# Reconfiguring Fashion through Artificial Intelligence: Opportunities, Ethics and Emerging Challenges

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DOI: https://doi.org/10.5281/zenodo.21206152

**ABSTRACT**

*Artificial Intelligence (AI) is reshaping contemporary fashion by transforming design processes, production systems, and sustainability strategies in the textile and apparel sector. Amid growing concerns over overconsumption, environmental degradation, carbon emissions, and social inequities, AI has emerged as both a technological enabler and a subject of ethical scrutiny. This study examines the influence of AI on creative practice, circular design implementation, and responsible innovation in fashion. Drawing on a qualitative synthesis of systematic literature, design theory, and industry case analyses, this study proposes a framework that situates AI within sustainable fashion discourse. Findings indicate that generative design tools, virtual prototyping, digital twins, and predictive analytics support waste reduction, virtual sampling, demand-responsive production, and informed material selection. AI-enabled resale systems, automated textile sorting, and blockchain-based traceability strengthen circular economy initiatives by extending product lifecycles and improving transparency. However, algorithmic decision-making challenges authorship, craftsmanship, dataset neutrality, and labor structures. Concerns over bias, intellectual property ambiguity, digital energy consumption, and workforce displacement complicate sustainability narratives. The study argues that sustainable transformation requires a human-centered governance approach in which AI augments rather than replaces creative agency and is supported by ethical regulation and critical design education. By integrating sustainability theory, computational creativity, and AI ethics, this research contributes a holistic framework for responsible AI adoption in fashion systems.*

**KEYWORDS:** *Artificial Intelligence, Sustainable Fashion, Circular Economy, Computational Creativity, Ethical AI Governance, Digital Twins.*

## 1. Introduction

As the fashion industry faces mounting pressure to address its environmental and social impacts, a parallel transformation is underway. Scholars and industry reports have highlighted how resource-intensive production, overconsumption, and globalized supply chains contribute to fashion's significant environmental footprint (see, e.g., Ellen MacArthur Foundation, 2017). Simultaneously, Artificial Intelligence (AI) technologies are being integrated across the fashion value chain, spanning demand forecasting, digital prototyping, automated textile sorting, and the development of resale platforms. While many researchers view AI as a potential remedy for longstanding industry challenges such as overproduction and the opacity of supply chains (Giri et al., 2019), its application in fashion extends well beyond operational efficiency. The integration of AI technologies is transforming creative workflows, shifting notions of authorship, and raising significant concerns related to governance, dataset bias, intellectual property, digital energy consumption, and labor dynamics. Such complexities challenge the assumption that AI adoption is inherently sustainable within the fashion sector (Strubell et al., 2019; Buolamwini & Gebru, 2018). This paper examines AI as a socio-technical transformation rather than merely a technological upgrade. It seeks to integrate sustainability discourse, computational creativity theory, and ethical governance perspectives to understand how AI is reconfiguring fashion systems.

## 2. Objectives

- To critically examine the role of Artificial Intelligence in reshaping design, production,

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and consumption within the contemporary fashion industry.

- To analyze how AI-driven technologies support sustainability and operationalize circular economy principles across the textile and apparel value chain.
- To investigate how computational creativity challenges conventional notions of authorship, craftsmanship, and aesthetic diversity in fashion design.
- To assess the socio-ethical implications of AI adoption, including dataset bias, intellectual property ambiguity, digital energy consumption, and labor restructuring.
- To develop a human-centered governance perspective that positions AI as an augmentative force promoting environmental responsibility and social equity.

## 3. Literature Review

This review integrates scholarship across three domains: AI in fashion systems, computational creativity, and ethical governance.

### 3.1 AI in the Fashion Value Chain

AI is increasingly embedded across forecasting, production, and recycling systems. Early studies emphasized inventory optimization and demand forecasting (Giri et al., 2019). More recent research highlights digital twins and lifecycle simulations that reduce sampling waste and enhance production transparency (Küsters et al., 2022). Computer vision technologies support automated textile sorting, strengthening circular recycling systems (Wang et al., 2021). Sustainability scholarship further positions AI within broader ecological debates. Niinimäki et al. (2020) contextualize fashion's environmental burden, while Chen (2024) and Karadayi-Usta (2024) show how virtual try-on and AI-augmented retail reduce returns and overproduction. However, most analyses focus on operational efficiency rather than systemic transformation.

### 3.2 Computational Creativity and Authorship

AI increasingly intersects with design authorship. Boden (2004) defines creativity through novelty and value, raising questions about whether algorithmic outputs qualify as creative acts. Mazzone and Elgammal (2019) and Jin et al. (2024) demonstrate designer–AI collaboration models in generative systems, where human interpretation remains central. Yet authorship becomes distributed. Lee and Kim (2024) show that consumer perceptions of authenticity influence acceptance of AI-designed products, indicating that legitimacy is socially negotiated. Thus, AI reshapes creative practice without eliminating human agency, complicating intellectual property norms.

