

# Zero Waste Pattern Making: Redefining Sustainable Fashion

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**Abstract:** In an era where environmental consciousness is paramount, the fashion industry has become increasingly scrutinized for its ecological impact. As a result, innovative approaches like zero waste pattern making have emerged, offering a promising solution to minimize textile waste and reduce the carbon footprint associated with clothing production. This revolutionary technique challenges traditional pattern-making methods and fosters a more sustainable future for fashion. Zero-waste pattern-making is a design philosophy that seeks to eliminate textile waste entirely during the garment creation process. Conventional pattern-making often results in offcuts and discarded fabric, contributing to the staggering amount of textile waste that ends up in landfills. Zero-waste pattern making aims to disrupt this norm by strategically arranging pattern pieces on the fabric to utilize every inch, leaving no remnants behind. For this study, the authors identified three fashion organizations that adopt the zero-waste pattern-making process. This paper uses the qualitative methodology of a case study, and the results are analyzed using the framework of eco-innovation. The brands' approach towards material choice, product design process and production system is presented through a comparative study. A framework is proposed for other fashion start-ups to achieve a zero-waste model. This approach represents a fundamental shift toward sustainability by reshaping the way garments are designed and manufactured. The cases underscore this approach's potential to reshape the fashion industry's relationship with waste. These case studies will serve as an inspiration for other fashion brands looking to adopt innovative and sustainable practices in their operations.

**Keywords:** *Zero-Waste Pattern-Making, Waste Management, Eco-Innovation, Zero-Waste Model, Textile Waste*

## Introduction

The Indian fashion and textile sector is a significant contributor to the country's economy and employment landscape. It is a diverse industry encompassing a wide range of activities, from traditional handloom and handicrafts to modern apparel manufacturing and retail. The Indian textile and fashion sector, while economically significant, is also known for its substantial contribution to waste generation and pollution. This industry's environmental impact stems from various stages of production, including raw material processing, dyeing and finishing, and the disposal of end-of-life products. However, some initiatives and organizations in India are working to address the issue of textile waste, including offcuts. They promote sustainable practices such as recycling, upcycling and the use of offcuts in creative ways to reduce waste. Some textile manufacturers in India are exploring recycling techniques to convert textile waste, including offcuts, into new products.

In this context, zero-waste pattern-making is a sustainable approach to clothing design and garment production that aims to minimize or eliminate the generation of textile waste during the manufacturing process. Traditional garment pattern-making often results in significant fabric wastage, as patterns are created with little regard for the efficient use of material. In contrast, zero-waste pattern-making focuses on maximizing the utilization of fabric, thereby reducing environmental impact and resource consumption. However, zero waste pattern making can be more challenging and time-consuming than traditional methods, and it may require a shift in design thinking and production processes. Despite these challenges, it offers a promising solution for a more sustainable and environmentally friendly fashion industry.

## Literature Review

The Indian fashion and textile industry is one of the largest in the world, with a market size of over USD 120 billion (as of 2021) and growing steadily. It accounts for a significant portion of India's GDP and export earnings (Sustainable Apparel Forum 2022). The sector is highly labor-intensive, providing employment to millions of people, both in rural and urban areas. Around 45 million people are employed in this sector (PwC 2019).

The Indian textile and fashion sector, while economically significant, is also known for its substantial contribution to waste generation and pollution. This industry's environmental impact stems from various stages of production, including raw material processing, dyeing and finishing, and the disposal of end-of-life products. There are a number of sustainability issues of the Indian textile and fashion sector in terms of the waste generation. The textile industry generates substantial waste during the production process, including cuttings, trimmings, and defective products. These end up as solid waste, often not properly managed or recycled. The disposal of clothing and textiles at the end of their life cycle is a significant issue. Many textiles end up in landfills, where they do not decompose easily due to synthetic materials used in their production (Sustainable Apparel Forum 2022). Excessive packaging materials, such as polybags and cardboard boxes, contribute to solid waste generation.

