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Digitalizing Green Fashion Design via Service-Learning to Empower Fashion SMEs

(Digitalisasi Desain Fashion Ramah Lingkungan melalui Service-learning untuk Pemberdayaan UMKM)

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Abstract: *This community service research introduces a model of digitalizing green fashion through a service-learning approach implemented at Rumah Jahit Nila, a fashion MSME in Medan. The intervention includes intensive training on 3D design software such as CLO 3D and Marvelous Designer, the use of AI-assisted tools like Repsketch for pattern optimization, and production mentoring throughout a 12-month project cycle. Measurements show an increase in students' average technical competency scores from 55.1 to 76.9, representing a gain of 21.8 points. Partner evaluation was conducted through satisfaction questionnaires and field observations, both of which indicated positive acceptance of digital patterns and user guides. Claims regarding waste reduction and material efficiency are currently indicative, as direct quantitative metrics such as percentage reduction in fabric use or paper pattern sheets are not yet available; thus, further measurement is recommended. This study offers a replicable digital technology-based community service model for empowering sustainable fashion MSMEs.*
Keywords: *design digitalization; green fashion; service-learning; fashion SMEs.*

Abstrak: *Penelitian pengabdian ini memperkenalkan model digitalizing green fashion melalui pendekatan service-learning yang diterapkan pada Rumah Jahit Nila, sebuah UMKM fesyen di Medan. Intervensi meliputi pelatihan intensif perangkat lunak desain 3D seperti CLO 3D dan Marvelous Designer, pemanfaatan alat bantu AI Repsketch untuk optimasi pola, serta pendampingan produksi selama siklus proyek 12 bulan. Pengukuran menunjukkan peningkatan rata-rata skor kompetensi teknis mahasiswa dari 55,1 menjadi 76,9, atau peningkatan sebesar 21,8 poin. Evaluasi terhadap mitra dilakukan menggunakan kuesioner kepuasan dan observasi lapangan yang melaporkan penerimaan positif terhadap pola digital dan panduan pengguna. Klaim mengenai pengurangan limbah dan efisiensi material saat ini bersifat indikatif karena metrik kuantitatif langsung seperti persentase pengurangan kain atau pengurangan lembar pola kertas belum tersedia, sehingga pengukuran tersebut direkomendasikan untuk tindak lanjut. Studi ini menawarkan model replikasi PkM berbasis teknologi digital untuk pemberdayaan UMKM fesyen berkelanjutan.*
Kata kunci: *digitalisasi desain; green fashion; service-learning; UMKM fesyen.*

Introduction

The digital era has transformed the way fashion designers design, visualize, and produce garments. 3D technologies (CLO 3D, Marvelous Designer) and artificial intelligence (AI) enable accurate virtual prototypes, reducing physical sampling and textile waste. Digital fashion also

opens opportunities for virtual-only designs that are fully sustainable, reducing carbon footprints and raw material consumption (Renaningtyas, 2025). The concept of virtual fashion or digitally created designs that exist only virtually is becoming increasingly popular as a way to minimize textile waste. Recent case studies show that the use of 3D prototypes and the metaverse can reduce 50–70% of physical sampling waste, introduce immersive e-commerce "try-before-you-buy" business models, and allow exploration of alternative materials without physical production (Jodi et al., 2023). An analysis reveals the potential of the metaverse to promote sustainability, as well as the risk of increased energy footprints if not balanced by server and blockchain optimization (Xin et al., 2025).

Technological advances in various professions, particularly in fashion design activities, have given rise to a new concept known as Green Fashion. Green Fashion emphasizes minimizing environmental impact through the use of eco-friendly materials, recycling, and energy-efficient production processes. Digitalization facilitates the exploration of alternative materials and "zero-waste pattern making" processes virtually before physical production, supporting the principles of green design (Hamdan et al., 2022). Green Fashion focuses on selecting sustainable materials (recycled fibers, bio-based textiles), designing zero-waste patterns that minimize fabric remnants, and using on-demand production models to prevent overproduction. Environmentally conscious fashion consumption encourages the preservation of natural ecosystems for present and future generations. This includes purchasing and using textiles made from organic and sustainable materials, repairing, reusing, and recycling textile products, as well as adopting the slow fashion concept. The environmental aspects of fashion products have attracted the attention of researchers and practitioners in recent years. Consequently, a large number of scientific papers have been compiled on the key aspects of this consumer behavior.

