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Exploring the Zero Waste Fashion Strategy for Enhancing Fabric Utilization in Sustainable Fashion

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***Abstract*—** *The fashion business is one of the most prominent economic sectors on a global scale, and it has a significant impact not only on society but also on the environment. The juxtaposition of zero waste fashion pattern methodology with conventional pattern approaches is the primary focus of the emphasis that is being placed on the promotion of sustainability within the fashion industry. A significant reduction in the amount of waste that is generated by the garment industry during the manufacturing cycle can be achieved through the utilization of zero waste pattern cutting. Furthermore, this method offers an alternative to traditional pattern creating processes that is more environmentally conscious, which helps to develop higher ecological sustainability that is more environmentally responsible. There are two techniques that make up the design process in traditional pattern-making. These methodologies include drafting patterns and draping patterns. A similar approach is taken in the zero waste fashion design process, which incorporates both the "design to pattern" and the "pattern to design" methodologies. In order to investigate the design process, analyze its potential, and assess its applications and influence within the fashion sector, a comprehensive comparison of different techniques is carried out. It is important to note that the zero waste fashion pattern is a technique for the creation of garment templates that aims to reduce the amount of textile waste produced during the manufacturing of apparel to less than 15%. In order to investigate and evaluate the differences between zero waste fashion patterns and standard fashion patterns within the fashion business, this study makes use of qualitative research methodologies, specifically literature reviews and simulations. After doing this research, the researchers came to the conclusion that the Zero-Waste pattern technique has emerged as a more sustainable solution for fostering environmental responsibility within the fashion sector. It is projected that the fashion industry will undergo a transformative change toward more sustainable practices on a broader scale. This shift is anticipated to occur as a result of the increased*

awareness of zero-waste design patterns and their capacity to positively influence the environment and generate better social progress.

I. INTRODUCTION

The term "fashion industry" refers to the process of transforming imaginative concepts into fashionable styles of clothing that are then used to establish popular trends in society(Bertola & Teunissen, 2018).It has been discovered through research conducted by the Copenhagen Fashion Summit that the planet generates a total of 92 million tons of waste textiles every single year (Östlund et al., 2020). It is estimated that textiles generate around 2.54% of the total national garbage depending on the type of waste they produce, with an annual amount of approximately 1.7 thousand tons (Singh et al., 2025). The process of designing and manufacturing garments has evolved into a number of different techniques in current modern era. The fashion business is one of the most significant economic spheres on the planet, and it has a significant impact not ju st on society but also on the environment (Mukherjee, 2023). In spite of its importance, the fashion business has a number of negative effects on the environment, most notably the huge amount of garbage that it generates. Over the course of many years, the creation of traditional clothing has been one of the most major contributors to the accumulation of textile waste and has had a detrimental impact on the environment of the entire planet (Yalcin-Enis et al., 2019). The fashion industry currently uses two manufacturing methods: the zero-waste fashion process and traditional patterns (Lei & Li, 2021).

The emphasis on fabric efficiency is the primary distinction between Zero Waste Pattern Cutting and traditional patterns (Saeidi & Wimberley, 2018). By creating clothing so that no fabric pieces are thrown away, the Zero-Waste Pattern Cutting process reduces textile waste and promotes environmental sustainability. The goal of zero-waste fashion is to create apparel with less than 15% waste. In this regard, Zero Waste Fashion an inventive method of designing and manufacturing apparel has surfaced as a possible way to lessen detrimental effects on the environment. Using effective fabric disposal techniques, this approach takes fashion design into account. Every pattern piece and piece of leftover fabric in Zero Waste Fashion patterns serves a purpose and may be combined and repurposed. In the meantime, the fashion industry frequently uses Conventional Fashion Patterns as a pattern-making technique. The traditional approach frequently uses basic pattern-making processes, which leads to a significant amount of fabric wastage when creating clothing patterns (Lei & Li, 2021). As a result, a large amount of fabric waste is produced by this procedure. Prevention is preferable to treatment: Preventing waste production is preferable to managing it.

