Review Article

Advancing Sustainability and Circularity in Fashion: A Comprehensive Review of Management Practices, Technologies, and Consumer Engagement

Kavya Pratab Singh

Student, Institute of Fashion Technology Kerala (IFTK), Kollam, India

I N F O

A B S T R A C T

The fashion industry is one of the world's most resource-intensive and polluting industries, characterized by globalized supply chains, high water and chemical use, and growing waste generation. This review critically examines recent academic and industry literature on sustainable fashion management and circular economy practices across the entire value chain — from sustainable sourcing and procurement, through production and design, to consumption, end-of-life, and reverse logistics. We synthesize strategies and obstacles to adoption, highlight innovations (technological, organizational, business models), explore the role of consumer behavior and corporate reporting, and reflect on socioeconomic and environmental implications. We conclude by identifying key research gaps and proposing a future research agenda for enabling systemic circularity in fashion.

Keywords: sustainable fashion, circular economy, supply chain management, eco-friendly materials, sustainable design, ethical sourcing, consumer behavior,

Introduction

The fashion industry, one of the largest global manufacturing sectors, has long been associated with a linear "take–make–dispose" model. In this system, raw materials are extracted, transformed into garments, and ultimately discarded after a relatively short period of use. This approach has contributed significantly to environmental degradation, including excessive water consumption, high energy use, chemical pollution, and growing textile waste, which increasingly ends up in landfills or incineration facilities. Beyond environmental concerns, the traditional fashion model has also been linked to social and ethical issues, such as exploitative labor practices, poor working conditions, and inequitable value distribution across global supply chains.

In response to these challenges, both academia and industry are increasingly emphasizing sustainability and the need for systemic transformation toward circularity. Circular fashion aims to extend product lifecycles, reduce waste, and optimize the use of resources by integrating principles of reuse, repair, recycling, and waste minimization into all stages of the value chain — from material sourcing and product design to production, distribution, consumption, and end-of-life management . This transition not only addresses environmental sustainability but also offers economic opportunities through resource efficiency, innovative business models, and enhanced brand value.

Despite growing awareness, implementing circularity at scale remains complex. Structural barriers, such as

Singh K P
J. Adv. Res. Sustain. Fashion Manag. Circ. Econ. Pract. 2025; 1(2)

28

fragmented supply chains and lack of traceability, can impede material recovery and resource optimization. Economic and technological constraints, including high costs of sustainable materials or limited recycling technologies, further challenge adoption. Additionally, behavioral factors, such as consumer habits, low awareness of sustainable alternatives, and preference for fast-fashion trends, hinder the widespread acceptance of circular practices .

Sustainable Supply Chain Management And Procurement

Complexity And Challenges Of Fashion Supply Chains

The fashion and textile supply chain is often highly globalized and fragmented, involving multiple stakeholders — from rawmaterial suppliers, fabric mills, garment manufacturers, dyeing/finishing units, logistics providers, retailers, to consumers. This complexity presents major obstacles to supply chain transparency, traceability, and adoption of circular practices.[3]

A systemic perspective is critical: without coordinated engagement of all actors — designers, suppliers, manufacturers, retailers, consumers — circular solutions remain piecemeal and insufficient.[4]

Environmental Sustainability Practices In Procurement

Sustainable supplychain management involves selecting environmentally friendlier materials (e.g., organic cotton, hemp, recycled fibres), reducing chemical and water use, and adopting cleaner production methods.[5]

Thirdparty certifications and standards (e.g., organic certifications, fair-trade, environmental standards) can bolster transparency and ethical sourcing, helping brands and consumers make informed decisions.[6]

Institutional and Managerial Enablers

Transitioning to circularity requires robust management strategies: strategic partnerships (with suppliers, recyclers), integration of technology (for traceability, sorting, reverse logistics), regulatory support, and business-model innovation (on-demand production, made-to-measure, take-back schemes).[7]

Brands and retailers that commit to transparency and engage stakeholders across the chain are more likely to succeed — but this demands shift in mindset, corporate governance, and long-term planning.[3]