Textile waste generated in India due to offcuts from fabric cutting is a significant concern within the fashion and textile industry. Offcuts, also known as fabric remnants or fabric scraps, are the small pieces of fabric left over after garments or other textile products are cut from larger rolls of fabric. These offcuts can accumulate in large quantities and contribute to the overall textile waste problem in India. There are several issues of textile waste generated from offcuts in India. The textile and apparel industry in India is known for its high production volume. Consequently, the generation of offcuts is substantial. These offcuts can account for a significant portion of textile waste in the country (Nangia 2021). Offcuts are often small and irregularly shaped, making them difficult to recycle or repurpose. Many of them end up as waste because recycling facilities for such scraps are limited in India (Sustainable Apparel Forum 2022). When offcuts are not properly managed, they can contribute to environmental problems. If disposed of in landfills, they can take a long time to decompose due to the synthetic fibers commonly used in textiles. The production of textiles consumes significant resources, including water, energy, and raw materials. When offcuts are discarded, it represents a waste of these valuable resources.

Zero waste pattern making is a design and production approach in the fashion industry that aims to minimize or eliminate textile waste generated during the garment manufacturing process. The traditional method of garment production often results in substantial waste, with fabric offcuts and scraps discarded as byproducts. Zero waste pattern making seeks to change this by optimizing pattern layouts to use fabric more efficiently, ensuring that little to no fabric is wasted.

The first principle of zero-waste pattern-making is an efficient pattern layout. Designers and pattern makers create garment patterns in a way that optimizes the use of fabric, ensuring that there are no leftover scraps or offcuts. The goal is to cut the fabric in a manner that result in no waste. This often involves innovative techniques like single-piece or modular construction, where the entire garment is cut from a single piece of fabric. Ensuring minimal seam allowance is essential. Reducing seam allowances to the absolute minimum helps in maximizing fabric utilization. Designers also need to think creatively to design garments that work within the constraints of zero waste while maintaining aesthetics and functionality.

Zero-waste pattern-making significantly reduces the amount of textile waste that ends up in landfills, thereby minimizing the environmental footprint of the fashion industry (Fletcher and Grose 2012). By using fabric more efficiently, this approach helps conserve resources such as water, energy, and raw materials that are used in textile production (Mifflin 2017). While zero waste pattern making may require initial adjustments in design and production processes, it can lead to cost savings by reducing material waste and lowering disposal costs (PwC 2019). Brands

that adopt zero waste practices can differentiate themselves in the market by showcasing their commitment to sustainability and innovation in design.

A number of techniques are used in zero-waste pattern-making. Folded origami patterns can be made using intricate folding techniques to create three-dimensional garments from a single piece of fabric (McQuillan and Rissanen 2016). Modular garment design involves creating garments from interconnected pieces, eliminating waste by using the entire fabric piece (McQuillan and Rissanen 2016). Additionally, by aligning pattern pieces along the fabric's grain lines, designers can minimize fabric waste (Joseph-Armstrong 2014).

However, zero-waste pattern-making techniques come with several challenges and limitations. The process is complex and designing zero waste patterns can be more challenging and time-consuming than traditional methods, requiring advanced skills and creativity. There can be limitations in terms of fabric properties. Some fabrics may not lend themselves well to zero waste patterns due to their weave, weight, or stretch. Evaluation of market demand is essential. The market for zero waste garments may still be niche, so brands must carefully consider consumer demand and pricing.

Zero waste pattern making is a sustainable approach in the fashion industry that seeks to reduce or eliminate textile waste generated during garment production. It requires creative design thinking, efficient pattern layout, and innovative construction techniques. While it presents challenges, it offers significant environmental benefits and can contribute to the overall sustainability of the fashion industry.

## **Objective**

The objective of this paper is to study and analyze the zero-waste pattern-making process followed by three Indian fashion brands and develop a circular framework for other small-scale fashion start-ups.

## **Methodology**

For the purpose of this study, the authors identified three fashion organizations that adopt the process of zero waste pattern making. This paper uses the qualitative methodology of case study to understand their key innovations and impact on the fashion industry. The brands' approach towards product and process are studied through the theoretical framework of eco-innovation. A further comparative study is done on the basis of material choice, product design process and production system. On the basis of the above findings, a framework is proposed that can be followed by other fashion start ups to achieve a zero waste model.