Textile waste is classified into two categories: pre-consumer textile waste, generated during the production of fibers, yarns, fabrics, and garments, and post-consumer textile waste, arising from consumers as discarded apparel and household textiles (Azad et al., 2024). Textile waste in the industry is intricate and worldwide, with 80% of its environmental impact arising during the production stage (Roy Choudhury, 2014). The Zero Waste Fashion design technique produces a favorable result by reducing textile waste during production. Conversely, traditional pattern processes frequently generate increased textile waste due to the fact that garment layouts do not consistently prioritize optimal fabric utilization (Keating, 2025). This indicates that several wasted fabric remnants contribute to garbage, adversely affecting the environment. Suboptimal material utilization in traditional processes leads to greater consumption of natural resources and heightened ecological effect in textile manufacturing facilities (Farhana et al., 2022). Merely 80-85% of fabrics are utilized efficiently.

This research seeks to illustrate the advantages of zero-waste fashion patterns in contrast to traditional patterns within the fashion industry. This research focuses on detecting environmental implications, assessing material use efficiency in both techniques, and exploring the possibility of Zero Waste Fashion patterns as a sustainable solution to the environmental and social concerns confronting the fashion industry. The anticipated result of this research seeks to enhance comprehension of how the fashion industry may adopt more sustainable practices and mitigate its negative effects.

II. LITERATURE REVIEW

The fashion sector significantly contributes to global waste, especially with fabric scraps generated during garment production (Shirvanimoghaddam et al., 2020). Approximately 15% of fabric utilized in garment manufacture is squandered due to inefficiencies in pattern cutting and fabric arrangement (Ramkalaon & Sayem, 2021). With the expansion of the global fashion industry, the demand for sustainable fashion has intensified. Zero-waste fashion design (ZWFD) is a viable method that seeks to reduce fabric waste by assuring complete utilization of all materials in the garment during the design and production phases.

2.1. Traditional Pattern-Making and Waste Generation

The clothing industry has historically employed traditional pattern-making methods to produce designs, including as draping and flat pattern drafting (Grayer Moore, 2019). However, because of the inefficient use of fabric, these techniques frequently result in significant fabric waste. After cutting out pattern pieces, a lot of cloth is sometimes thrown or left unusable in flat pattern drafting. In a similar vein, cutting, pinning, and adjusting fabric while draping it on a mannequin to shape the garment leaves extra bits that are later discarded. According to studies, up to 15% of the fabric used in the manufacture of clothing may be lost when using traditional pattern-making techniques, which might result in fabric scraps that pollute the environment (Mifetu, 2021). By employing creative design strategies that guarantee each piece of fabric is used, zero-waste fashion aims to eradicate fabric waste in response to these problems, reducing the environmental effect of clothing production and fostering sustainability in the fashion sector.

2.2. Zero-Waste Fashion Design: Concept and Methods

At the beginning of the 21st century, a novel strategy to reduce the amount of fabric waste produced by the garment industry arose in the form of zero-waste fashion design. The goal of this methodology is to design garment patterns that make the most efficient use of fabric, so reducing or even doing away with offcuts and material that is left over. Pioneers such as Timo Rissanen and Holly McQuillan highlight the significance of integrating design and pattern-making at the very beginning of the garment production process (Rissanen & McQuillan, 2023). This is done to guarantee that the appropriate amount of fabric is utilized in the most effective manner possible. Utilizing geometric patterns, innovative fabric manipulation, and clever cutting techniques are all components of zero-waste design, which aims to maximize the utilization of materials. The elimination of superfluous fabric waste is achieved by the rethinking of standard pattern-making processes, which makes this method a more environmentally friendly alternative to the conventional garment production process (Surjit et al., 2026). Furthermore, it enables designers to innovate and experiment with fabric layout, which helps to ensure that all components of the garment are manufactured with a low impact on the environment through their production.There are two primary methods used in zero-waste design:

2.2.1. Design to Pattern

In zero-waste fashion, the "Design to Pattern" method concentrates on designing clothing with fabric proportions in mind, making sure that every piece of fabric is used to its fullest (Gwilt & Rissanen, 2012). In order to maximize the usage of each piece of material, the designer starts with the available fabric measurements and modifies the design to fit within those limitations. By carefully designing the pattern layout often utilizing geometric designs and creative cutting techniques, this method reduces fabric wastage. "Design to Pattern" incorporates sustainability from the outset, matching the pattern to the fabric's measurements to prevent offcuts, in contrast to typical design approaches that put the garment's appearance first. By guaranteeing effective fabric use, it contributes to more sustainable and eco-friendly clothing manufacture, even though it necessitates a high level of knowledge and may restrict some creative freedoms.