Table 1.Sustainable Fashion Management Practices Across the Supply Chain

Supply Chain Stage	Sustainable Practices	Key Benefits
Raw Material Sourcing	Organic cotton, hemp, recycled polyester/nylon, plant-based fibres	Reduced water usage, lower chemical input, decreased environmental footprint
Production & Manufacturing	Cleaner production technologies, low-impact dyes, energy-efficient machinery, wastewater treatment	Lower emissions, reduced energy and water consumption
Design	Circular design, durability, repairability, modular garments	Extended product lifecycle, easier recycling/upcycling
Procurement & Supplier Management	Ethical sourcing, certifications (GOTS, Fair Trade), supplier audits	Transparency, compliance with social and environmental standards
Distribution & Retail	Eco-packaging, green logistics, on-demand production	Reduced carbon footprint, minimized overproduction
End-of-Life	Take-back schemes, resale/rental, repair, recycling	Waste reduction, closed-loop material flow

Sustainable Production Techniques, Eco-friendly Materials, and Design

Eco-friendly Materials and Fibres

Sustainable fashion increasingly relies on eco-fibres: organic cotton, hemp, recycled polyester, recycled nylon, and other plant-based or recycled materials that minimize environmental footprint compared to virgin synthetics or conventional cotton.[5]

Adoption of such materials reduces water consumption, chemical usage, and negative ecological impact.[6]

Sustainable Production & Cleaner Technologies

Beyond materials, sustainable production calls for cleaner manufacturing processes: efficient water use, wastewater treatment, lowimpact dyes or natural dyes, energy-efficient machinery, and minimization of chemical pollution.[5]

29

Singh K P
J. Adv. Res. Sustain. Fashion Manag. Circ. Econ. Pract. 2025; 1(2)

Sustainable & Circular Design Principles

Design plays a central role in enabling circularity. Designers must make material, construction, and stylistic choices that support durability, repairability, recyclability, and end-of-life reuse.[1]

Moreover, circular design demands a shift from short-lifecycle, trend-driven fashion to timeless, durable garments — a paradigm shift that challenges prevailing fast-fashion business models.[2]

Circular Economy Practices: Models, Reverse Logistics, And Waste Management

Circular Business Models & Valuechain Integration

Circularity is not only about materials or recycling — it requires rethinking business models. Examples include take-back schemes, resale/rental, repair services, on-demand manufacturing, and integrating recycling into strategy.[7]

Such models align production with actual demand, reducing overproduction and waste, and extend product lifecycles.[3]

Reverse Supply Chain and End-of-Life Management

Implementing reverse supply chains — collecting used garments, sorting, recycling or repurposing them — is pivotal for circular fashion.[8]

Barriers include: limited sorting technologies for complex materials, inadequate collection schemes, high costs, and uncertain consumer participation.[3]

Waste Reduction, Recycling, and Upcycling

Waste management in fashion emphasizes reuse and recycling, illustrating the dominant role of waste management in circularity efforts.[9]

Upscaling upcycling and repurposing can reduce dependence on virgin materials while generating economic opportunities.[10]

Technological solutions such as AI-enabled robotic sorting for textile recycling improve scalability and efficiency.[9]

Table 2.Circular Business Models in Fashion

Business Model	Description	Examples	Key Benefits
Take-back & Recycling	Collecting used garments for recycling into new products	H&M Conscious, Patagonia Worn Wear	Material recovery, waste reduction
Rental & Subscription	Renting garments for short-term use	Rent the Runway, Le Tote	Reduced production demand, increased garment utilization
Resale & Second-hand	Selling pre-owned garments	Depop, ThredUp	Extends product life, supports circular economy
Repair & Upcycling	Repairing, refurbishing, or transforming garments	Local tailors, designer upcycling	Reduces waste, creates new value
On-Demand Manufacturing	Producing items only after purchase	Zara "Just-in-Time", Adidas Made-to-Order	Minimizes overproduction, reduces inventory waste