According to the Indonesian Dictionary, fashion (*fesyen*) is defined as a style or design related to clothing or textiles. This paper aims to provide an overview of the literature on consumer behavior toward green fashion products, as well as to identify and categorize significant driving factors and, additionally, to identify the most critical barriers (Kemi & Zilahy, 2024). To ensure that this research can be applied to the community, we used the service-learning method. Service-learning integrates community service activities with academic learning, creating real-world experiences for students while providing direct benefits to community partners (Myers & Eike, 2020). The development of craft products, particularly in the fashion industry, involves various aspects ranging from design and production to marketing. Crafts are handmade products that utilize skills and creativity in making goods, including fashion products. In developing fashion craft products, several steps can be taken to create items that are not only appealing but also have high functional and aesthetic value (Suhendar et al., 2023). In the context of fashion, studies show that service-learning projects enhance students' self-efficacy in garment construction management, communication skills, and understanding of sustainable production processes (Kincade et al., 2022).

This community service activity was conducted with Rumah Jahit Nila as a partner. Rumah Jahit Nila is a traditional tailoring workshop in the local area that serves as an ideal partner for implementing service-learning. The application of Green Fashion at Rumah Jahit Nila was motivated by observations of fabric waste and leftover paper patterns generated during the cutting and sewing processes, as well as the absence of a supply chain linking tailors to retailers. Based on these findings, this activity was deemed necessary to be implemented so that the MSME Rumah Jahit Nila could establish a more competent production management process while improving the welfare of the surrounding community.

Although the literature shows that digital design can reduce the need for physical sampling and potential waste, there is a lack of evidence regarding practical implementation models of 3D and AI technologies tailored to Muslim fashion MSMEs in Indonesia, which

generally face limitations in digital capacity, capital, and access to training. This gap forms the focus of this community service activity. The objective of the project is to design, implement, and evaluate a model of digitalizing green fashion through the service-learning approach at Rumah Jahit Nila, with the goals of enhancing students' digital competencies, transferring digital pattern-making practices and zero-waste principles to MSME partners, and assessing the initial impact on material efficiency and partner satisfaction.

Methods

This activity is part of a Community Service program using a service-learning approach that integrates students' academic learning with direct application in the community. This method was chosen because it encourages two-way collaboration between the university and its partners, allowing students to gain professional experience in using digital technology while partners benefit practically through increased production capacity and awareness of sustainable fashion practices.

The activity was carried out at Rumah Jahit Nila, Medan Deli District, Medan City, involving students from the Fashion Design Study Program, supervising lecturers, and MSME partners. The participants consisted of 10 students who acted as the technical implementers of the activities, two supervising lecturers who served as facilitators and evaluators, and five tailors from Rumah Jahit Nila who participated as training partners and beneficiaries (see Table 1).

Table 1. Participant Characteristics

No	Participant Group	Number	Main Role Summary
1	Fashion Design Students	5	Needs analysis, digital pattern design, prototyping, documentation
2	Supervising Lecturers	2	Technical facilitators, reflection mentors, process evaluators
3	MSME Partners (Tailors)	10	Providers of production needs information, prototype testers, practical feedback providers

The implementation method consisted of six stages:

1. Partner needs assessment, conducted to map the initial condition of digital literacy and sustainability understanding at Rumah Jahit Nila;
2. Basic software training, introducing CLO 3D and AI-assisted pattern making;
3. Design digitalization workshop, where students practiced creating zero-waste digital patterns;
4. Prototyping assistance, involving partners in the testing and revision of digital designs;
5. Evaluation and reflection, including pre-test and post-test measurements as well as feedback discussions; and
6. Finalization and dissemination, involving the preparation of user guides and a seminar on the activity outcomes.

Data collection instruments consisted of pre-test and post-test assessments to measure students' improvement in technical competence, partner satisfaction questionnaires to evaluate the acceptance of digital patterns, as well as student reflection journals and observation sheets to document the learning process and changes in production practices. The pre-test and post-test questions were developed based on digital design competency indicators, validated by two experts for content validity, and tested for reliability using Cronbach's alpha coefficient.