2.2.2. Pattern to Design

In zero-waste fashion, the "Pattern to Design" approach emphasizes choosing the fabric first and then modifying the design to suit the material. This method begins with the measurements and characteristics of the fabric, and the designer adjusts the garment design to guarantee that all of the fabric is utilized effectively, reducing waste and offcuts. The design process starts with choosing the fabric, taking into account its width, length, texture, and pattern, rather than developing the garment and then attempting to fit it to the cloth. Designers can optimize the fabric layout to guarantee that there are no remaining scraps by modifying the design based on these parameters. When combined with contemporary technologies like CAD and 3D simulation software to visualize and improve fabric utilization, this approach helps guarantee that every piece of fabric is utilized to its full potential, contributing to more sustainable and eco-friendly production practices in the fashion industry.

2.3. Challenges and Benefits of Zero-Waste Fashion

Zero-waste fashion provides considerable environmental benefits by reducing the amount of waste produced from fabric and promoting sustainable practices in the garment manufacturing industry (Gupta & Saini, 2020). On the other hand, it comes with its own unique set of difficulties, such as the requirement for highly talented pattern makers who are able to create and cut cloth with precision, as well as the intricacy of the design process, which necessitates creative thinking and careful preparation. On top of that, the greater production costs that are connected with zero-waste fashion might be a hurdle, particularly for mass production (Younus, 2025). Research has demonstrated that zero-waste fashion can significantly reduce waste and help to more sustainable production processes when every component of the fabric is used. This is despite the fact that there are some difficulties associated with the practice. The connection of this technique with the concepts of a circular economy, which place an emphasis on the reuse and repurposing of materials, is one of the most significant advantages of this strategy. Zero-waste fashion is an important step toward more sustainable practices in fashion design and manufacturing

since it extends the lifespan of fabrics, lowers the depletion of resources, and mitigates the environmental impact of the fashion industry. This is accomplished by decreasing the amount of fabric waste that happens during the manufacturing process.

2.4. Digital Tools and Simulation in Zero-Waste Design

The effectiveness of zero-waste fashion design has greatly increased thanks to developments in digital tools and simulation software. Before moving on to the production stage, designers can now experiment with fabric combinations and improve patterns using computer-aided design (CAD) and 3D simulation software. With the aid of these digital tools, designers can see how patterns will fit into the fabric that is available, assisting them in spotting any waste and inefficiencies. With the use of this technology, designers may modify the fabric layout in real time to make the best use of the material. Designers can electronically test several pattern variations with tools like CLO3D and Optitex, which eliminates the need for physical prototypes and significantly reduces fabric waste. By reducing the amount of material waste that would otherwise result from conventional trial-and-error approaches, the capacity to simulate and improve patterns in a virtual environment not only improves the efficiency of the design process but also promotes sustainability.

2.5. Applications and Case Studies

The fashion industry has shown through multiple case studies how zero-waste design techniques may be applied in practice. Using zero-waste principles, designers such as Holly McQuillan and Yeohlee Teng have produced cutting-edge, practical clothing with very little fabric waste (Rissanen & McQuillan, 2023). Stella McCartney and other sustainable fashion brands have used zero-waste design, proving that these methods can be mass-produced (Sharma, 2018).

To incorporate zero-waste design into large-scale garment manufacturing, modular methods have been investigated within the context of mass production. In order to improve fabric consumption while retaining consumer desire for aesthetic diversity and style variance, another study offered a modular strategy that utilizes 3D digital fashion technology to generate virtual garment prototypes.

2.6. Future of Zero-Waste Fashion

Scalability and the capacity to cause disruption in the fashion sector are two factors that will determine the future of zero-waste fashion. In response to the growing demand for environmentally friendly and sustainable fashion, both small businesses and large manufacturers are increasingly implementing zero-waste processes. This is happening in response to the growing awareness of sustainability among consumers. In recognition of the fact that sustainability is no longer a niche but rather a growing consumer expectation, an increasing number of designers are incorporating zero-waste ideas into their collections (Kälkäjä, 2016). In addition, zero-waste fashion is gaining popularity in the field of fashion education, where it is rapidly becoming an integral component of design academic programs. By including zero-waste design projects into their curriculum, fashion schools are bringing attention to the issue of fabric waste and encouraging the next generation of designers to engage in more environmentally responsible design practices. This transition toward zero-waste fashion has the potential to revolutionize the whole fashion industry, propelling innovation while simultaneously contributing to a future that is more sustainable and environmentally responsible.