Consumer Behavior, Awareness & Green Marketing

Consumers are pivotal in shaping the sustainability trajectory of the fashion industry, as their choices regarding purchasing, use, care, and disposal of garments directly influence environmental and social outcomes.[6] Research demonstrates that consumer behavior is affected by multiple factors, including cultural norms, individual values, education, social influence, and economic considerations.[6] For example, studies have shown that consumers with higher environmental awareness are more likely to engage in sustainable practices such as choosing eco-friendly materials, extending garment lifespans, participating in resale or rental schemes, and properly disposing of clothing for recycling.[6,10]

Fashion brands are responding by adopting green marketing and communication strategies that emphasize sustainability, circularity, and ethical production. Campaigns promoting recycled fabrics, eco-labels, take-back programs, or rental and resale options aim to align consumer values with brand offerings and encourage responsible purchasing decisions.[7] Prominent examples include H&M's Conscious Collection, Patagonia's Worn Wear program, and luxury rental platforms like Rent the Runway, which combine environmental messaging with convenience and style to influence consumer behavior.

Despite these initiatives, significant challenges remain. Many consumers exhibit low awareness of sustainable fashion practices or lack knowledge about recycling and take-back programs, limiting engagement.[3] Price sensitivity, convenience, and fast-fashion habits further complicate

Singh K P
J. Adv. Res. Sustain. Fashion Manag. Circ. Econ. Pract. 2025; 1(2)

30

the adoption of sustainable choices. Therefore, increasing consumer education, raising awareness about circular options, and integrating sustainability into mainstream fashion experiences are critical for fostering long-term behavioral change and supporting circular economy objectives in the industry.[6,7,10]

Corporate Sustainability Reporting, Governance & Systemic Perspectives

Achieving sustainability and circularity in the fashion industry requires holistic approaches that integrate environmental, social, and economic considerations across the entire value chain.[2] Corporate governance plays a critical role in ensuring that sustainability initiatives are not only implemented but also aligned with long-term organizational strategies. Strong governance frameworks can guide ethical sourcing, labor practices, environmental compliance, and transparency, which are essential for establishing trust with stakeholders and promoting systemic change.[1]

Corporate sustainability reporting is a key mechanism for enhancing accountability and measuring progress. Companies increasingly publish reports detailing environmental footprints, water and energy consumption, greenhouse gas emissions, labor conditions, and supply chain traceability.[1,3] These reports not only inform investors and regulators but also serve as communication tools to engage consumers and demonstrate commitment to circular practices. Standardized reporting frameworks, such as the Global Reporting Initiative (GRI) or the Sustainability Accounting Standards Board (SASB), help ensure consistency and comparability across organizations.

Scaling circular practices, however, requires more than internal initiatives. Alignment and collaboration among multiple stakeholders — including companies, suppliers, regulators, NGOs, and consumers — are essential.[3] Policies and regulations supporting circular economy principles, such as extended producer responsibility, eco-design standards, and waste management legislation, provide external incentives for businesses to adopt sustainable practices. At the same time, consumer demand for sustainable products reinforces corporate commitments, creating a feedback loop that accelerates the transition to circularity. In this context, corporate governance, reporting, and cross-sector collaboration collectively form the backbone of systemic approaches necessary for transforming the fashion industry into a more sustainable and circular sector.[2,3]

Opportunities, Barriers & Challenges

The transition toward sustainable and circular fashion presents both significant opportunities and considerable challenges across environmental, economic, technological, and social dimensions.

Opportunities

- **Resource Efficiency**: Circular practices enable substantial reductions in resource consumption, including water, energy, and raw materials, while minimizing greenhouse gas emissions associated with textile production.[1] For example, adopting recycled fibres, water-efficient dyeing technologies, and closed-loop manufacturing processes can dramatically lower the environmental footprint of garments.
- **Economic Potential**: Circular business models, such as rental, resale, repair, and upcycling, provide new revenue streams for brands and create economic value beyond traditional sales. These models not only reduce waste but also increase consumer engagement and brand loyalty by offering innovative ways to extend product lifecycles.[3]
- **Technological Innovation**: Advances in technology are crucial enablers of circularity. AI-enabled sorting, blockchain for traceability, and circular management platforms facilitate efficient material recovery, monitor supply-chain sustainability, and optimize inventory and production planning.[9] These tools help overcome traditional barriers of complexity and opacity in fashion supply chains.
- **Consumer Demand**: Growing eco-consciousness among consumers creates opportunities for slow fashion, durable products, and participation in circular programs such as take-back, resale, and rental schemes. Educated and environmentally aware consumers can drive market shifts, incentivizing brands to adopt sustainable practices and innovate across the value chain.[6,7]