Quantitative data from pre-test and post-test scores were analyzed descriptively and tested using the paired t-test to determine the significance of students' competency

improvement. If the data were not normally distributed, the Wilcoxon signed-rank test was used. In addition, the effect size (Cohen's d) was calculated to assess the magnitude of competency change. Qualitative data from reflection journals, questionnaires, and observations were analyzed using a thematic approach to identify patterns in participants' experiences and behavioral changes.

The quality and validity of the results were maintained through triangulation between quantitative and qualitative data and researcher discussions to ensure consistency of interpretation. Ethical considerations included obtaining informed consent from all participants, maintaining data confidentiality, and ensuring that the research results were used solely for academic and community service purposes.

Results

The results of the activity showed an increase in students' technical competencies after participating in the series of training and mentoring sessions. Based on the measurements, the average pre-test score of the students was 55.1, which increased to 76.9 in the post-test, indicating an improvement of 21.8 points. The number of students who participated in both assessments was (n = 10). Statistical tests showed that the improvement was statistically significant ($p < 0.05$), with an effect size (Cohen's d) categorized as medium to high. This demonstrates that the service-learning approach is effective in enhancing students' ability to use digital design software and apply green fashion principles.

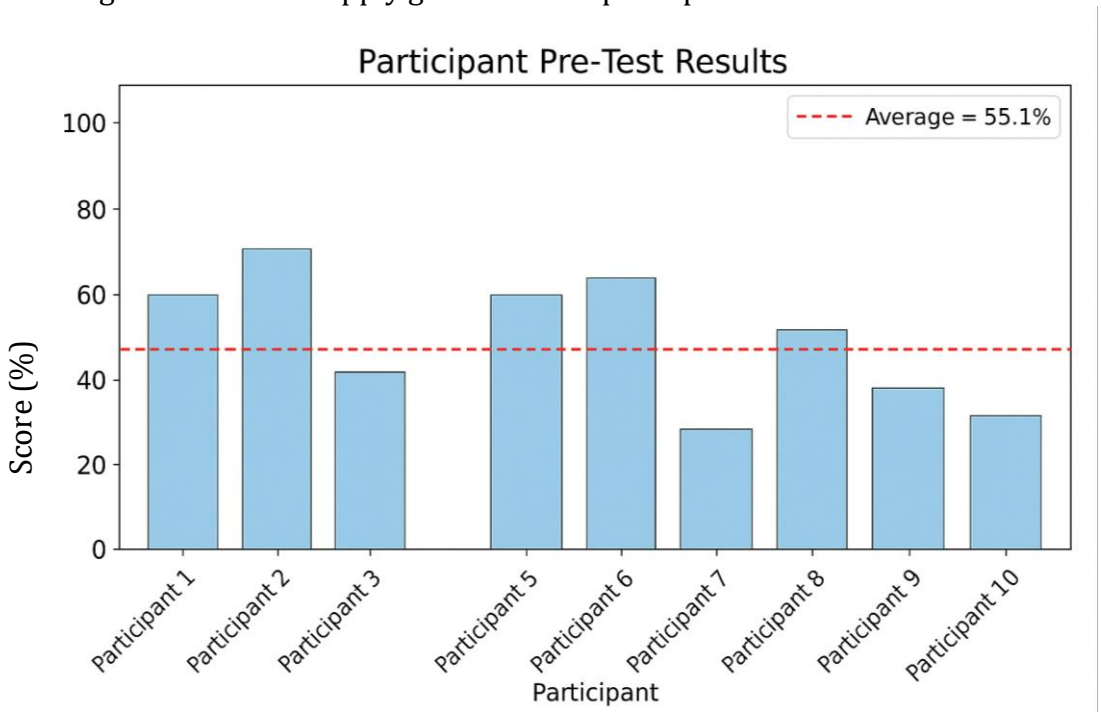

Figure 1. Pre-test Results of Participants' Competence in Digital Design Software

Figure 1 shows the distribution of pre-test scores before the training began. Most participants were in the medium competency category, with an average score of 55.1. This condition reflects that participants still had limited proficiency in using CLO 3D software and understanding the basic principles of green fashion prior to the training.