III. METHODOLOGY

The research methodology that was utilized in this study was qualitative, and it included both simulation and a review of the relevant literature. The qualitative technique was utilized to collect data and information regarding conventional design methods and Zero Waste Fashion from a variety of sources, including books, journals, and articles. This was accomplished through the process of literature review. In order to collect information concerning zero-waste pattern cutting, traditional methods, design processes, and fabric waste, the researcher carried out a literature review. This review included an evaluation of sources such as the book "Zero-Waste Fashion Design" written by Timo Rissanen and prior studies (Rissanen & McQuillan, 2023). A comparison of the two approaches was the end result of the investigation. In addition, simulations were carried out in order to visualize and investigate the practical implementation of traditional designs as well as zero-waste patterns. The comprehensiveness of the study was improved as a result of these simulations, which revealed more in-depth insights into the aesthetic consequences, as well as the efficiency and sustainability of each strategy.

IV. RESULTS AND DISCUSSION

4.1. Conventional Fashion Design

In fashion, a "pattern" is a piece of paper or woven fabric that is used as a guide or example for cutting fabric before sewing it into clothes (Aldrich, 2012). When cutting cloth, patterns are used as guides to avoid making mistakes. In the fashion industry, there are a few different ways to make patterns, one of which is the conventional pattern. This pattern is a set of rules or steps for creating clothes using conventional or classical methods. These rules tell you how to put together and sew fabric components to make a certain

style of clothes. When you use regular fashion patterns to make clothes, you have to measure your body, make patterns on paper, cut the fabric according to the pattern, and then sew it all together. You may make traditional design patterns for many different sorts of apparel, like shirts, dresses, blouses, skirts, jeans, and more. When it comes to designing traditional clothes, there are only three basic things to think about: how it looks, how it fits, and how much it costs. There are many different sorts of conventional fashion patterns, and they have all evolved into different systems. There are many techniques to make fashion patterns, including:

4.1.1. Draping or Draping Pattern

A traditional technique in conventional pattern-making is draping or draping pattern, which involves the direct cutting and shaping of fabric on a three-dimensional model, typically a dress form or mannequin (Zhang, 2017). The fabric is draped on the form by the designer, who then adjusts and pins it to achieve the desired silhouette. This approach enables the designer to manipulate the fabric in real time and observe its behavior in 3D space. Draping is especially advantageous for the development of garments that necessitate more intricate or fluid shapes, such as couture or formal wear, as it enables the user to exert more control over the fabric's drape, fit, and flow. The draped fabric is meticulously marked and transferred into a flat pattern for further refinement and cutting after the design is finalized, ensuring that the fabric contours the body in the manner that the designer envisions. The process involves precision adjustments. Although it provides design flexibility, drapery frequently leads to fabric waste due to the trimming of excess material to achieve the desired aesthetic.

4.1.2. Drafting Pattern

Drafting patterns is a traditional pattern-making technique that involves drawing patterns directly on paper or fabric (Habib & Alam, 2024). This process entails getting precise body measurements from the subject and applying them to generate a flat template. The designer creates the pattern using these dimensions, either directly on fabric or on pattern paper, where the shape of the garment is carefully drawn and marked. The drafting method is commonly used to create two-dimensional patterns that can then be cut and stitched into clothes. This technique is highly structured and based on mathematical calculations to ensure that the pattern fits the model's body precisely. Although it enables the creation of standard garment shapes with greater precision, it frequently results in fabric waste during the cutting process, as excess fabric is discarded to fit the pattern parts together. Drafting is a commonly used, traditional method that necessitates a thorough understanding of geometry and body proportions (Ching, 2019).

4.1.3. Pattern of Combinations

Pattern of Combinations is a classic pattern-making process that creates designs by combining drafting and draping techniques. In order to fit the three-dimensional model, the cloth is first draped on a dress form or mannequin and then cut and molded. After draping the desired shape, the designer moves on to drafting, where they take measurements and use the draped design to produce a flat pattern on paper. Designers can improve the fit and structure of the garment by combining the accuracy of drawing with the flexibility of draping. Combining these two methods guarantees that the design will continue to be well-made and aesthetically pleasing. Although this method works well for making intricate forms and unique fits, it may waste fabric because extra material may be cut away to make the pattern correct.

