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Barriers and enablers of zero-waste implementation in sustainable fashion: Designer-centric insights

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Abstract

Tons of textiles are thrown away by the fashion industry before they even reach customers, making it one of the biggest sources of trash in the world. As a result, stakeholders are being urged to reconsider the conventional methods of clothing manufacture and consumption by the fashion industry's zero-waste movement. From the viewpoint of fashion designers, this study examines the main obstacles to and facilitators of zero-waste adoption. It explores problems including scalability, market demand for quick fashion, and manufacturing limitations while emphasizing solutions like creative patternmaking, consumer education, and supporting regulations. The conclusions are derived from case studies, industry analysis, and designer interviews. The study offers design-centered approaches and policy recommendations to enhance pre-consumer waste management and promote sustainability in the fashion industry based on these insights.

Keywords: Zero-waste fashion, sustainable design, textile waste, designer challenges, pre-consumer waste, consumer behavior, scalability, policy solutions, eco-fashion, sustainable manufacturing

Introduction

Ironically, the global fashion business, which is renowned for its inventiveness and ability to define trends, plays a major role in environmental deterioration. Often disregarded, pre-consumer textile waste builds up during the design and manufacturing phases. A change in perspective is necessary to address this problem, especially among those who create clothing: the designers. The idea behind zero-waste fashion is to design clothing such that no fabric is wasted in the manufacturing process. Despite the movement's growing popularity, certain operational and institutional issues hinder its practical applicability. Using a designer-centric approach, this study examines the obstacles, enabling factors, and everyday realities that influence the adoption of zero-waste practices. By doing this, it seeks to find solutions that may be used both at the macro (industry-wide) and micro (design studio) levels.

When compared to pre-consumer textile waste, post-consumer textile waste is a more serious and complex issue to address, but pre-consumer textile waste is easier to recycle and reuse due to its lack of collection and hygiene issues. In India, however, the situation seems to be more dire because consumers and manufacturers are relatively ignorant of the risks connected to environmental deterioration.

With an estimated 1.33 billion people living there, post-consumer textile waste is growing in India, according to Bairagi (2018) [1]. Research on India's post-consumer garment waste recycling routes has been lacking. Few Indian companies are turning post-consumer clothing waste into designer goods. The resale of used clothing through businesses' and brands' online applications is another alternative channel that was created in India. Few tiny businesses in India turn post-consumer clothing waste into fibers, which are then recycled into yarns or used as fillers in the unorganized mattress, pillow, and cushion industry.

