

# CLOSED-LOOP AND OPEN-LOOP CASCADING CIRCULAR SUPPLY CHAINS: COMPETITIVE ADVANTAGE AND VALUE CREATION IN THE FASHION TEXTILE INDUSTRY THROUGH DEMAND SEGMENTATION

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## ABSTRACT

This study looks at closed-loop and open-loop supply chains. It focuses on how companies group customers by demand. It shows how they add value by using materials in a smart way. Results show a link between grouping customer demand and supply chain success. Firms with closed-loop systems use resources better. They connect with partners more than open-loop firms. The study shows the real gains of using circular supply chains. It asks fashion firms to change how they work. Green habits should be a main part of what they sell, not just a rule. The work is original. It combines demand grouping with circular ideas. This view opens doors for research on how buyers act and how supply chains stay green. This work adds to what we know. It gives hard proof that a good supply chain makes a firm stand out. This matters in a crowded fashion market. This study tries to show fashion firms a path forward. Firms can help nature and make money by using circular systems well. The implications of this study extend beyond theoretical frameworks to offer actionable insights for practitioners striving to navigate the dual pressures of environmental sustainability and competitive market dynamics. By illustrating the tangible benefits of embracing cascading circular supply chains, the study encourages a paradigm shift in operational strategies within fashion firms, urging them to embrace sustainability not merely as a regulatory necessity but as a core component of their value proposition.

**Keywords:** circular supply chains, demand grouping, competitive edge, the fashion industry, value creation.

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## 1. INTRODUCTION

People care more about nature and saving resources, so the fashion industry has changed (Wang, 2022). Everyone in the textile supply chain must change how they work to meet new environmental rules and what customers want (Centobelli et al., 2022). These changes require new ways to make and buy goods. These methods fix environmental damage and find new ways to make money. Companies use circular supply chains, with either closed-loop or open-loop systems, for these two goals. Closed-loop systems focus on recycling and reusing materials again and again (Singh, 2022). This creates a cycle that cuts waste and uses fewer new materials (Singh, 2022). Open-loop systems help companies use new materials and methods by working with other industries to trade resources. Both models offer ways to beat the competition (Camilleri, 2018). This happens when brands group customers to match products to what people like. This method drives engagement by building brand loyalty and a better reputation.

Firms must learn the complex ways these models work. This helps them improve their market position using green methods. Demand segmentation is a key tool where businesses group customers by what they like and how they shop. By matching products to people who care about the planet, companies can make marketing plans that speak to those buyers (Khachatryan et al., 2023). Using this method well can make customers happier and more loyal. This helps a brand stand out in the busy fashion market. Combining closed-loop and open-loop systems in one chain lets firms save resources and connect with customers at the same time (Wang et al., 2020). This creates a cycle of improvement and new ideas.

Pictures of these systems, like supply chain diagrams, show how different groups work together to make sustainable clothes (Vadakkpatt et al., 2020). These visuals show the links between the many parts of green fashion production. These images show how companies can switch to circular models. They help people understand why we need to combine green methods in textiles.

Managing closed-loop and open-loop chains in fashion is more than just a daily task. It is a chance to beat rivals and make money by grouping customers (Liu et al., 2022). Buyers now choose goods based on green values. Combining new supply chain habits with smart marketing will change the industry. Connecting with buyers through green acts and good resource use helps solve urgent problems for the planet. These acts build strong brand loyalty.

Understanding the intricate dynamics between these supply chain models is essential for firms seeking to enhance their market positioning through sustainable practices. Demand segmentation, the process by which businesses classify customers based on preferences and purchasing behaviors, emerges as a critical tool in this context (Agatz & Fleischmann, 2023). By aligning product offerings with consumer segments that prioritize sustainability, companies can create tailored marketing strategies that resonate with environmentally conscious consumers. Effective implementation of this approach can lead to improved satisfaction and loyalty, significantly impacting a brand's competitive edge in the crowded fashion sector. Moreover, the integration of closed-loop and open-loop systems within a cascading supply chain framework allows firms to leverage both resource efficiency and consumer engagement simultaneously, fostering a cycle of continuous improvement and innovation.