4.2. Zero Waste Fashion Design

One of the ideas of sustainable development is the processing of trash produced by industrial activity. A design strategy known as "zero-waste fashion patterns" seeks to produce apparel with a fabric waste level of less than 15%. The zero-waste fashion design process must take into account five key factors. First, the garment's appearance, or its aesthetic qualities. The second is the fit, which shows that the size of the item fits the body shape and is pleasant to wear. Third, the price, making sure that the selling price is consistent with the design. The fourth factor is sustainability, which includes figuring out the kind of fiber and the effects of clothing consumption. The final factor is manufacturability, which guarantees that the clothing can be produced in large quantities. Depending on the circumstances and the stages being done in the design process, these requirements may change. The aforementioned elements should be included in the requirements for waste-free apparel, but this also depends on the specific context of the garment design criteria. However, attempts to cut down on fabric waste should never be used as an excuse to compromise comfort or aesthetics, nor should they lead to needless increases in production costs, such as from needlessly complicated constructions. When creating zero-waste clothes, a designer must take into account a number of factors. These factors include the kind of fabric being used, the width of the fabric, and the sort of garment being designed. The garment's silhouette, any fixed regions, and particular features must also be taken into account by the designer. In addition, the pattern pieces and construction and finishing methods are crucial elements that must be taken care of.

4.3. Waste Calculation Simulation for Conventional Design Patterns and ZWFD

In order to notice and comprehend common designs for women's tee, this study investigates traditional patterns. Conventional tee patterns will be contrasted with the investigation of tee, designs using the zero-waste fashion technique. Furthermore, a simulation will be run to show how to compute fabric waste in standard and zero-waste fashion patterns. The comparison seeks to draw attention to how the two strategies differ in terms of sustainability and efficiency. The study aims to shed light on how each technique affects the environment by examining the quantity of fabric waste produced. In addition to providing useful examples for designers wishing to cut waste in their design processes, this will aid in comprehending the possible advantages of zero-waste fashion. The clothes must have a fabric waste rate of less than 15% in order to meet the requirements of the zero-waste fashion pattern cutting procedure. The following formula was used to calculate cloth waste (Mawaddah et al., 2024) based on the research:

$$\frac{Waste\ Area}{Total\ Fabric\ Area} \times 100 = Waste(\%)$$

When conducting the research, a standard method with a plotting system was utilized. This method involved the creation of a drawing prior to the development of the design. For the purpose of carrying out this design process, the waste outcomes were influenced by a variety of aspects, including the dimensions of the cloth, plotting methods, silhouettes, and fashion design lines alike. It is possible to calculate the amount of fabric waste in a number of different ways, depending on the method that a designer chooses to take. However, in the majority of the earlier research, the calculation of waste was carried out by employing the formula of waste area divided by the total fabric area. Both of these areas can be manually estimated by applying mathematical formulas. Therefore, the purpose of this research is to provide a simulation example for determining the amount of waste trash produced by fabric and to investigate the comparison between zero-waste fashion and traditional patterns.

Figure 1 shows the design of a typical women's tee with a fabric width of 112 cm and a length of 100 cm. In order to determine the area of the remaining fabric, the waste from this pattern is manually computed using mathematical methods. Shapes like squares, rectangles, triangles, circles, and others are formed and altered to fit the shape of the remaining fabric. The process of determining waste in a traditional ladies tee pattern is demonstrated by an example simulation in Table 1.