## **Case Study Method:**

Case studies are typically conducted to gain a deep and holistic understanding of a specific case or phenomenon. Researchers use them to explore, describe, and analyze complex issues or real-world situations (Yin 2014). In case studies, the unit of analysis can be an individual, a group, an organization, a community, or even an event. Researchers select cases that are relevant to their research questions (Stake 1995). Case study data can be collected through various methods, such as interviews, observations, documents, and archival records. Researchers often use a combination of these methods to triangulate information (Merriam 1998). Qualitative data analysis techniques are commonly used in case studies. Researchers engage in thematic analysis, content analysis, or coding to identify patterns, themes, and insights within the data (Miles and Huberman 1994). One of the distinguishing features of case study methodology is the emphasis on understanding the context in which the cases exist. Researchers examine the socio-cultural, historical, and environmental factors that influence the case (Flyvbjerg 2006).

Case studies can serve both exploratory and explanatory purposes. They can be used to develop new theories or test existing ones, depending on the research objectives (Eisenhardt 1989). Ensuring the validity and reliability of case study research is essential. Researchers must establish the trustworthiness of their findings through techniques like member checking, peer debriefing, and prolonged engagement (Lincoln and Guba 1985). The findings of case studies are typically presented in a detailed narrative format. Researchers provide rich descriptions of the case, along with quotations and examples to support their conclusions (Stake 1995).

## Eco-Innovation

Eco-innovation, also known as environmental innovation or green innovation, refers to the development and implementation of new or improved products, processes, services, or business models that have a positive environmental impact. Eco-innovations aim to reduce the negative environmental effects of economic activities, enhance resource efficiency, and promote sustainability. Eco-innovation can be classified into various categories or types based on different criteria, such as the nature of the innovation, its focus, or its impact on the environment. For the purpose of this research, the product and process eco-innovation is considered.

**Product Eco-Innovation:** This category focuses on innovations related to the design, production, and use of eco-friendly products. It often involves improvements in product features, materials, and packaging to reduce environmental impact. Examples include energy-efficient appliances and biodegradable packaging (Horbach and Rammer 2019).

**Process Eco-Innovation:** Process eco-innovation relates to changes in production processes or methods that result in reduced resource use, emissions, or waste. For instance, implementing closed-loop manufacturing or adopting lean production techniques can be considered process eco-innovations (Rennings 2000).

## Data Collection and Analysis

For the purpose of this study, the authors identified three fashion organizations that adopt the process of zero waste pattern making. These are:

1. Ka Sha
2. Doodlage
3. RaasLeela

The following section discusses each of these three cases in detail:

### Ka Sha

Ka Sha, an Indian fashion brand, has emerged as a pioneer in the fashion industry, combining traditional craftsmanship with sustainable practices. Founded by Karishma Shahani Khan in 2012, Ka Sha has gained recognition for its unique designs, ethical approach, and commitment to preserving India's rich textile heritage. This section delves into the brand's journey, its innovative practices, and its impact on the fashion industry. Ka Sha was born out of Karishma Shahani Khan's passion for sustainable fashion and her fascination with India's diverse textile traditions. After completing her education in fashion design from Central Saint Martin's College of Art and Design in London, she returned to India with a vision to create a brand that celebrated Indian textiles while promoting eco-conscious practices.

### *Key Innovations:*

**Sustainable Material Sourcing:** Ka Sha prioritizes the use of eco-friendly and ethically sourced materials. The brand collaborates with local artisans and weavers to develop unique textiles. They work with organic cotton, hand-woven fabrics, and natural dyes, reducing the environmental footprint associated with conventional textile production (Khandual and Pradhan 2019).

**Zero Waste Design:** Ka Sha is known for its innovative zero-waste design philosophy. They maximize fabric utilization, ensuring that no material goes to waste during production. This approach not only reduces textile waste but also minimizes the environmental impact of the fashion industry (Srivastava 2019).

**Craftsmanship and Artisanal Collaboration:** The brand collaborates with skilled artisans and craftsmen from different regions of India. This not only promotes traditional craftsmanship but also provides sustainable livelihoods to local communities (Srivastava 2019).

**Transparency and Ethical Practices:** Ka Sha places a strong emphasis on transparency in its supply chain. They ensure fair wages and ethical working conditions for their artisans, empowering them economically while preserving their craft (Khandual and Pradhan 2019).