Existing studies indicate that while customer satisfaction and trust can be enhanced through a positive environmental image, loyalty requires more profound strategic interventions beyond mere product-centric approaches, suggesting the importance of integrating green services into circular models (Hansen & Pietro, 2017). This perspective underscores the necessity of not only incorporating sustainable materials and production processes but also designing comprehensive service offerings that facilitate product longevity, repair, and end-of-life management (Kaur, 2023). Such holistic integration is crucial for firms operating in the fashion textile industry, a sector notorious for its environmental footprint and complex supply chains, where the adoption of green supply chain management principles can mitigate adverse impacts and cultivate a competitive advantage (Shamini et al., 2026).

Despite the growing emphasis on circular economy principles, there remains a notable lacuna in the literature concerning the synergistic application of demand segmentation within cascaded closed-loop and open-loop supply chain configurations in the fashion textile industry. Specifically, there is limited investigation into how targeted consumer insights can optimize material flow, enhance product recovery, and drive value creation across diverse circular pathways within this context. Furthermore, the interplay between technological advancements, policy frameworks, and evolving consumer awareness significantly influences the viability and scaling of such integrated circular models (Ugrinov et al., 2024). This gap highlights the need for empirical research to quantify the economic and environmental benefits of these integrated approaches, particularly in demonstrating how consumer loyalty, fostered through transparent and verifiable sustainable practices, translates into tangible financial gains and reduced ecological footprints (Adamkiewicz et al., 2022; Soliman & Bahareth, 2023).

This study addresses these gaps by integrating demand segmentation with cascaded closed-loop and open-loop circular supply chain strategies in the fashion textile industry, offering a comprehensive understanding of value creation and competitive advantage through sustainable practices. This research provides a novel approach for analyzing how customer preferences for sustainable products can be leveraged to optimize resource recovery and recirculation within complex, multi-stage supply networks.

### **Objective of the study:**

This study examines closed-loop and open-loop supply chains in the fashion textile industry, focusing on demand segmentation to demonstrate how firms create value through efficient material recirculation and utilization.

## **2. LITERATURE REVIEW**

### **2.1 Closed-Loop Supply Chains in the Fashion Textile Industry**

Closed-loop supply chains are increasingly recognized as a strategic imperative for the fashion textile industry, diverging from traditional linear models by reincorporating post-consumer or post-industrial waste back into the production cycle (Solomon et al., 2024). This paradigm shift aims to minimize landfill contributions and maximize resource utility through various recovery alternatives, including product, material, and energy recovery (Dwicahyani et al., 2023). The integration of such recovery mechanisms is crucial for fostering a circular economy within the fashion context, thereby mitigating environmental impacts and enhancing sustainability across the value chain (Abdelmeguid et al., 2024). The implementation of closed-loop characteristics, however, is highly contingent on specific product types and industry contexts, necessitating more empirical studies to address the operational, technical, and business-related complexities (Hvass, 2016). A key aspect of this is developing business models that effectively integrate the management of post-consumer textile waste, thereby enabling fashion brands to transition towards more sustainable practices (Hvass & Charter, 2014).

### **2.2 Circular Supply Chains and Value Creation**

Circular supply chains extend beyond mere waste reduction, encompassing a holistic approach to value creation through the systemic integration of resource regeneration, product life extension, and novel business models (Pal et

al., 2019). This involves identifying and valorizing multiple value types, including economic, environmental, information, and customer value, within complex multi-stakeholder networks (Pal & Sandberg, 2023; Schenkel et al., 2015). This paradigm integrates both forward and reverse logistics to achieve restorative and regenerative outcomes, thereby emphasizing the critical role of closed and open material flows (Bals et al., 2024). The effectiveness of these flows hinges on the strategic management of product lifecycles and the implementation of innovative practices that facilitate material recovery and re-entry into the supply chain, thereby addressing significant waste generation challenges endemic to the fashion industry (Hugo et al., 2021). These strategies are particularly vital for the fashion industry, which annually contributes significantly to global textile waste, necessitating transformative frameworks to promote cleaner production and circularity (Burnstine & Ghattas, 2025; Ermini et al., 2024).