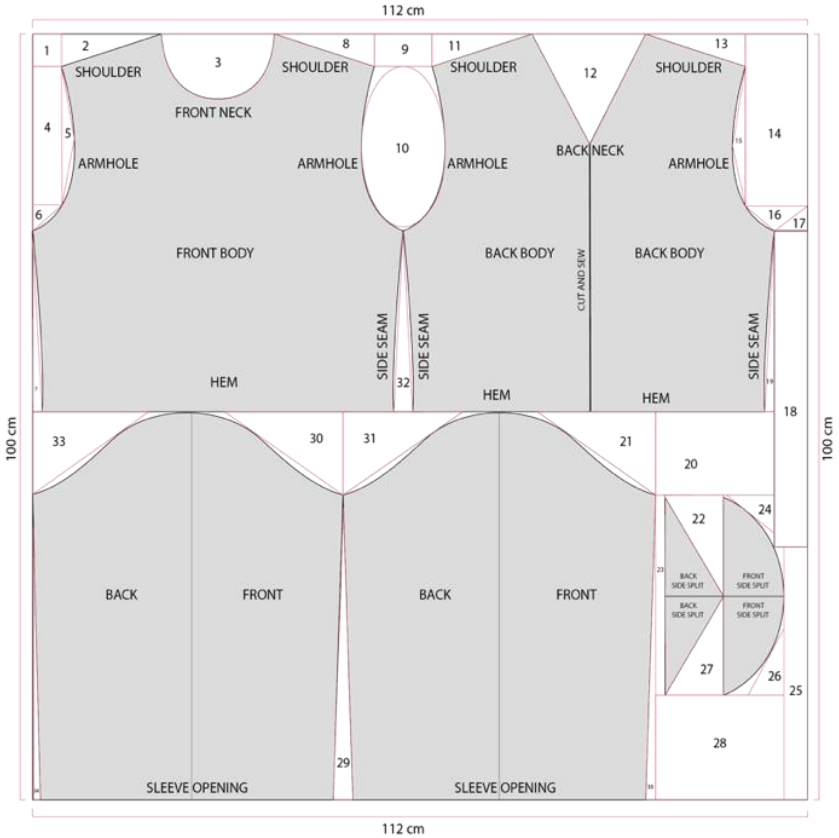

Fig.1. Example of Conventional Tee Pattern (Personal Documentation)

Table 1. Formula and Results of Waste in Conventional Pattern

No.	Formula	Result
1.	4.5×3.5	15.75 cm^2
2.	$\frac{1}{2} \times 14.5 \times 4.5$	32.62 cm^2
3.	$\frac{1}{2} \times 3.14 \times (9^2)$	127.17 cm^2
4.	20.6×3.5	72.10 cm^2
5.	$\frac{1}{2} \times 12 \times 2$	12 cm^2
6.	$\frac{1}{2} \times 2.5 \times 3.5$	4.37 cm^2
7.	$\frac{1}{2} \times 2 \times 24$	24 cm^2
8.	$\frac{1}{2} \times 14.5 \times 4.5$	32.62 cm^2
9.	4.5×9.5	42.75 cm^2
10.	$3.14 \times 11.2 \times 6$	211 cm^2
11.	$\frac{1}{2} \times 14.5 \times 4.5$	32.62 cm^2
12.	$\frac{1}{2} \times 16.5 \times 14.7$	121.27 cm^2
13.	$\frac{1}{2} \times 14.5 \times 4.5$	32.62 cm^2
14.	37.5×8	300 cm^2
15.	$\frac{1}{2} \times 19 \times 1.3$	12.35 cm^2
16.	$\frac{1}{2} \times 8 \times 3.6$	14.4 cm^2
17.	$\frac{1}{2} \times 3.8 \times 3.4$	6.46 cm^2
18.	24.7×3.4	83.98 cm^2
19.	$\frac{1}{2} \times 2 \times 24$	24 cm^2
20.	10.3×20	206 cm^2
21.	$\frac{1}{2} \times 15.8 \times 10.3$	81.37 cm^2
22.	$\frac{1}{2} \times 8.5 \times 12.5$	53.12 cm^2
23.	25.5×2	51 cm^2
24.	$\frac{1}{2} \times 4.6 \times 6.5$	14.95 cm^2
25.	36.5×2.1	76.65 cm^2
26.	$\frac{1}{2} \times 4.6 \times 6.8$	15.64 cm^2

27.	$\frac{1}{2} \times 8.5 \times 12.5$	53.12 cm^2	Data Source: Personal
28.	12.2×17.3	211.06 cm^2	
29.	$\frac{1}{2} \times 4 \times 24$	48 cm^2	
30.	$\frac{1}{2} \times 17 \times 10.2$	86.70 cm^2	
31.	$\frac{1}{2} \times 17 \times 10.2$	86.70 cm^2	
32.	$\frac{1}{2} \times 2 \times 24$	24 cm^2	
33.	$\frac{1}{2} \times 17 \times 11.5$	97.75 cm^2	
34.	$\frac{1}{2} \times 2 \times 24$	24 cm^2	
35.	$\frac{1}{2} \times 2 \times 24$	24 cm^2	
	Total	**2356.14 cm^2**	

Documentation

Fig.2. Result of Conventional Women Tee Prototype

According to Table 1's results, the overall fabric area is 112 cm x 100 cm = 11200 cm^2, but the fabric leftovers from the traditional tee pattern have an area of 2356.14 cm^2. The waste result is then determined by entering these values into the formula, which is:

$$\frac{2356.14}{11200} \times 100 = 21.03\%$$

The traditional women' tee pattern generates waste amounting to 21.03%. Figure 2 depicts the outcome of the prototype derived from the traditional pattern utilizing cotton fabric. The results indicate that the traditional arrangement generates a substantial amount of waste. In traditional garment manufacturing, 21.03% of fabric is wasted.