**Educational Initiatives:** The brand is actively involved in educational initiatives, conducting workshops and seminars on sustainable fashion and traditional textiles. This helps raise awareness about the importance of responsible fashion consumption (Srivastava 2019).

### *Impact on the Fashion Industry:*

Ka Sha's innovative approach to sustainable fashion has had a significant impact on both the fashion industry and the communities it collaborates with. Some key impacts include:

**Promotion of Sustainable Practices:** Ka Sha has inspired other Indian fashion brands to adopt sustainable practices, contributing to a broader shift in the industry towards eco-consciousness.

**Preservation of Traditional Craftsmanship:** Through its collaborations with artisans, the brand has played a pivotal role in preserving India's traditional craftsmanship, ensuring that these skills are passed down to future generations.

**Economic Empowerment:** By providing fair wages and employment opportunities to local artisans, Ka Sha has contributed to the economic empowerment of marginalized communities.

**Consumer Awareness:** The brand's educational initiatives have raised awareness among consumers about the environmental and ethical issues associated with fast fashion, encouraging more responsible buying habits.

Ka Sha's journey from its inception to its current standing as a sustainable fashion icon in India showcases the power of innovation, ethical values, and a commitment to preserving cultural heritage. Karishma Shahani Khan's vision has not only transformed her brand but has also left a lasting impact on the fashion industry and the communities it serves. Ka Sha serves as a shining example of how fashion and sustainability can coexist, and its story continues to inspire both designers and consumers alike.

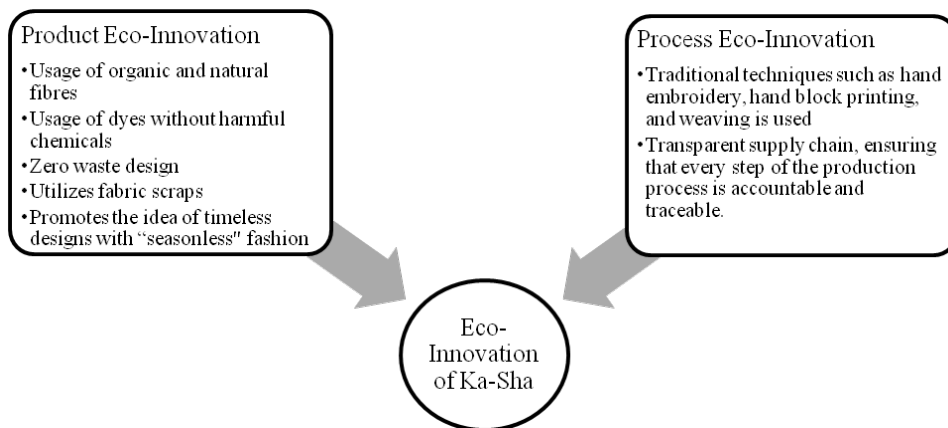


Figure 1: Eco-Innovation Framework of Ka Sha.

## Doodlage

Doodlage is an Indian fashion brand that has made a significant impact on the fashion industry by embracing sustainability and upcycling as core principles of its design philosophy. Founded by Kriti Tula in 2012, Doodlage has gained recognition for its innovative approach to fashion, blending eco-consciousness with unique, artistic designs. This section explores the journey of Doodlage, its innovative practices, and its influence on the Indian fashion landscape. Kriti Tula started Doodlage with a vision to address the environmental issues associated with the fashion industry, such as textile waste and overproduction. She was inspired by India's rich textile heritage and the desire to promote responsible consumption while creating distinctive fashion pieces.

### *Key Innovations:*

**Upcycling and Zero-Waste Design:** Doodlage's primary innovation lies in its commitment to upcycling and zero-waste design principles. The brand uses post-consumer waste and surplus fabrics to create unique, one-of-a-kind garments. By repurposing discarded textiles, Doodlage minimizes the environmental impact of fashion production (Tagra 2022).

**Handcrafted and Artisanal Techniques:** Doodlage collaborates with local artisans and craftsmen, incorporating traditional techniques into its designs. This not only preserves India's craft heritage but also empowers skilled artisans by providing them with sustainable employment opportunities (Tasfia 2020).