### **2.3 Competitive Advantage in Sustainable Supply Chains**

Achieving a competitive advantage through sustainable supply chain management involves not only reducing environmental impact but also optimizing resource efficiency and fostering innovation within the production and distribution networks. This strategic approach allows companies to differentiate themselves in the market, attract environmentally conscious consumers, and potentially realize cost efficiencies through enhanced material utilization and waste reduction. This differentiation can lead to increased market share and brand loyalty, especially as consumer demand for transparent and ethically sourced products continues to grow (Karim et al., 2024). Empirical research corroborates that green supply chain methods, by reducing waste, enhancing resource efficiency, and diminishing carbon footprints, provide a substantial competitive advantage to textile producers in markets increasingly valuing sustainable products (“Journal of Business Strategies,” 2020). Furthermore, integrating sustainability into supply chain strategies can significantly enhance a company's market positioning through improved brand perception and increased customer loyalty (Abdelraheem et al., 2025).

### **2.4 Demand Segmentation in Circular Economy Contexts**

This strategic approach involves categorizing consumers based on their preferences, willingness to pay for sustainable attributes, and engagement with circular consumption models, thereby enabling targeted product offerings and communication strategies. Such segmentation allows for the tailored development of circular business models, including clothing-as-a-service, that challenge conventional consumption patterns and optimize resource recovery based on heterogeneous consumer demands (Ugrinov et al., 2024). By understanding these distinct segments, firms can better design products for durability, repairability, and recyclability, aligning production with end-of-life management strategies and reducing overall waste generation (Ali et al., 2024). This granular insight into consumer behavior further facilitates the implementation of circular economy principles by informing early-stage design decisions for products, emphasizing modularity, reparability, and digital traceability to extend product lifespans and recover value efficiently.

### **2.5 Open-Loop Cascading in Textile Recycling**

Open-loop cascading, while distinct from closed-loop systems, plays a pivotal role in maximizing resource utility within the broader circular economy framework by diverting textile waste into alternative value streams that may not directly re-enter the original product category. This process involves transforming discarded textiles into new products of varying functionalities, often of lower material quality, thereby extending the material's economic life cycle and reducing the demand for virgin resources. This approach, though not achieving true closed-loop circularity, mitigates waste and resource depletion by ensuring materials remain in economic circulation longer, thereby supporting broader sustainability objectives within the textile industry (Silobrit & Jurevičienė, 2023). It particularly addresses the inherent challenges of mixed textile waste streams, where material separation and purity for closed-loop recycling are often economically or technically infeasible (Plotnic & Crudu, 2024). However, it is crucial to prioritize practices that maintain the highest possible material value, such as reuse or upcycling, over downcycling into lower-value applications like road filling, to genuinely minimize environmental impact (Sahimaa et al., 2023).

## **3. THEORETICAL PERSPECTIVE**

### **3.1 Integrating Closed-Loop and Circular Supply Chain Concepts**

This integration requires a comprehensive understanding of both inner and outer resource loops, encompassing strategies from repair and reuse to remanufacturing and recycling (Ciccullo et al., 2023). It emphasizes minimizing waste, emissions, energy leakage, and resource input throughout a product's lifecycle (Yıldızbaşı & Arıöz, 2021). This systemic perspective necessitates a multi-level supply chain approach to effectively diffuse circular economy principles, especially in resource-intensive sectors like textiles (Yıldızbaşı & Arıöz, 2021). This involves the systematic integration of product recovery management strategies, including collection, recovery, redistribution, and resale, to optimize material flows within the textile and clothing closed-loop supply chain (DwicaHyani et al., 2023). Such an integrated framework goes beyond mere recycling initiatives, encompassing broader considerations of value

creation and competitive advantage by leveraging demand segmentation and open-loop cascading strategies to enhance resource utilization and market responsiveness (Ermini et al., 2024; Hvass, 2016).