Figure 3 illustrates the design of a zero-waste fashion tee employing a traditional method. Developing a zero-waste fashion pattern necessitates the efficient use of fabric, yielding waste levels under 15%. One can manually calculate a zero-waste fashion pattern utilizing the mathematical procedure presented in Table 1.

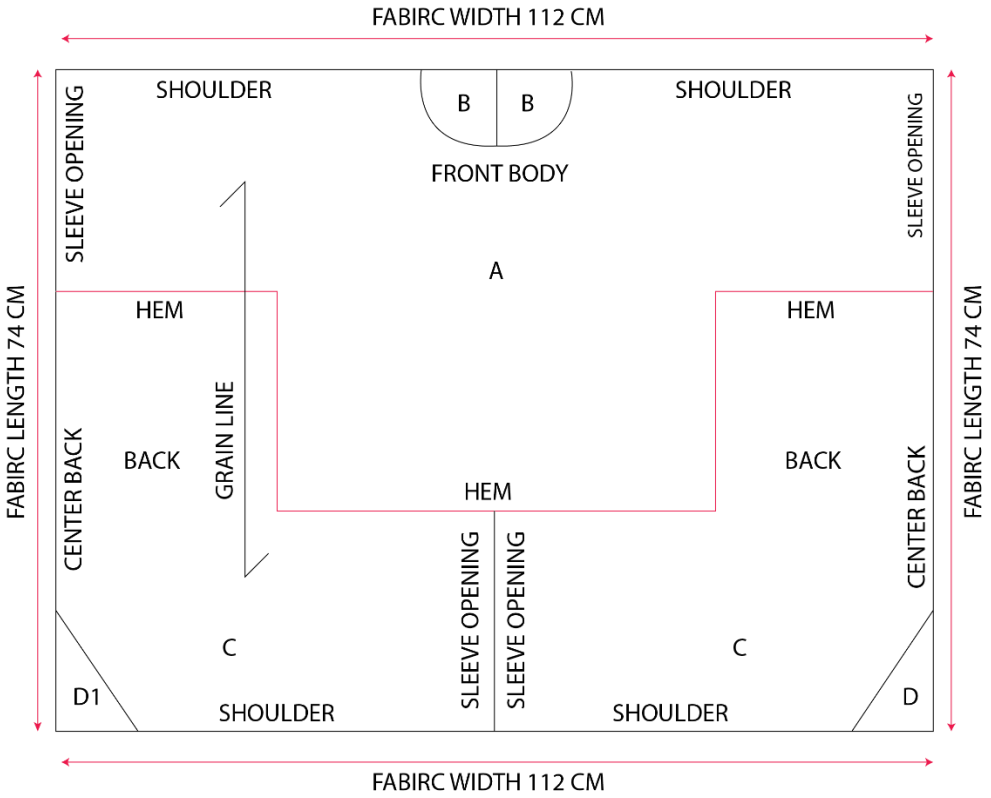

Fig.3. Example of Zero Waste Fashion Tee Pattern

A. Front body/sleeve

B. Front Split facing (template B)

C. Back body/sleeve

D. Back split facing (template D, D1)

A zero-waste pattern layout is shown in Figure 3, where the garment design's fabric measures 112 cm in width and 74 cm in length. These two measurements are multiplied to determine the overall cloth area This total area ensures that the fabric is used as efficiently as possible without producing any waste because it reflects the complete accessible space from which the garment pieces will be cut. The goal of the zero-waste pattern technique is to efficiently arrange the different pattern pieces in this region so that all of the fabric is used and no material is thrown away. By guaranteeing that all available materials are used in the garment production process, this method not only minimizes fabric waste but also advances sustainability. Figure 3's layout, which shows how various garment parts (such the torso and sleeves) are organized within the designated fabric dimensions, illustrates the meticulous planning and design needed to accomplish this goal.