**Transparency and Ethical Practices:** The brand places a strong emphasis on transparency in its supply chain. Doodlage ensures fair wages and ethical working conditions for its workers and artisans, contributing to the social sustainability of its products (Tiwari 2022).

**Educational Initiatives:** Doodlage actively engages in educational initiatives, hosting workshops and seminars to raise awareness about sustainable fashion practices. These initiatives aim to educate consumers about the importance of responsible fashion choices (Tagra 2022).

### *Impact on the Fashion Industry:*

Doodlage's innovative approach to sustainable fashion has had a substantial impact on the Indian fashion industry and beyond:

**Inspiration for Sustainable Fashion:** Doodlage has inspired numerous Indian fashion brands to adopt sustainable practices and reduce waste in their production processes, contributing to a more eco-conscious industry.

**Revival of Traditional Craftsmanship:** Through its collaborations with artisans, Doodlage has played a crucial role in preserving and promoting traditional craftsmanship in India.

**Social and Economic Benefits:** By ensuring fair wages and ethical working conditions, Doodlage has made a positive impact on the lives of its workers and artisans, uplifting local communities.

**Consumer Education:** Doodlage's educational initiatives have heightened consumer awareness about the environmental and ethical issues associated with fast fashion, encouraging more responsible consumer behavior.

Doodlage's journey from its inception to its current status as a sustainable fashion icon in India exemplifies the power of innovation, ethical values, and a commitment to environmental and social responsibility. Kriti Tula's vision has not only transformed her brand but has also left a lasting impact on the fashion industry, inspiring designers and consumers alike to embrace sustainability in fashion. Doodlage serves as a shining example of how fashion can be both creative and sustainable, and its story continues to inspire positive change in the industry.

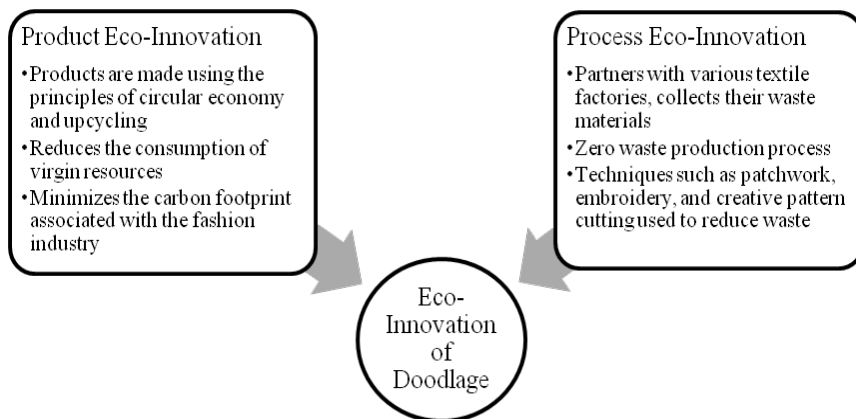


Figure 2: Eco-Innovation Framework of Doodlage.

## RaasLeela

In the ever-evolving world of fashion, RaasLeela has emerged as a distinguished brand that marries artistic elegance with ethical practices. Established in 2013 by visionary Hetal Shrivastav, this brand has not only made its mark but has also left an indelible impact on the industry. This section delves into the unique journey and success story of RaasLeela, highlighting its innovative approach to fashion and its commitment to sustainability and tradition. RaasLeela stands apart with its distinctive brand identity and positioning. Rooted in the rich tapestry of Indian culture and heritage, it strives to showcase traditional Indian textiles and craftsmanship through a contemporary lens. The brand's tagline, "Tradition Reimagined," aptly encapsulates its dedication to blending the timeless with the modern.

### *Key Innovations:*

**Sustainable Materials:** RaasLeela champions eco-friendly materials like organic cotton, linen, and ethically sourced silk, reducing the ecological footprint associated with conventional fabric production (Parakala 2020).

**Fair Trade and Artisan Collaboration:** The brand actively collaborates with skilled women artisans and weavers from rural areas in India, ensuring fair wages, safe working conditions, and long-term partnerships that uphold traditional craftsmanship (Selvedge 2022).