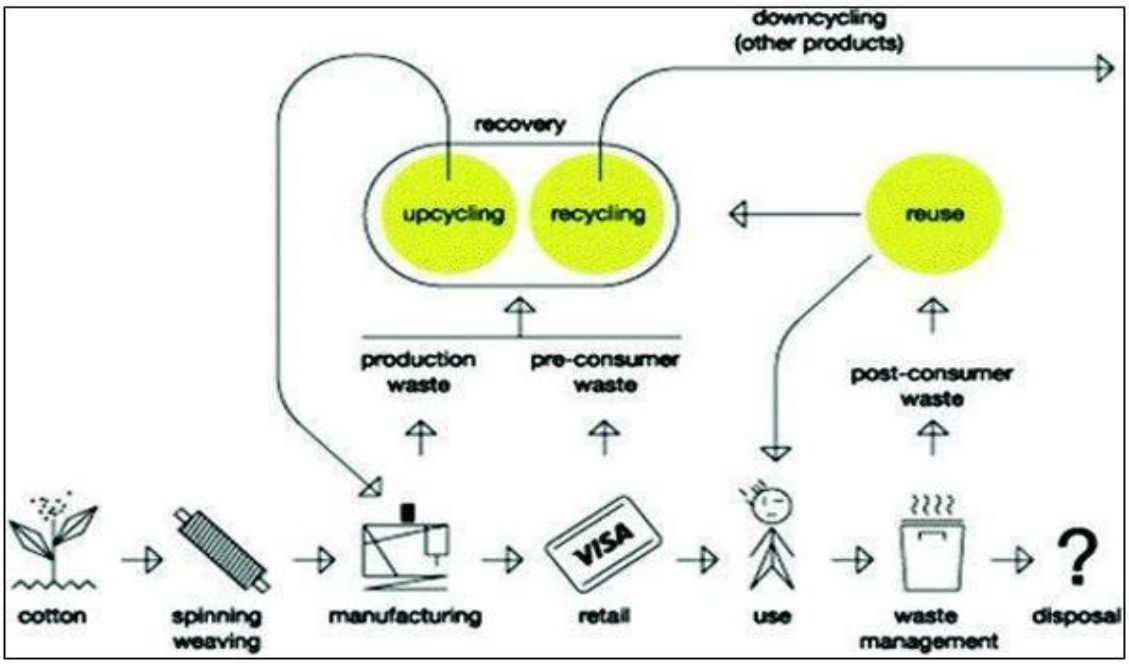

Fig 1: Circular apparel manufacturing supply chain

One advantage of the textile and clothing business is that all of its waste can be recycled. Reuse and recycling are therefore crucial and need to be considered at every stage of the fashion supply chain. El-Haggar *et al*. (2008) [2] assert that transparent and methodical approaches are necessary for the management of waste in the fashion sector.

In waste management jargon, the three R's, seven R's, and more recently, the twelve R's are commonly employed. They stand for remember, respect, refuse, reduce, reuse, return, refill, rot, restore, repurpose, repair, and recycle. Since landfill space is limited and waste creation and processing costs are rising, the 12 R's have become a guiding principle of sustainable waste management. Researchers studying waste management have generally embraced this strategy.

Aims and Objectives

This research aims to:

1. Identify the main challenges fashion designers face in implementing zero-waste principles.
2. Examine industry-specific constraints such as production logistics, consumer preferences, and cost-effectiveness.
3. Highlight successful cases and strategies that have facilitated zero-waste practices.
4. Propose design strategies and policy recommendations to support broader adoption of zero-waste approaches.
5. Explore how designer education and collaboration with manufacturers can foster sustainable innovations.

Review of Literature

Over the past 20 years, there has been a tremendous increase in the body of literature on sustainable fashion. Recycling, ethical sourcing, and post-consumer waste were the main topics of early study. But lately, there has been a move toward pre-consumer waste, emphasizing the need of waste prevention throughout the design phase. According to studies, a sizable amount of textile waste occurs before clothing is sold. According to a study by Faradillah & Husna (2019) [3], innovation and new ideas lead to a zero-waste garment with up to seven different styles based on a single fundamental design created using two unique pattern-making techniques, flat pattern cutting and draping. Almond (2017) [4] suggests that zero waste designs might be made using draping, subtraction, and puzzle techniques.

According to Elahe and Schreffler (2017) [5], clothing designed using various zero-waste techniques can either minimise or completely eradicate fabric waste. This new implementation of the zero-waste framework makes use of the transformational reconstruction technique. Additionally, Sinwon and Lee Heun (2015) [6] established the foundation for Zero Waste fashion education, which can reduce textile waste and pave the way for the future's wider implementation of Zero Waste Fashion. Zero Waste Pattern Cutting offered a great chance for a blended learning approach to creative cutting, according to a study by Katherine and Fiona (2013) [7]. Gay (2011) [8] emphasized that the economy of design, fabric, and execution principles are aided by reducing waste in the first place. Although fast fashion has contributed to its current surge in popularity, the zero-waste notion has been practiced for many years. A Japanese kimono is an example of a zero-waste clothing because the fabric used to make it is not garbage. The Indian sari, which wraps the entire cloth around the body without wasting any little pieces, is another excellent example of a zero-waste garment. People made clothing pieces to fit the length and width of the available material, and gussets or gores were commonly utilized as design elements, as were little arm shaping, rectangular sleeves, or pants.

According to Chavan (2014) [9], the textile waste produced during the production process can be recycled or repurposed and used as a source for paper, furniture, and other products because of the increased cooperation between the textile and related industries. However, it is far more challenging to monitor and start partnerships to reduce textile wastes because post-consumer textile wastes are linked to the

purchase and disposal practices of individual families.

Reusing old and raw materials is only one aspect of upcycling. The raw material becomes a more valued product because of this kind of reuse. Repurposing ancient materials and making them more aesthetically pleasing than the originals is the goal. The Zero Waste International Alliance (2010) research states that repurposing outdated, waste, and abandoned materials in a creative and efficient manner can assist address environmental sustainability issues as well as textile and fashion waste. A better way to advance environmental sustainability is through upcycling. According to Murray (2002) [10], upcycling textiles results in the preservation of the resources utilized in their production and the addition of value through the application of knowledge throughout the refashioning process. The researcher used the following upcycling procedure:

In order to handle the disposal stage of the circular economy model of sustainable clothing, James and Kent (2019) [11] provided information on how used clothing that is easily accessible in the market of a poor nation can be sourced and creatively remade into new apparel and accessories. Bhatt *et al*. (2018) [12] found that customer cleverness, curiosity about buying recycled goods, and fashion conscience were positively and significantly correlated with interest in learning upcycling skills. Additionally, according to Sunhilde and Tripa (2019) [13], sustainable production could give an advantage over competitors. Strengthening the creative department, fashion design, and marketing and sales involvement will make this approach successful.