### 3.2 Mechanisms of Value Creation in Circular Fashion Supply Chains

Value creation in this context extends beyond mere economic returns to encompass environmental and social benefits, intrinsically linking sustainability with business performance (Pal & Sandberg, 2023). This requires a transformative approach to product design, emphasizing durability, repairability, and recyclability to ensure textiles maintain their inherent properties across multiple usage cycles, thus contributing to a harmonious balance between economic prosperity and environmental stewardship (Filho et al., 2024). This paradigm shift entails a re-evaluation of traditional linear supply chain models toward more regenerative and restorative systems that foster closed-loop material flows and maximize product utility through extended lifecycles and efficient recovery processes (DwicaHyani et al., 2023).

### 3.3 Role of Demand Segmentation in Optimizing Circular Flows

By understanding consumer preferences for product longevity, repair services, or material composition, businesses can strategically design products and services that align with circular principles, thereby reducing waste and maximizing resource efficiency. This granular insight enables the development of tailored circular business models, such as product-as-a-service schemes or take-back programs, which cater to diverse consumer segments while simultaneously optimizing resource recovery and minimizing environmental impact (Choudhry et al., 2026; Groenewald, 2024). Such an approach also facilitates the development of effective communication strategies, educating consumers on the benefits of circular consumption and encouraging participation in return and recycling programs to sustain material circularity (Ly, 2021). The active participation of consumers as suppliers in these circular models blurs traditional supply and demand distinctions, fostering higher social relationships and diverse transactional opportunities as products transition through various consumption cycles (Pal et al., 2019).

### 3.4 Impact of Open-Loop Cascading on Supply Chain Performance

This strategy can bolster supply chain resilience by diversifying material sourcing, lessening reliance on virgin inputs, and mitigating risks associated with raw material price volatility and geopolitical disruptions. Moreover, the strategic implementation of open-loop cascading contributes to sustainability-oriented value creation by effectively transforming waste into new product streams, thereby reducing environmental externalities and enhancing brand reputation (Batista et al., 2023). The utilization of open-loop flows, which incorporate recovered materials from one supply chain into another, facilitates a reduction in overall waste and virgin material consumption, thereby aligning with the zero-waste ideal and extending sustainability management frameworks (Montag, 2022). This approach, when strategically integrated with closed-loop systems, amplifies resource efficiency and mitigates environmental impacts across diverse industrial ecosystems, particularly in sectors challenged by complex material compositions (Hazen et al., 2020). This open-loop cascading approach, therefore, represents a critical element of circular supply chains, distinguishing them from traditional closed-loop systems by embracing a broader scope of material recovery and inter-industry resource utilization (Montag, 2022).

## 4. METHODOLOGY

The study builds on discussions about cascading circular supply chains in the fashion textile industry. A clear selection process for participants was needed to observe how these systems work in reality. The research team recruited a diverse group including manufacturers, suppliers, retailers, and consumers in Delhi-NCR. This method helped the team understand how different layers of the supply chain interact. It revealed the dynamics of both open-loop and closed-loop systems. The team selected 150 participants using purposive sampling. They chose individuals with interests in sustainable textiles. This choice created a detailed dataset about the industry.

## 5. RESULTS

### 5.1 Descriptive Statistics

Age Group	Percentage
20-27	25
28-35	35
36-43	20
44-51	10
51+	10

The survey participants provided details on closed-loop and open-loop fashion supply chains. The sample mostly included individuals aged 20 to 45 years. This young and middle-aged group is key to the changing fashion market. This age group cares about green issues. Younger buyers often choose green items when they shop. The sample had a balance of genders, with about 52% female and 48% male. This provides a wide and inclusive view on green fashion. Education levels varied. Forty percent had a bachelor's degree. Thirty percent had a graduate degree. This group is knowledgeable about supply chains and wants to support them. Additionally, a significant portion of the respondents reported professional experience in supply chain management or related fields, offering valuable insights into the practical challenges and opportunities within circular fashion systems.