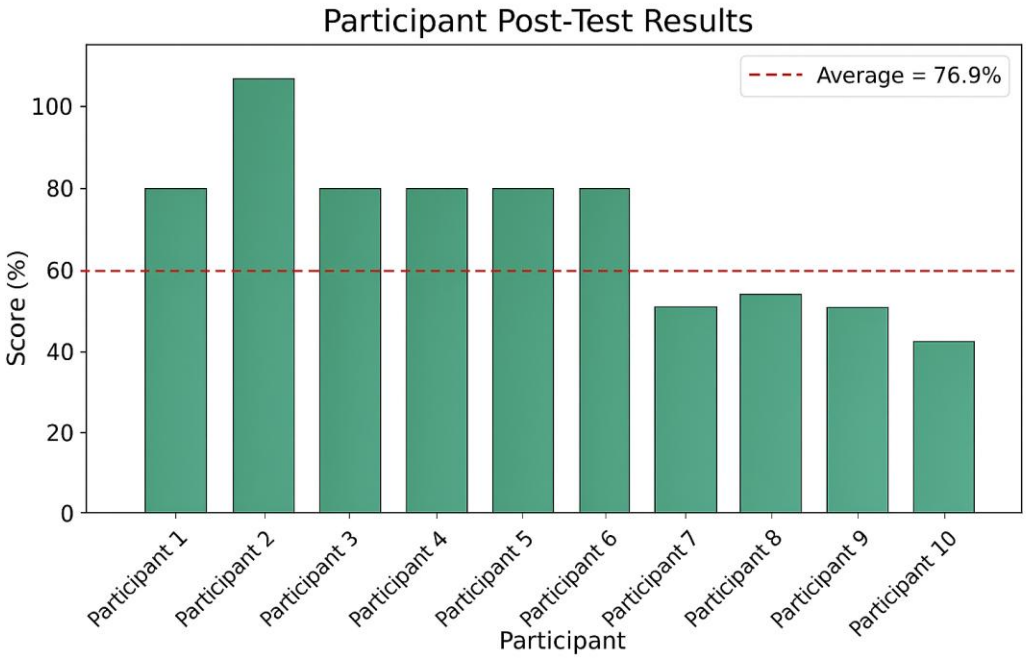

Figure 2. Post-test Results of Participants' Competence after Training and Mentoring

Figure 2 illustrates a significant improvement in the post-test results after participants completed all stages of the activity. The average score increased to 76.9, with a more even distribution in the high category. This improvement indicates that the service-learning–based training process successfully enhanced participants' ability to design and simulate efficient and sustainable digital patterns.

In addition to quantitative results, qualitative data obtained from reflection journals, interviews, and observations showed increased participant engagement during the training. Participants became more confident in using CLO 3D software and developed a better understanding of the AI-assisted pattern-making functions available in Repsketch.

Figure 3. Documentation of CLO 3D Training and AI Implementation at Rumah Jahit Nila

The basic software training was conducted in three sessions using a demonstration and hands-on practice approach (see Figure 3). Participants learned to recognize the interface, use the basic features for digital pattern making, and understand the principles of zero-waste pattern design. Although some participants initially faced technical challenges, direct mentoring from facilitators helped accelerate their adaptation to the new technology.