According to Janigo *et al*. (2017) [14], many respondents stated that recycling resources is required because of environmental pollution and resource consumption, and they were all interested in refashioning their old and discarded clothing and adopting the upcycling technique (Se-Lin *et al*., 2014) [15]. Upcycling has the potential to significantly alter society, and if fashion is used to help a local community in need, students can gain from a course of study that emphasizes eco-fashion, sustainable design, and environmental issues, among other related subjects (Karina, 2016) [16].

Zero-waste fashion design techniques include draping, zero-waste pattern cutting, and using fabric scraps for new garments. Yet these techniques require substantial skill and often longer production timelines, making them difficult to scale in fast fashion models. Consumer behavior also plays a pivotal role. Despite growing awareness, many shoppers still prioritize cost and trendiness over sustainability. Furthermore, government policies have yet to catch up with the need for tighter regulations on textile waste, leaving designers with little external support.

As businesses realize how important it is to operate in an environmentally, socially, and economically responsible manner, sustainability has emerged as a popular business aim in recent years. The ability of a system, be it an ecosystem, a company, or a society, to persist over time is referred to as sustainability. The core tenet of sustainability is that decisions and activities taken today should be evaluated considering their effects on the environment and future generations. According to Oláh *et al*. (2020) [17] and Sarkis and Zhu (2018) [18], sustainability in the environmental context refers to the prudent use of natural resources in a way that guarantees their availability for future generations. This entails cutting back on waste and pollution, preserving energy, and safeguarding species and ecosystems. Additionally, it entails substituting renewable resources-like wind and solar power-for finite ones, like coal and oil.

The ability of a firm to function in a way that is socially, economically, and environmentally responsible while yet satisfying the demands of its stakeholders is referred to as sustainability in the business context. This entails considering how operations affect the environment, making sure that sustainable resources are used to make products, and putting socially conscious procedures into place, like encouraging diversity and inclusion and fair labor practices. According to Testa *et al*. (2019) [19], sustainability in the context of society refers to the development of communities and systems that can withstand the test of time and satisfy the needs of all individuals, irrespective of their social or economic standing. This entails fostering social justice, lowering inequality, and building a thriving, inclusive economy that is advantageous to everybody.

Intergenerational equity, which holds that decisions and actions taken today should consider how they will affect future generations, is another term for sustainability. This entails making certain that the environment is safeguarded, natural resources are preserved, and social and economic structures remain just and long-lasting for coming generations. As the globe deals with a variety of environmental and social issues, such as climate change, biodiversity loss, and rising inequality, the goal of sustainability has gained importance in recent years.

Addressing these issues and guaranteeing a better future for everybody is seen to depend on the adoption of sustainable practices and the advancement of sustainable development (Obrecht *et al*., 2022; Westley & Vredenburg, 1996; N. Yadav *et al*., 2018) [20, 21, 22]. A complex idea, sustainability includes the prudent use of natural resources, the application of socially conscious behavior, and the development of systems and communities that can support the needs of all people for a long period. We can improve the future for present and future generations by working toward sustainability.

Research also reveals that the success of zero-waste implementation depends heavily on interdisciplinary collaboration, continuous innovation, and education of both creators and consumers. Designer-centric literature stresses the importance of creative freedom, technological support, and market incentives.

Research Methodologies

To uncover real-world insights, this study employed a qualitative approach. Semi-structured interviews were conducted with 20 designers who actively engage in sustainable practices, with at least five years of experience in the industry. Additionally, case studies of five fashion brands known for zero-waste production were analyzed.

A thematic analysis was conducted on interview transcripts to identify recurring patterns, perceptions, and challenges. Data triangulation was employed by comparing findings from literature, interviews, and case studies to ensure credibility.