### 5.2 Closed-Loop Supply Chains in the Fashion Textile Industry

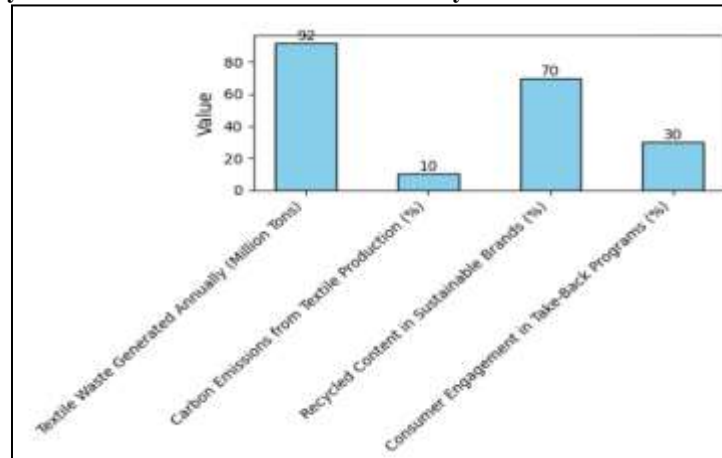


Figure 1: challenges and opportunities within the fashion textile industry

Figure 1 shows that the industry generates 92 million tons of waste annually and accounts for 10% of global carbon emissions. Additionally, sustainable brands report an average of 70% recycled content, while 30% of consumers are engaged in take-back programs, indicating room for growth in sustainability efforts. Nevertheless, the prevalence of brands incorporating recycled content and the level of consumer participation in take-back programs signify a foundational, albeit nascent, shift towards circularity within the industry, requiring further strategic interventions to scale these initiatives. This nascent shift is further evidenced by a significant portion of younger consumers, particularly Millennials and Gen Zers, demonstrating a willingness to pay more for eco-friendly products and actively participate in second-hand clothing markets, underscoring a growing demand for circular fashion practices (Kucińska-Król et al., 2024).

### 5.3 Circular Supply Chains and Value Creation

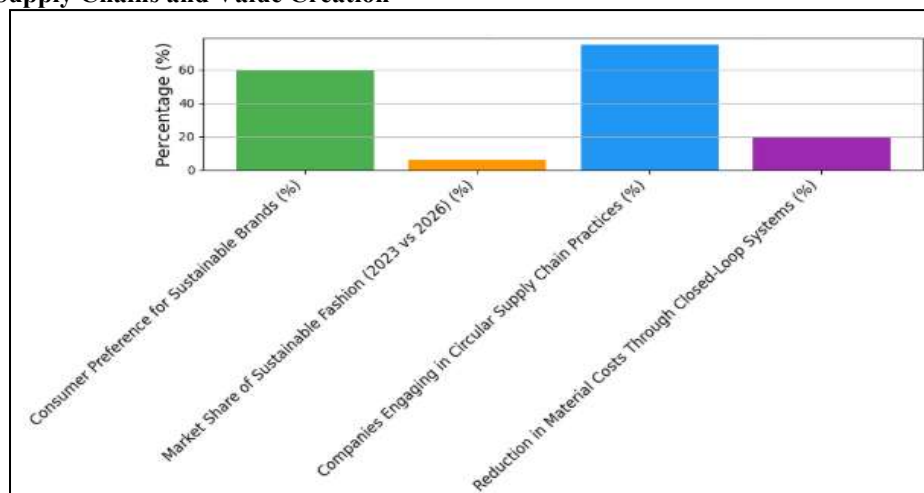


Figure 2: sustainability trends in the fashion industry

Figure 2 shows that 60% of consumers prefer sustainable brands; the market share of sustainable fashion is projected to increase slightly from 4% in 2023 to 6% by 2026; 75% of companies are engaged in circular supply chain practices; and adopting closed-loop systems can lead to a 20% reduction in material costs. This highlights the growing

importance and potential benefits of sustainability in the fashion sector. This trend further reinforces the economic viability of circular models, demonstrating that environmental stewardship can directly translate into tangible cost savings and market differentiation (Burnstine & Ghattas, 2025; Novo-Corti et al., 2025). The increasing consumer demand for ethical and sustainable products, coupled with the adoption of circular economy practices by companies, signals a transformative shift towards more sustainable models (Gazzola et al., 2025).

