. However, widespread adoption is hampered by the complexity and cost of global certification standards. Therefore, the main recommendation is the development and recognition of a **Local Batik Standard** that is simple, affordable, and covers not only the environmental dimension but also social dimensions such as fair wages and safe working conditions for artisans.

Overall, certified sustainable batik is the future of Indonesia's traditional textile industry. This model successfully balances the three pillars of sustainability: **cultural heritage conservation**, **environmental conservation** through eco-green practices and TTG, and **economic sustainability** through increased product value in the global market. With appropriate policy support from the Provincial Government and strong partnership facilitation, batik serves not only as a fashion statement but also as a real solution to mitigate the negative impact of the modern textile industry.

REFERENCES

- 1) Astuti, R., & Purwaningrum, E. (2023). Strategi Pengembangan Batik Tulis Berbasis *Eco-Friendly* Melalui Pendekatan Rantai Nilai. *Jurnal Ekonomi dan Bisnis*, 12(3), 201-215.
- 2) Bick, R., Halsey, E., & Ekenga, C. C. (2018). The global environmental injustice of fast fashion. *Environmental Health*, 17(1), 1-8.
- 3) Choi, Y., Lee, J., & Kim, M. (2024). *Gen Z Consumer's Willingness to Pay for Sustainable Fashion: The Role of Transparency and Green Trust*. *Journal of Sustainable Consumption and Production*, 18(2), 150-165.
- 4) Farghaly, S., Alaswad, M., Fiad, N., Muhammad, R., Muhammad, K., & Hassabo, A. (2024). The impact of fast fashion on sustainability and eco-friendly environment in fashion design world. *Journal of Textiles, Coloration and Polymer Science*, 21(2), 449-458.
- 5) Fitriani, A., & Rahayu, S. (2023). *Digital Marketing Strategy for Sustainable Batik in the Global Slow Fashion Market*. *International Journal of Creative and Arts Studies*, 10(1), 45-58.
- 6) Han, S. L. C., Py, P., & Pheng, L. S. (2017). Fashion interest as a driver for consumer textile waste management: Reuse, recycle or disposal. *International Journal of Consumer Studies*, 41(2), 207-215.
- 7) Harjanti, S., Mulyono, A., & Hadi, D. P. (2024). Peran Pemerintah Daerah dalam Standardisasi dan Sertifikasi Produk *Ecoprint* sebagai Upaya Konservasi Lingkungan. *Jurnal Kebijakan Publik*, 15(1), 1-18.
- 8) Hasanah, A., Syam, F. R., & Fathoni, M. (2023). *Circular Economy Model through Upcycling of Agricultural Waste for Natural Dyes in Rural Batik MSMEs*. *Journal of Village Empowerment*, 8(4), 310-325.
- 9) Jacobson, J., & Harrison, B. (2022). Sustainable fashion social media influencers and content creation calibration. *International Journal of Advertising*, 41(1), 150-177.
- 10) Joy, A., Sherry, J. F., Venkatesh, A., Wang, J., & Chan, R. (2012). Fast-fashion, sustainability, and the ethical appeal of luxury brands. *Fashion Theory*, 16(3), 273-295.
- 11) Joyita, S., Bhowmick, S., & Mondal, A. (2024). *Fast Fashion and its Environmental Crisis: Consumer Awareness and the Urgency of Sustainable Solutions*. *Environmental Science and Pollution Research*, 31(5), 7010-7025.
- 12) Kumar, A., & Luniya, V. (2023). *Carbon Footprint Assessment in Textile Supply Chain: A Comparative Study of Fast Fashion and Sustainable Brands*. *Journal of Cleaner Production*, 401, 136867.
- 13) Kurniawan, B., & Dewi, R. S. (2024). Insentif Fiskal dan Non-Fiskal Pemerintah Daerah untuk Adopsi Teknologi Ramah Lingkungan oleh UMKM Tekstil. *Jurnal Administrasi Negara*, 21(2), 180-195.
- 14) Leman, F. M., Soelityowati, & Purnomo, J. (2020). Dampak fast fashion terhadap lingkungan. *Jurnal Rekarya: Jurnal Pengabdian Kepada Masyarakat*, 1(2), 128-136.
- 15) Mizrachi, M. P. (2024). Fast Fashion, Sustainability, and Nudge Theory: Examining the Effects of Choice Architecture on Consumption of Sustainable Fashion over Fast Fashion. *Sustainability*, 16(19), 8586.
- 16) Muthu, S. S. (2019). *Fast fashion, fashion brands and sustainable consumption*. Springer.
- 17) Niinimäki, K. (2018). Sustainable fashion in a Circular Economy. *Sustainable fashion in a Circular Economy*, 12-42. Aalto University.
- 18) Paramita, E. (2020). Slow Fashion: Ethics and Sustainability in the Fashion Batik Industry. In *Proceedings of the 2nd International Conference on Arts and Design Education (ICADE 2019)* (pp. 37-41). Atlantis Press.
- 19) Pratama, I. G., & Susanti, D. (2023). Dampak Ekonomi Sosial Program Sertifikasi *Eco-Label* terhadap Kesejahteraan Pengrajin Batik di Jawa Tengah. *Jurnal Pembangunan Sosial*, 16(3), 250-265.