**Waste Reduction and Recycling:** RaasLeela minimizes waste by employing techniques such as upcycling and recycling, repurposing leftover fabrics to create new designs and promoting a circular economy (RaasLeela 2022).

**Transparent Supply Chain:** The brand maintains transparency throughout its supply chain, from sourcing materials to production and distribution, prioritizing ethical practices and fair treatment of workers (Parakala 2020).

**Product Innovation and Design Excellence:** A cornerstone of RaasLeela's success is its unwavering focus on product innovation and design excellence. The brand boasts a team of talented designers who seamlessly merge modern design elements with traditional Indian garments, crafting a unique and appealing product range. This fusion of traditional textiles, intricate embroideries, and contemporary silhouettes has resonated strongly with customers seeking a harmonious blend of cultural heritage and modern aesthetics (RaasLeela 2022).

### *Impact on the Fashion Industry:*

RaasLeela's innovative and sustainable approach to fashion has left an indelible mark on the industry:

**Promoting Ethical Fashion:** RaasLeela's commitment to sustainability and fair trade has set a positive example for other fashion brands, influencing industry discussions towards ethical and responsible practices.

**Supporting Artisans and Craftsmanship:** Collaborations with skilled artisans and weavers have provided them with sustainable livelihoods, playing a pivotal role in preserving traditional craftsmanship and empowering rural communities.

**Conscious Consumerism:** RaasLeela's emphasis on sustainability and transparency has raised consumer awareness, encouraging informed buying decisions, increasing the demand for ethically produced fashion, and inspiring other brands to follow suit.

RaasLeela's journey from its inception to becoming a trailblazing fashion brand exemplifies the harmonious merger of artistic elegance and ethical practices in the fashion industry. By upholding sustainable principles, collaborating with artisans, and offering unique designs, RaasLeela has positioned itself as a leader in the ethical fashion movement. The brand's success has not only shaped industry practices but has also spurred conscious consumerism and empowered traditional craftsmen, creating a positive impact on both the fashion industry and society at large.

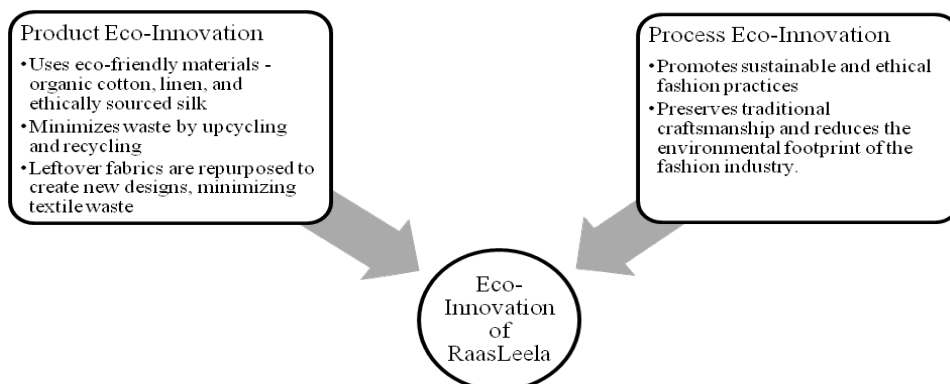




Figure 3: Eco-Innovation Framework of RaasLeela.

## Findings

This section discusses the three cases through a comparative analysis of raw materials used, design development processes and production systems.

Table 1: Comparative Analysis

	<i>Ka Sha</i>	<i>Doodlage</i>	<i>RaasLeela</i>
Raw Material	Organic Cotton Natural Dyes	Partnering with textile and apparel manufacturing units to source wastes generated from bulk production Community collection	Organic cotton, linen, and ethically sourced silk
Product Design and Development to ensure zero waste	Patchwork Multi-panel product designs	Boxy Silhouettes Patchwork Upcycled products	Leftover fabrics are repurposed to create new designs
Production	Usage fabric offcuts for patchwork and multi-panel products	Usage of fabric end-bits and scraps for upcycled products Sorting and recycling fabric from community collection	Usage of fabric scraps Upcycling and recycling

## Results

On the basis of the comparative analysis the following framework has been developed that can be followed by other fashion start ups to achieve a zero waste model.