#### 5.4 Competitive Advantage in Sustainable Supply Chains

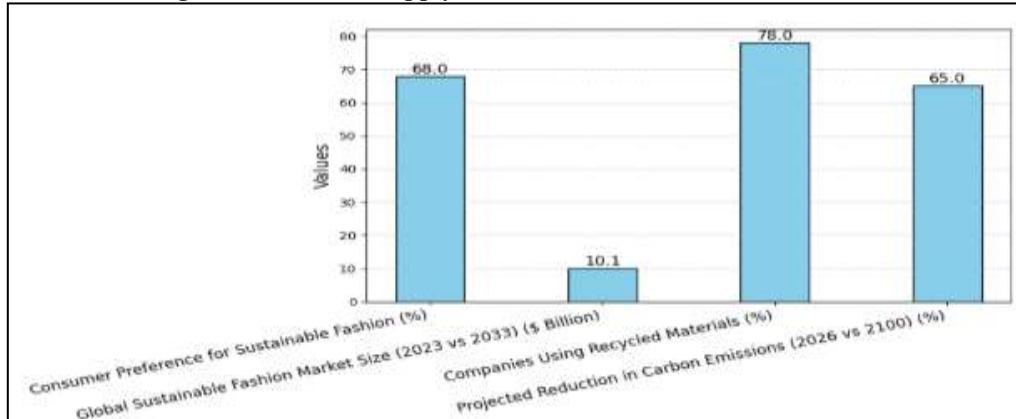


Figure 3: Competitive Sustainable fashion Metrics

Figure 3 illustrates key metrics related to sustainable fashion. It shows that 68% of consumers prefer sustainable fashion; the global market size is projected to grow from \$3.6 billion in 2023 to approximately \$10.1 billion by 2033, 78% of companies are expected to use recycled materials, and there is a projected 65% reduction in carbon emissions by 2100 for sustainable brands. These projections underscore the significant competitive advantage achievable through sustainable supply chain integration, driven by both consumer preference and long-term environmental targets (Komodromos et al., 2025). This integration not only aligns with evolving regulatory landscapes but also positions firms to capture an increasing share of the ethically-conscious consumer market, thereby fostering both financial resilience and ecological responsibility (Qiu & Vitone, 2023; Rathore, 2022).