Table 1: Designer Interview Demographics – India Sample (N = 5)

Participant ID	Years of Experience	City	Fashion Sector	Zero-Waste Practice Type	Brand Type
D-IN01	7	Delhi	Ethnic Wear	Zero-Waste Pattern Cutting	Independent
D-IN02	10	Mumbai	Fusion Wear	Modular Design	Commercial
D-IN03	5	Bengaluru	Urban/Sustainable	Fabric Remnant Upcycling	Independent
D-IN04	9	Kolkata	Handloom-Based Design	Minimal Cut Technique	Independent
D-IN05	10	Jaipur	Heritage Textile	Block Patterning	Commercial

Table 2: Indian Case Study Brands (N = 2)

Brand Name	City	Main Product Line	Zero-Waste Strategy	Design Approach
Brand IN-A	Ahmedabad	Ethnic/Artisan Wear	Remnant Recycling & Upcycling	Craft Cluster Collaboration
Brand IN-B	Bengaluru	Urban Contemporary	Pre-structured Pattern Making	Smart Minimal Cutting

Results and Interpretation

Several key barriers and enablers emerged from the data:

Barriers

1. **Production Limitations:** Designers reported difficulties in sourcing eco-friendly materials that suit zero-waste patterns. Manufacturing partners were often unwilling to adapt traditional workflows.
2. **Time and Cost Constraints:** Zero-waste design often requires more time, creativity, and technical effort. This leads to higher production costs, which many consumers are unwilling to bear.
3. **Consumer Awareness:** Many designers felt that their sustainable efforts were underappreciated or ignored by consumers, especially in mass markets.
4. **Scalability Issues:** Scaling a zero-waste model to fit large production demands remains a major hurdle.

Enablers

1. **Design Innovation:** Techniques like modular design and zero-waste pattern drafting allow greater material efficiency.
2. **Brand Philosophy:** Brands with a strong commitment to sustainability tend to offer more freedom to designers to experiment with waste-free models.
3. **Consumer Education:** Educating buyers through storytelling, labeling, and marketing has helped increase acceptance of zero-waste fashion.
4. **Policy Support:** In regions where textile waste is regulated or incentivized (e.g., EU countries), designers have found it easier to implement such practices.

Table 3: Thematic Coding from Indian Designer Interviews – Barriers

Theme	Frequency (out of 5)	Representative Comments
Production Limitations	4	"Local tailors resist zero-waste templates and ask for simpler cuts."
Time/Cost Constraints	5	"We invest more time in pattern engineering than standard brands."
Consumer Awareness	3	"Educated urban buyers are supportive, but rural markets reject it."
Scalability Issues	4	"We can't meet large retail orders with these processes yet."

Table 4: Thematic Coding – Enablers from Indian Designers

Theme	Frequency	Representative Comments
Design Innovation	5	"We mix traditional textiles with modern zero-waste cuts."
Brand Philosophy	4	"Being a slow fashion brand gives us room to experiment."
Consumer Education	3	"Workshops and storytelling help us connect with buyers."
Policy/Support	2	"Some grants are available under handloom revival schemes."

Table 5: Cross-Comparison Matrix – India Only

Barrier/Enabler	Found in Interviews	Found in Case Studies	Overlap/Comment
Production Limits	✔ Yes	✔ Yes	Especially when scaling handloom integration
Time/Cost Constraints	✔ Yes	✔ Yes	Slow production timelines and high cost of local fabric
Consumer Awareness	✔ Yes	✘ No	Designers cite lack of mass market interest
Design Innovation	✔ Yes	✔ Yes	Creative traditional-modern fusions
Government Support	✔ Yes	✔ Yes	Found mostly via artisan development boards
Scalability Problem	✔ Yes	✔ Yes	Not yet feasible for large-volume fashion retail

Discussion and Conclusion

This study demonstrates that designers may both solve and be burdened by the issue of pre-consumer textile waste. Systemic problems, such as rigid manufacturing, low consumer demand for sustainability, and weak legislative frameworks, impede their efforts. Zero-waste design, however, is feasible in areas with customer involvement, brand dedication, and institutional backing. To innovate, designers need to be equipped with platforms, tools, and training. There should be incentives for manufacturers to adapt to non-traditional workflows. Customers must be informed about how their decisions affect the environment. Finally, governments need to enact laws that encourage production-level waste reduction.

The implementation of zero-waste fashion cannot rest on designers alone. It requires a multi-layered approach, involving collaboration between design professionals, manufacturers, retailers, consumers, and policymakers. With a united effort, fashion can shift from being a source of pollution to a beacon of sustainability.

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