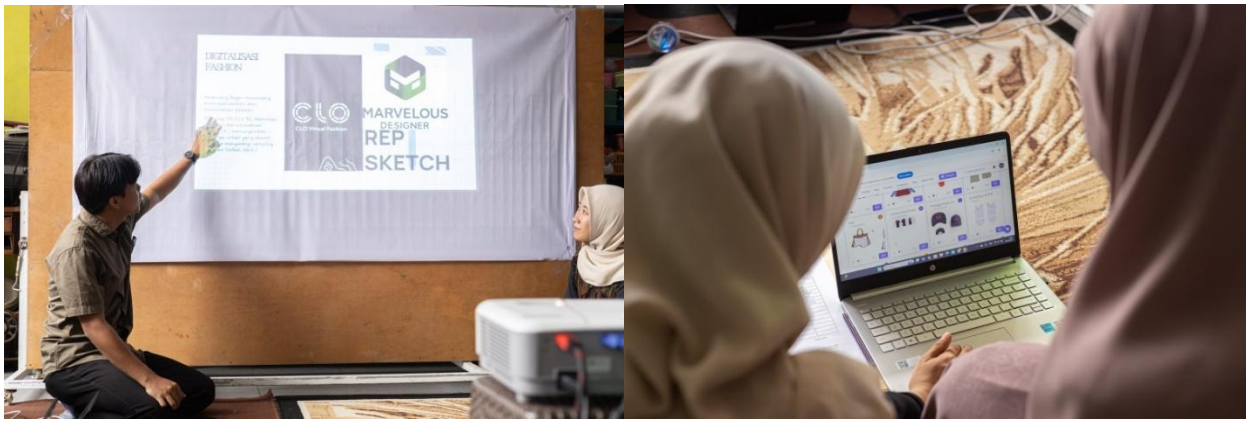

Figure 4. Prototyping Assistance and Digital Pattern Revision Process at Rumah Jahit Nila

The prototyping assistance phase involved participants in testing their digital design outcomes (see Figure 4). Together with the facilitators, participants evaluated pattern accuracy, product comfort, and material efficiency. Feedback from this process was used to refine the digital patterns and produce a more precise final design.

Figure 5. Final Product Prototype Resulting from Digitalization and Zero-Waste Pattern Design

The final product demonstrated the successful application of green fashion principles through an efficient digital design process (see Figure 5). Based on observations, fabric waste from the cutting process was reduced due to the optimization of pattern layouts using the marker optimization feature in Repsketch. In addition, virtual fitting simulations using CLO 3D reduced the need for physical trials, making the production process more efficient in terms of both time and material use.

Discussion

This community service activity demonstrates that the service-learning approach is effective in enhancing participants' competencies and supporting the sustainability of MSME partners. The increase in test scores indicates an improvement in participants' knowledge and skills in the field of design digitalization. The results of this activity align with the findings of Myers and Eike (2020), Kincade et al. (2022) and Diez-Ojeda et al. (2025), who state that service-based learning can enhance participants' technical and communication abilities through direct involvement in social activities.

The design digitalization implemented using CLO 3D also supports production efficiency and waste reduction, as described by Hamdan et al. (2022) and Renaningtyas (2025).

Furthermore, Han (2025) asserts that integrating artificial intelligence in digital pattern making can accelerate the pattern drafting process while optimizing fabric layout, resulting in significant material savings. Rizzi and Bertola (2025) also emphasize that the application of generative AI in fashion design has the potential to expand designers' creativity while reducing production waste through more accurate digital simulations.

From the perspective of MSME empowerment, Syarkani (2025) explains that digital business model innovation in Indonesia's creative economy sector strengthens small entrepreneurs' technological adaptability and operational efficiency. The results of this activity are also consistent with the findings of Setiawati and Nuvriasari (2025), who show that digitalization and product quality directly influence the competitive advantage of local fashion MSMEs in Yogyakarta. In addition, Cruz et al. (2025) highlight that transparency and authenticity in digital communication are essential for small sustainable fashion brands to build trust and strengthen market positioning, which becomes increasingly relevant as MSMEs adopt digital tools and sustainability strategies.

Beyond technical impacts, this activity also strengthens collaboration between academics and small industry partners. As Vehbi et al. (2025) describe, the synergy between digitalization and green strategies can enhance business competitiveness. Therefore, the implementation of this training not only improves knowledge but also encourages a transformation toward sustainable fashion industry practices at the MSME level.

Conclusion

The implementation of green fashion design digitalization through a service-learning approach at Rumah Jahit Nila proved effective in enhancing digital capacity and sustainability awareness among both students and MSME partners. The program resulted in a 21.8-point increase in knowledge and produced efficient, environmentally friendly digital designs. Collaboration between academia and the industrial community has been shown to serve as a sustainable empowerment model for the local fashion sector.

For program sustainability, it is recommended to develop follow-up initiatives such as train-the-trainer programs for local tailors, the establishment of a Green Fashion MSME community, and the replication of similar activities in other regions.