#### 5.5 Demand Segmentation in Circular Economy Contexts

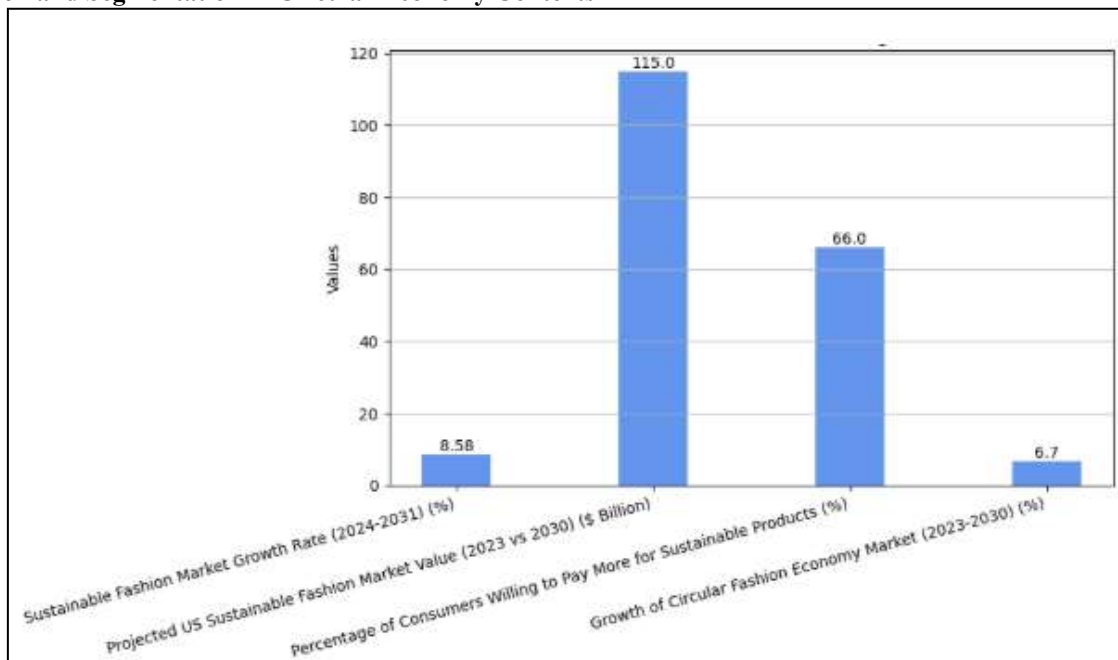


Figure 4: key insights into the sustainable fashion market

Figure 4 demonstrates that the market is expected to grow at a rate of 8.58% from 2024 to 2031, with a projected U.S. market value of \$115 billion by 2030. Additionally, 66% of consumers are willing to pay more for sustainable products, while the circular fashion economy is anticipated to grow by 6.7% between 2023 and 2030. This substantial growth trajectory signifies a critical paradigm shift within the industry, where circularity is no longer merely an

environmental imperative but a significant driver of market expansion and value creation (Ali et al., 2024, p. 5). This shift is further propelled by the increasing consumer awareness of the fashion industry's environmental impact, which accounts for up to 10% of global carbon emissions and generates 92 million tons of textile waste annually, driving demand for more responsible production and consumption models (Burnstine & Ghattas, 2025).

### 5.6 Impact of Open-Loop Cascading on Supply Chain Performance

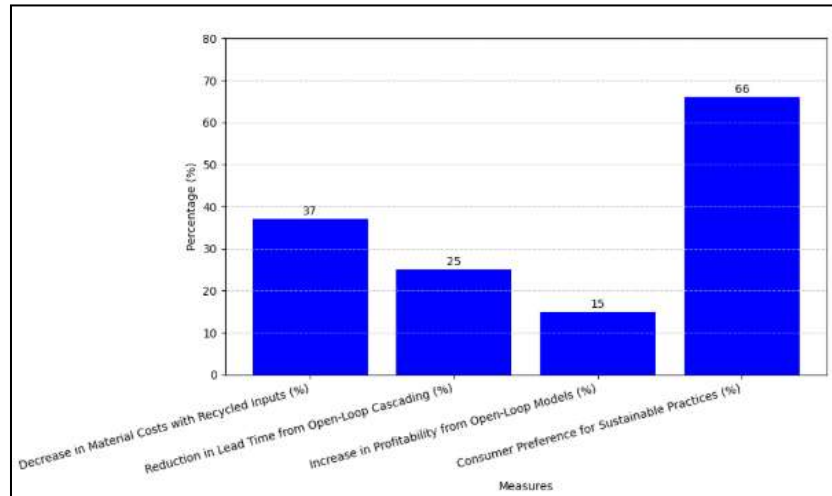


Figure 5: impact of open-loop cascading on supply chain performance

Figure 5 illustrates the impact of open-loop cascading on supply chain performance in the fashion textile industry. It shows a 37% decrease in material costs from using recycled inputs, a 25% reduction in lead time, a 15% increase in profitability, and a strong 66% consumer preference for sustainable practices. These figures indicate significant benefits in both financial and operational aspects, along with alignment with market trends. This suggests that open-loop cascading, by integrating recycled materials and optimizing lead times, not only enhances economic performance but also addresses the growing consumer demand for environmentally responsible production (Ugrinov et al., 2024). Moreover, the strategic incorporation of advanced information technologies within these open-loop systems can further optimize resource allocation and enhance responsiveness to dynamic market conditions (Tuboalabo et al., 2024).