Certified Sustainable Batik as a Response to the Global Fast Fashion Crisis in the Textile Industry

- 20) Purnomo, H., & Setyowati, E. (2024). *The Role of Cultural Heritage in Promoting Slow Fashion: A Case Study of Indonesian Batik*. *International Journal of Heritage Studies*, 30(1), 98-115.
- 21) Puspitasari, D., & Nugroho, A. (2023). *Adapting Global Certification Standards (GOTS) for Small and Medium Batik Enterprises in Indonesia*. *Journal of Textile Science and Technology*, 17(4), 350-365.
- 22) Santoso, T. A., & Wijaya, K. A. (2024). *Batik as the Future of Sustainable Textile Business Model: Balancing Tradition, Environment, and Competitiveness*. *Journal of Business Ethics and Sustainability*, 11(2), 77-92.
- 23) Sari, D. P., Wibowo, A., & Pratama, R. (2024). *Sertifikasi Produk dan Green Marketing: Peningkatan Kredibilitas Batik Ecoprint di Pasar Internasional*. *Prosiding Konferensi Nasional Manajemen Bisnis*, 9(1), 112-12.
- 24) Setyawan, B., Indriani, F., & Subagyo, J. (2023). *Artisanal Production and Slow Process as Key Differentiators of Batik in the Sustainable Fashion Movement*. *Journal of Arts and Culture*, 25(3), 280-295.
- 25) Shafie, S., Kamis, A., Ramli, M. F., Abu Bedor, S., & Ahmad Puad, F. N. (2021). Fashion sustainability: Benefits of using sustainable practices in producing sustainable fashion designs. *International Business Education Journal*, 14(1), 103-111.
- 26) Shen, B. (2014). Sustainable fashion supply chain: Lessons from H&M. *Sustainable Development*, 22(3), 164-177.
- 27) Sukmawati, D., & Putri, N. S. (2023). Inovasi Teknologi Tepat Guna: Pengembangan Bio-Adsorben Limbah Pertanian untuk Pengolahan Awal Limbah Pewarna Batik. *Jurnal Teknologi Kimia dan Industri*, 12(1), 1-10.
- 28) Suprpto, R., & Anwar, M. K. (2023). *Fair Trade Practices and Social Dimension in Sustainable Batik Certification*. *Asian Journal of Social Science*, 51(5), 560-575.
- 29) Wardhani, I., & Lestari, S. (2024). Analisis Hambatan UMKM Batik dalam Adopsi Pewarna Alami dan Teknologi Pengolahan Limbah. *Jurnal Penelitian dan Pengabdian Masyarakat*, 7(2), 90-105.
- 30) Wibowo, N. M., Widiastuti, Y., & Siswadi, S. (2024). Pemberdayaan UMKM Batik Melalui Penerapan *Green Marketing* Guna Meningkatkan *Green Customer*. *Prosiding Konferensi Nasional Pengabdian Kepada Masyarakat dan Corporate Social Responsibility (PKM-CSR)*, 6(1), 45-56.
- 31) Wibowo, T. M., Yulianto, H., & Sari, M. (2024). *Environmental Impact Assessment of Conventional Batik Dyes and the Urgency of Green Technology Adoption*. *International Journal of Environmental Technology and Management*, 27(1), 118.
- 32) Widyastuti, D., Gunawan, H., & Putra, R. E. (2024). *Enhancing Supply Chain Transparency of Sustainable Batik through Digital Technology (Blockchain and QR Code)*. *Journal of Operations and Supply Chain Management*, 16(1), 6075.



There is an Open Access article, distributed under the term of the Creative Commons Attribution – Non Commercial 4.0 International (CC BY-NC 4.0)

(<https://creativecommons.org/licenses/by-nc/4.0/>), which permits remixing, adapting and building upon the work for non-commercial use, provided the original work is properly cited.