Barriers

- **Complex Supply Chains**: Fashion supply chains are highly fragmented and globalized, making transparency and traceability challenging. Coordination across multiple tiers of suppliers is often limited, creating obstacles for consistent implementation of sustainable and circular practices.[3]
- **Technical Limitations**: Recycling mixed-material garments, particularly blends of natural and synthetic fibres, remains technically difficult. Current recycling technologies are often inefficient or unable to recover high-quality fibres, limiting the scalability of circular approaches.[3]
- **Economic Constraints**: Circular initiatives can involve higher upfront costs, including investments in recycling infrastructure, design for circularity, or new business models. Smaller brands or suppliers may lack the financial capacity to implement such measures effectively.[3]
- **Consumer Awareness**: Limited consumer understanding of circular fashion and sustainable practices reduces

31

Singh K P
J. Adv. Res. Sustain. Fashion Manag. Circ. Econ. Pract. 2025; 1(2)

participation in recycling, repair, resale, and other circular initiatives. Without education and awareness campaigns, even well-designed programs may fail to achieve their intended impact.[6]

- **Need for Systemic Solutions**: Isolated interventions, such as recycling or green marketing alone, are insufficient for creating systemic change. A holistic, multi-stakeholder approach integrating governance, technology, business models, policy, and consumer engagement is necessary to scale circularity across the fashion industry.[2]

Emerging Technologies & Innovation Directions

Technological innovation plays a pivotal role in advancing sustainability and circularity in the fashion industry. Among the most promising developments are AI-enabled sorting systems, which can efficiently separate textiles by material type, color, and quality, significantly improving the effectiveness of recycling and reducing contamination in the waste stream.[9] These technologies enhance the scalability of textile recycling operations and help recover high-quality fibres, which can be reintroduced into production processes.

Digital traceability platforms are another critical innovation. By leveraging blockchain or other digital ledger technologies, these platforms enable full transparency across complex supply chains, tracking materials from raw sources to end-of-life. Such visibility helps brands monitor compliance with environmental and ethical standards, verify sustainability claims, and provide consumers with accurate information about the origin and lifecycle of their garments.[9,7]

Additionally, circular business-model platforms are emerging as innovative solutions to manage product lifecycles, support take-back schemes, resale, repair, and rental services. These platforms facilitate collaboration among stakeholders, optimize resource flows, and enable companies to implement circular strategies efficiently while engaging consumers in sustainable practices.[7]

Despite the potential of these technologies, widespread adoption faces challenges. Substantial investment is required for development, deployment, and integration into existing supply chains. Cross-industry collaboration is essential to standardize processes, share best practices, and ensure interoperability of digital systems. Regulatory support, including policies that incentivize circular production and recycling, is also crucial to encourage adoption at scale. Finally, consumer engagement and education are necessary to create demand for circular services, ensuring that technological innovations translate into meaningful environmental and social benefits.[7]

Table 3. Emerging Technologies Enabling Sustainable Fashion

Technology	Application in Fashion	Benefits
AI-enabled Sorting	Automated sorting of textiles for recycling	Increased efficiency, reduced labor costs, improved recycling rates
Blockchain & Digital Traceability	Tracking materials across supply chains	Transparency, fraud prevention, improved compliance
Digital Product Lifecycle Management (PLM)	Design-to-production integration, circular design planning	Streamlined circular design, better resource management
Advanced Recycling Techniques	Chemical recycling, fibre regeneration	Higher-quality recycled fibres, reduced dependence on virgin materials
Eco-design Software	Lifecycle assessment, material impact visualization	Informs designers, optimizes material use

Socio-economic and Environmental Implications

The transition toward sustainable and circular fashion carries significant environmental, social, economic, and ethical implications.