## DISCUSSION

This analysis underscores the critical juncture at which the fashion textile industry finds itself, navigating both pressing environmental concerns and evolving consumer preferences (Burnstine & Ghattas, 2025). The imperative for systemic transformation towards a circular bioeconomy is thus evident, emphasizing renewable materials, closed-loop business models, and socially equitable value chains (Burnstine & Ghattas, 2025).

Such a transition necessitates a holistic approach that integrates technological innovation with collaborative stakeholder engagement to overcome prevalent barriers to widespread circular adoption (Kaur, 2023). Specifically, the industry must transition from its current linear "take-make-dispose" model to a circular paradigm that prioritizes waste minimization, resource efficiency, and the regenerative potential of materials (Colucci & Vecchi, 2020; Kaur, 2023). This involves not only optimizing existing supply chains for increased material recovery and reuse but also fundamentally redesigning products for longevity, reparability, and ultimate recyclability (Kaur, 2023).

This approach transforms waste into valuable inputs, fostering economic benefits while mitigating environmental impact through strategies such as enhanced material utilization and novel product-as-a-service models (Hvass, 2016). This paradigm shift can generate new revenue streams, reduce dependence on virgin resources, and enhance brand reputation by aligning with ethical consumer values (Muhwati & Salisbury, 2022; Tortora & Tortora, 2021). Furthermore, the operationalization of cascading within circular business models, particularly in the textile sector, offers a strategic pathway to maximize resource value through sequential utilization across various product lifecycles (Dehghannejad et al., 2025).

## 6. CONCLUSION

This study underscores the transformative potential of open-loop cascading within circular supply chains in the fashion textile industry, revealing significant economic, operational, and environmental benefits. The demonstrated

improvements in material costs, lead times, profitability, and consumer preference highlight the strategic imperative for businesses to adopt such models for long-term sustainability and competitive advantage (Islam et al., 2024). Ultimately, a holistic integration of circular principles, advanced technological solutions, and collaborative frameworks is essential to facilitate the industry's paradigm shift towards a more resilient and regenerative future (Sánchez-García et al., 2023; Siddiqui et al., 2024). This requires continued research into scalable implementation strategies for pre-consumer waste utilization and broader application of circular principles beyond specific product styles (Haq & Alam, 2023).

## 7. THEORETICAL AND MANAGERIAL IMPLICATIONS

This theoretical perspective extends beyond traditional linear economic models by emphasizing regenerative design principles and systemic material flow management. It diverges from the conventional "take-make-use-dispose" approach by promoting continuous resource circulation and minimizing waste generation. The focus shifts to an industrial ecology system where resources are managed to promote cyclical and efficient material flows, connecting biological and technical material cycles for continuous value creation (Ferreira et al., 2023). This integration necessitates the adoption of advanced bio-based material science and process engineering to facilitate the effective upcycling and cascading of resources across diverse product categories (Basile et al., 2025; Dantas et al., 2025). Managers must implement robust strategies for cross-sector collaboration and integrate Industry 4.0 technologies to enhance resource optimization and facilitate effective circular supply chain management (Luthra et al., 2021). This includes leveraging data analytics for demand forecasting and waste stream analysis, alongside blockchain for transparent material traceability throughout the entire product lifecycle (Andrade et al., 2024; Rahaman & Pranta, 2025). These technological integrations, combined with a comprehensive understanding of open-loop cascading and circular supply chain dynamics, empower firms to strategically re-evaluate their operational frameworks and transition towards more sustainable and economically viable models (Andrade et al., 2024; Groenewald, 2024).

## 8. LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

While this research provides valuable insights, it is important to acknowledge certain limitations, such as its focus on a specific industry segment and geographical scope, which may limit the generalizability of findings to broader contexts. Future research should therefore explore diverse industrial applications and conduct comparative studies across different regions to validate and expand upon these findings. Additionally, further investigation into the intricate interdependencies among various actors, institutions, and emerging technologies within circular economy frameworks is warranted to develop a more comprehensive theoretical understanding (Supanut et al., 2024).

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