### 3.3 Ethical Governance, Bias, and Labor

Algorithmic bias presents significant risks. Buolamwini and Gebru (2018) demonstrate how data systems reproduce structural inequalities, which in fashion may affect sizing systems, recommendation engines, or representation. Environmental debates also extend to digital infrastructures. Strubell et al. (2019) highlight the energy intensity of AI models, complicating sustainability claims. Meanwhile, Agrawal et al. (2021) emphasize blockchain's potential for supply chain transparency, though governance mechanisms remain fragmented.

### 3.4 Research Gap

Although AI's operational benefits, creative implications, and ethical concerns are individually documented, these dimensions are rarely integrated. The literature lacks a unified framework connecting sustainability performance, creative agency, and governance accountability. This study addresses that gap through a human-centered governance perspective that situates AI as a socio-technical system rather than a neutral efficiency tool.

## 4. Methodology

This study adopts a qualitative exploratory design grounded in systematic literature synthesis. A structured search of Scopus, Web of Science, and Google Scholar (2015–2024) using keywords such as "AI in fashion," "circular economy," "computational creativity," and "AI ethics" identified over 200 publications. After screening and relevance filtering, interdisciplinary sources spanning sustainability research, computational creativity, AI governance, and industry case studies were selected. Data were analyzed using thematic synthesis. Codes were developed around sustainability enablement, creative reconfiguration, bias and governance, digital energy use, and labor restructuring. Through iterative comparison, three analytical dimensions emerged:

- AI as sustainability enabler
- AI as generator of socio-ethical complexity
- Governance fragmentation

These intersecting dimensions revealed a central "sustainability paradox": AI simultaneously reduces material waste and increases digital resource dependency. This insight informed the development of a condensed human-centered governance framework.

## 5. Findings

### 5.1 AI as Circular Enabler

Predictive analytics improves demand accuracy, reducing overproduction. Digital twins and virtual prototyping limit physical sampling waste (Küsters et al., 2022). Computer vision enhances textile sorting (Wang et al., 2021). AI therefore strengthens operational circularity across the value chain.

### 5.2 The Sustainability Paradox

While material waste declines, digital infrastructures expand. Energy-intensive model training (Strubell et al., 2019) introduces hidden environmental costs. Sustainability gains thus coexist with new ecological burdens.

### 5.3 Reconfigured Creative Agency

Generative tools assist but do not replace designers (Jin et al., 2024). Authorship becomes collaborative and distributed. Questions of ownership and originality intensify, though human contextual judgment remains central.

### 5.4 Fragmented Governance

Bias, labor displacement, and intellectual property are addressed inconsistently. Without coordinated oversight, efficiency gains risk reinforcing inequality or obscuring trade-offs.

## 6. Discussion

AI in fashion must be understood as a structural transformation rather than a technical upgrade. Its integration reshapes environmental practices, redistributes creative agency, and exposes regulatory gaps. Operationally, AI supports circular strategies through forecasting accuracy, virtual sampling, and automated sorting. However, environmental evaluation must include digital energy costs to avoid incomplete sustainability narratives. Creatively, AI modifies authorship models by embedding algorithmic systems within design workflows. Creativity becomes relational rather than singular, demanding revised intellectual property frameworks. Institutionally, governance mechanisms lag behind innovation. Ethical auditing, transparency standards, and labor transition strategies remain fragmented. Sustainable transformation therefore requires integrative oversight that aligns innovation with accountability. The findings reinforce the need for a balanced approach in which AI augments human creativity while remaining environmentally and socially responsible.

## 7. Proposed Framework: Human-Centered AI Governance

The framework operationalizes three interconnected priorities: creative agency, environmental responsibility, and governance alignment.

### 7.1 Creative Augmentation

AI should function as an assistive system. Designers retain interpretive authority and accountability. Clear attribution standards and transparent disclosure of AI involvement are necessary to preserve authorship integrity.

### 7.2 Expanded Sustainability Metrics

Environmental evaluation must extend beyond material savings to include digital energy consumption (Strubell et al., 2019). Lifecycle assessments should integrate both physical and computational impacts. Bias auditing and transparent data sourcing are equally essential.

### 7.3 Coordinated Governance and Education

Industry-level ethical guidelines, intellectual property clarification, and labor transition planning are required. Fashion education must integrate AI literacy to prepare designers for collaborative technological environments.

### 7.4 Integrated Principle

Creativity, sustainability, and governance are interdependent. Addressing one dimension in isolation risks unintended trade-offs. A human-centered governance model therefore emphasizes augmentation over automation and accountability over efficiency alone.

## 8. Conclusion

Artificial Intelligence is reshaping fashion's environmental practices, creative processes, and governance systems. While AI supports circular innovation through forecasting, digital prototyping, and recycling technologies, it simultaneously introduces new ecological and ethical complexities. This study advances a holistic perspective that integrates sustainability theory, computational creativity, and AI governance. The proposed human-centered framework positions AI as an augmentative tool guided by environmental accountability and social responsibility. Long-term transformation in fashion depends not merely on technological capability but on ethical oversight, institutional coordination, and education that ensures AI contributes to systemic resilience rather than reproducing hidden inequalities.

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