- **Environmental Benefits**: Circular and sustainable practices can substantially reduce the environmental footprint of the fashion industry. By implementing strategies such as water-efficient dyeing, energy-efficient production, recycling, and waste minimization, companies can decrease water consumption, energy use, greenhouse gas emissions, and the volume of textile waste sent to landfills.[5] These practices not only conserve natural resources but also mitigate pollution, supporting global efforts to combat climate change and ecosystem degradation.

- **Social Impacts**: Circular fashion initiatives also have the potential to generate positive social outcomes. Programs centered on repair, recycling, resale, and upcycling create employment opportunities in local communities, supporting skills development and economic participation.[10] Moreover, promoting fair labor practices and ethical sourcing within supply chains ensures that social justice considerations are addressed, enhancing worker welfare and equity across global operations. However, these benefits depend

Singh K P
J. Adv. Res. Sustain. Fashion Manag. Circ. Econ. Pract. 2025; 1(2)

32

on effective regulation and monitoring to prevent exploitation or unsafe working conditions.

- **Economic Resilience**: Circular strategies contribute to economic stability by reducing reliance on virgin resources, which are subject to market volatility and environmental constraints. Businesses can diversify revenue streams through rental, resale, repair, and recycling services, creating new opportunities while simultaneously reducing production costs and resource dependency.[5] These approaches can make companies more adaptable and resilient in the face of environmental regulations, resource scarcity, and changing consumer demand.

- **Ethical Considerations**: Transparency, accountability, and equity are central to ethical circular practices. Ensuring that supply chains are traceable and that all stakeholders adhere to labor and environmental standards helps prevent greenwashing and builds consumer trust.[2] Brands that prioritize ethical practices can differentiate themselves in increasingly competitive markets while contributing to global social and environmental goals.

- **Risks and Challenges**: Despite these opportunities, certain risks remain. Greenwashing, where brands exaggerate or misrepresent sustainability claims, can undermine consumer trust and dilute the impact of genuine initiatives. Microplastic pollution from synthetic fibres and uneven distribution of environmental and economic benefits, particularly between developed and developing countries, pose additional challenges.[5] Addressing these risks requires robust governance, technological innovation, consumer engagement, and international collaboration to ensure that circular fashion achieves its intended environmental and socio-economic outcomes.

Recommendations And Future Research Agenda

To accelerate the transition toward sustainable and circular fashion, it is essential to adopt a comprehensive set of strategies that address environmental, social, technological, and economic dimensions.

- **Adopt Systemic, Multi-stakeholder Approaches**: Achieving circularity requires collaboration across all actors in the fashion ecosystem, including designers, manufacturers, suppliers, retailers, policymakers, NGOs, and consumers.[3] Future research should focus on frameworks for multi-stakeholder engagement, assessing how coordinated actions can overcome fragmented supply chains and promote consistent circular practices across regions and sectors.

- **Invest in Technological Infrastructure for Circularity**: Advanced technologies such as AI-enabled sorting,

digital traceability platforms, and circular management systems are critical enablers of circular fashion.[9] Investments in these technologies, as well as research into scalable recycling techniques and eco-design software, can enhance efficiency, material recovery, and transparency across complex global supply chains.

- **Promote Circular and Sustainable Business Models**: Fashion businesses need to integrate circular principles into core operations, moving beyond linear production and consumption models.[7] Research should explore innovative approaches, including rental, resale, repair, upcycling, and on-demand manufacturing, and evaluate their economic viability, scalability, and environmental impact.

- **Strengthen Consumer Education and Engagement**: Consumer behavior is a key determinant of circularity, yet awareness and participation in sustainable practices remain limited.[6] Future studies should examine effective strategies for educating consumers, promoting sustainable consumption, and incentivizing participation in take-back, recycling, and resale programs. Behavioral insights and digital engagement tools could play an important role in this effort.

- **Ensure Social Justice and Equitable Governance**: Circular initiatives must be implemented with attention to labor rights, equity, and ethical sourcing.[10] Research should address how governance frameworks can protect workers, ensure fair value distribution along supply chains, and prevent exploitation, particularly in developing countries where much of the fashion production occurs.