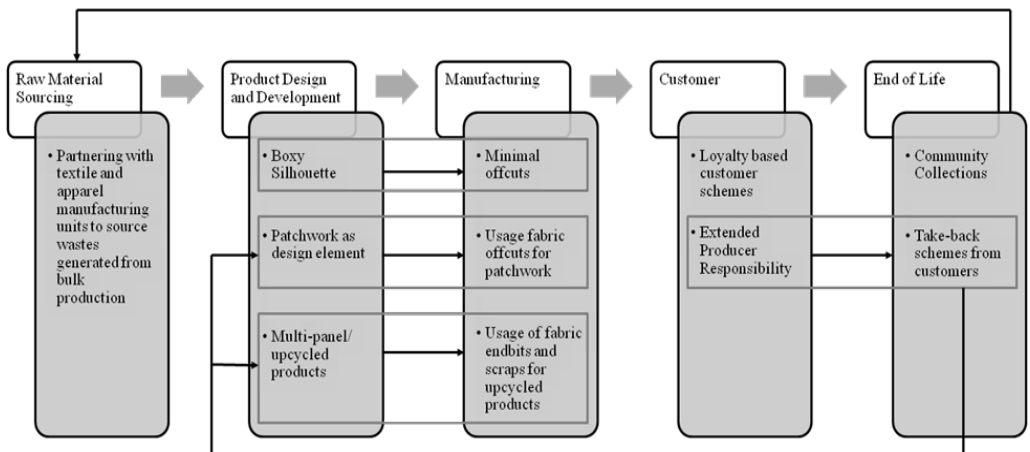


Fig 4: Proposed Framework.

According to the proposed framework, the fashion brands can partner with textile and apparel manufacturing units to source raw materials from wastes generated from bulk production. The design elements can include garments with boxy silhouettes that have patterns with straighter lines. This will lead to generation of minimal cutting waste. The offcuts that will be generated due to the curved shapes of neckline and armholes may be used for creating patchworks. Multi-panel designs may be used as a signature style to reduce fabric wastage. Loyalty based customer schemes may be introduced, where the customers can return the products once they want to dispose it off. Take-back programs can be introduced and customer may be encouraged for the same with coupons and vouchers for further purchases. Community collections can also take care of the end of life phase of the products. Extended Producer Responsibility can change the waste generation problem of the textile and fashion sector and take care of the post-consumer waste. The second hand garments collected can further be upcycled and recycled to create smaller products and lifestyle accessories. This will reduce the pressure on the production of virgin raw materials.

## Limitation and Scope

This research is limited to small-scale fashion start ups. The model will be applicable for fashion brands starting their business or are operating in a small-scale level. Further research is required to implement this model for a mass manufacturing set up.

## Conclusion

The practice of zero waste pattern making stands as a powerful testament to the fashion industry's growing commitment to sustainability and the circular economy. It represents a transformative shift in the way to approach garment design and production, focusing on minimizing waste and maximizing the utility of resources. Zero waste pattern making is not just a trend; it's a fundamental reimagining of the fashion industry's future. Adoption of these innovative techniques, not only reduces the environmental impact of clothing production but also acknowledging the interconnectedness of design choices with the broader ecosystem.

Zero-waste pattern-making perfectly aligns with the principles of "reduce, reuse and recycle." It extends the lifespan of textiles, minimizes waste, and promotes the use of sustainable materials, all of which are essential components of a circular fashion system. When combined with other circular practices like clothing repair, resale, and recycling, zero waste pattern making becomes a pivotal part of the solution to the environmental challenges posed by the fast fashion industry.

Consumers, designers, manufacturers, and policymakers, all have a collective responsibility to support and champion zero waste pattern making and the broader circular economy. This approach not only benefits the environment but also opens up exciting possibilities for creativity, innovation, and economic growth within the fashion industry. It's a paradigm shift that embraces the idea that fashion can be beautiful, functional, and sustainable, all at once. In the journey towards a more sustainable and circular fashion ecosystem, zero waste pattern making stands as an inspiring example of what is possible when the planet's well-being is prioritized.

## Informed Consent

The authors have obtained informed consent from all participants.

## Conflict of Interest

The authors declare that there is no conflict of interest.

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