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Conflict of Interest Statement

The authors declare that there is no conflict of interest related to the publication of this article. The implementation, data collection, analysis, and preparation of the manuscript were carried out independently and objectively. No financial, professional, or personal relationships influenced the outcomes or interpretations presented in this work. The funding sources, if any, did not have any role in the decision to conduct or publish this study.

References

Cruz, F. M. da S., Freitas, A. A. F. de, & Silva, F. R. da. (2025). Green on the outside, gray on the inside? Exploring transparency in the communication of small sustainable fashion

brands on Instagram. *Revista Brasileira de Marketing – ReMarK, 24*(Special Issue), 175–204. https://doi.org/10.5585/2025.26514

Diez-Ojeda, M., Queiruga-Dios, M., & Queiruga-Dios, M. Á. (2025). Service-learning in environmental education of primary preservice teachers: Advancing SDGs and improving attitudes towards sustainable development. *Education Sciences, 15*(1), 98. https://doi.org/10.3390/educsci15010098

Han, M. (2025). Integrating artificial intelligence to automate pattern making for personalized garment design. *International Journal of Advanced Computer Science and Applications, 16*(2). https://doi.org/10.14569/IJACSA.2025.0160229

Hamdan, H., Imaningsih, E. S., Ali, H., Raharja, I., & Ilhamalimy, R. (2022). Green fashion concept approach to MSMEs' sustainable green development. *Riau Journal of Empowerment, 5*(3), 149–161. https://doi.org/10.31258/raje.5.3.149-161

Jodi, I. W. G. A. S., Sarasvananda, I. B. G., Putra, B. N. K., Permana, I. P. H., & Meinarni, N. P. S. (2023). *Kumpulan riset produk fesyen pada Shopee dan Tokopedia*. Books For A Better World.

Kemi, A. P., & Zilahy, G. (2024). Green fashion consumption: A review of the literature. *Periodica Polytechnica Social and Management Sciences, 32*(2), 115–130. https://doi.org/10.3311/PPso.21052

Kincade, D. H., Solis, O. J., & Turner, W. D. (2022). You want your students to do service-learning where? On-campus options for fashion merchandising and consumer studies students. *Journal of Human Sciences and Extension, 10*(3), Article 9. https://doi.org/10.55533/2325-5226.1433

Myers, B., & Eike, R. J. (2020). The impact of service-learning on apparel design students' self-efficacy of apparel construction, management, and communication skills. *International Journal of Fashion Design, Technology and Education, 13*(3), 292–299. https://doi.org/10.1080/17543266.2020.1797904

Renaningtyas, L. (2025). The digital fashion: Concept of realness, design process and consumer experience with clothing tailored by AI. *DAMODA Journal, 6*(2), 89.

Rizzi, G., & Bertola, P. (2025). Exploring the generative AI potential in the fashion design process: An experimental experience on the collaboration between fashion design practitioners and generative AI tools. *European Journal of Cultural Management & Policy, 15*, Article 13875. https://doi.org/10.3389/ejcmp.2025.13875

Setiawati, L. P., & Nuvriasari, A. (2025). The influence of digital marketing, price, and product quality on the competitive advantage of MSMEs fashion in Yogyakarta. *East Asian Journal of Multidisciplinary Research, 4*(7), 1–10. https://doi.org/10.55927/eajmr.v4i7.273

Suhendar, H., Hermawan, H., & Setyowati. (2023). *Dasar-dasar desain dan produksi kriya*. Kemendikbudristek RI.

Syarkani, Y. (2025). Digital business model innovation for MSMEs in Indonesia's creative economy era: A strategic management approach. *Lex Localis – Journal of Local Self-Government, 23*(10), 1305–1324. https://doi.org/10.52152/801404

Vehbi, A., Farmanesh, P., & Solati Dehkordi, N. (2025). Nexus amid green marketing, green business strategy, and competitive business among the fashion industry: Does environmental turbulence matter? *Sustainability, 17*(5), 1769.

Xin, B., Song, Y., Tan, H., & Peng, W. (2025). Sustainable digital fashion in a metaverse ecosystem. *Journal of Retailing and Consumer Services, 82*, Article 104099. https://doi.org/10.1016/j.jretconser.2024.104099