- **Expand Lifecycle Assessment (LCA) and Impact Measurement**: Comprehensive evaluation of environmental and social impacts is essential for informed decision-making.[5] Future research should focus on developing standardized metrics, improving data collection, and integrating LCA into design, procurement, and production processes to measure the true sustainability of fashion products and circular interventions.

- **Policy and Regulatory Support**: Government policies, industry standards, and regulatory frameworks play a critical role in promoting circularity.[3] Research should examine how policies such as extended producer responsibility, eco-design mandates, incentives for recycling, and consumer awareness programs can support systemic adoption of sustainable practices across the global fashion industry.

Conclusion

The transition of the fashion industry from linear "take–make–dispose" models to circular and sustainable systems is both urgent and achievable. The environmental and social pressures associated with conventional fashion—ranging

33

Singh K P
J. Adv. Res. Sustain. Fashion Manag. Circ. Econ. Pract. 2025; 1(2)

from resource depletion and greenhouse gas emissions to labor exploitation and waste accumulation—underscore the need for immediate and coordinated action. While significant progress has been made in areas such as sustainable sourcing, eco-design, circular business models, consumer engagement, and technological innovation, substantial barriers remain that hinder widespread adoption.

To realize systemic circularity, sustainability must be integrated across the entire fashion value chain, including material sourcing, production, distribution, consumption, and end-of-life management. Adopting a systems-thinking approach that coordinates efforts across multiple stakeholders—brands, suppliers, policymakers, NGOs, and consumers—is essential for overcoming fragmented supply chains and ensuring consistent implementation of circular strategies. Leveraging emerging technologies such as AI-enabled sorting, blockchain traceability, and digital circularity platforms can enhance transparency, efficiency, and scalability, while evidence-based lifecycle assessments provide critical insights into environmental and social impacts.

Moreover, consumer engagement, education, and awareness are central to the adoption of circular practices, as behavioral choices determine the effectiveness of sustainable initiatives. Aligning economic incentives with environmental and social objectives, through circular business models, regulatory support, and innovative financing mechanisms, can further accelerate the transition. Finally, attention to ethical considerations, equity, and social justice is necessary to ensure that the benefits of circular fashion are distributed fairly across global supply chains.

In summary, while challenges remain, the combination of technological innovation, systemic governance, stakeholder collaboration, and informed consumer behavior offers a pathway toward a resilient, sustainable, and circular fashion industry. Continued research, investment, and policy support are vital to bridge remaining gaps, scale best practices, and realize the full potential of circular fashion to mitigate environmental impacts, promote social equity, and create long-term economic value.

References

1. Niinimäki, K. et al. The circular economy in the textile and apparel industry: A systematic literature review. Journal of Cleaner Production, 2020.
2. Bocken, N., Bakker, C., & Pauw, I. From simplistic to systemic sustainability in the textile and fashion industry. Circular Economy and Sustainability, 2023.
3. Camacho-Otero, J., et al. Towards circular fashion: Management strategies promoting circular behaviour along the value chain. Sustainable Production and Consumption, 2024.
4. Kirchherr, J., et al. Barriers to the circular economy: Evidence from the textile industry. Sustainable Production and Consumption, 2021.
5. Shen, B., et al. Eco-friendly materials and sustainable production techniques in the fashion industry. Journal of Cleaner Production, 2020.
6. Jaiswal, A., et al. Apparel consumer behavior and circular economy: Towards a decision-tree framework for mindful clothing consumption. Sustainability, 2023.
7. Haanes, K., et al. Sustainable style: Green marketing trends in the textile and apparel industry. Sustainability, 2025.
8. Govindan, K., et al. Reverse supply chain configurations in the fashion and textile industry. Sustainable Production and Consumption, 2025.
9. Zhang, Y., et al. Autonomous AI-enabled industrial sorting pipeline for advanced textile recycling. arXiv preprint, 2024.
10. Ahmed, S., et al. On circular models, upcycling, and repurposing: Perspectives on sustainable fashion. Journal of Advanced Research in Sustainable Fashion Management and Circular Economy Practices, 2025.