Total fabric area: $112 \times 74 = 8288 cm^2$

The residual fabric area from the zero-waste fashion pattern, which has an area of 0 cm^2, is shown in figure 3. The fabric area is 8288 cm^2 (112×74). After that, the fabric area and waste area values are entered into the following formula:

$$\frac{0}{8288} \times 100 = 0\%$$

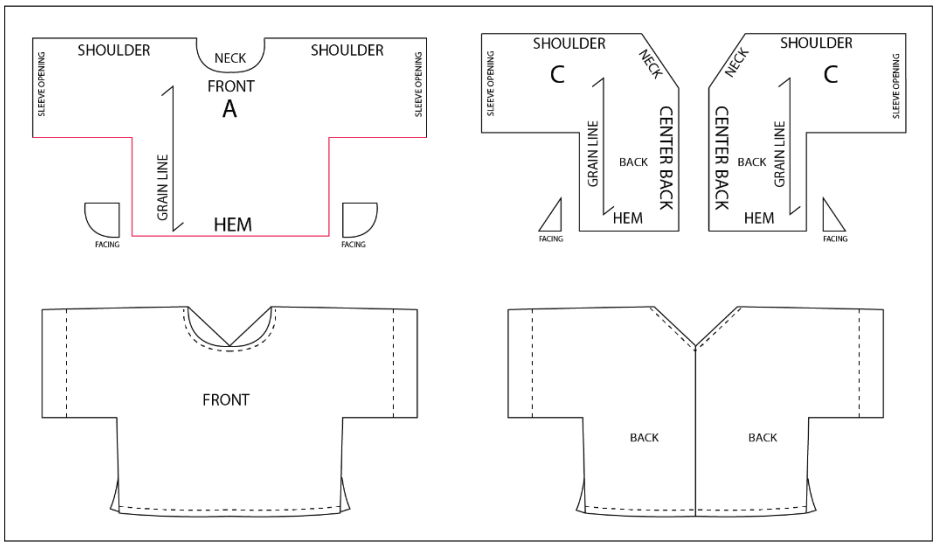

Fig.4. Zero Waste Pattern Cutting Technique.

The "Zero Waste Pattern Cutting Technique" is depicted in figure 4, which shows how various body portions of a garment can be efficiently ordered and cut from a single piece of fabric. This allows for the most efficient use of fabric while simultaneously reducing the amount of waste produced. This method entails strategically positioning the pattern pieces on the fabric in such a way as to maximize the use of the material. This ensures that every portion of the fabric is utilized without resulting in the creation of offcuts. The designer is able to avoid the customary waste that is typically associated with conventional pattern-making by making use of novel geometric forms and fitting the garment components together like a jigsaw; this allows the designer to save time and money. The arrangement that is depicted in the picture illustrates how to cut the garment pieces, such as the split section, the bodice, and the sleeves, from a single cloth pattern in an effective manner. In accordance with the principles of zero-waste fashion, this procedure guarantees that the pattern pieces are positioned in such a way that there is very little to no fabric that is left over.

This information yields a waste result of 0% for the zero-waste fashion trend. Consequently, it has been demonstrated that the zero-waste fashion approach may reduce fabric waste to less than 15%. The zero-waste concept has been used as a solution by the textile and apparel industries since 2008. Less than 15% of pre-production waste occurs during the clothing manufacturing process because to this strategy, which focuses on maximizing the type and availability of materials. In order to evaluate the practicality of the garment when worn, Figure 5 displays the prototype outcome of the zero-waste pattern using cotton fabric.

Fig.5. Result of Prototype Women Tee in Zero Waste Fashion

4.4. Comparison of Zero Waste Fashion and Conventional Methods

Conventional patterns are the established and widely used standard for the design and fabrication of clothing in the fashion industry (Habib & Alam, 2024). Sketching is the primary instrument utilized in traditional fashion design. Because the efficiency of material utilization is not a highly prioritized aspect or is more flexible in conventional design. The conventional design process is

characterized by an emphasis on visual aspects or appearance. The process of designing fashion products that generate no waste or production remnants from the materials used by optimizing pattern-cutting techniques in the design process is known as zero-waste fashion design (Gözene & Metlioğlu, 2025). Nevertheless, zero-waste fashion remains unfamiliar to a significant number of individuals, in contrast to the conventional patterns that are frequently employed in the fashion industry. Consequently, it is imperative to conduct a comparison between zero-waste fashion and traditional methods in order to increase its visibility and potentially establish it as a novel approach to the fashion industry.

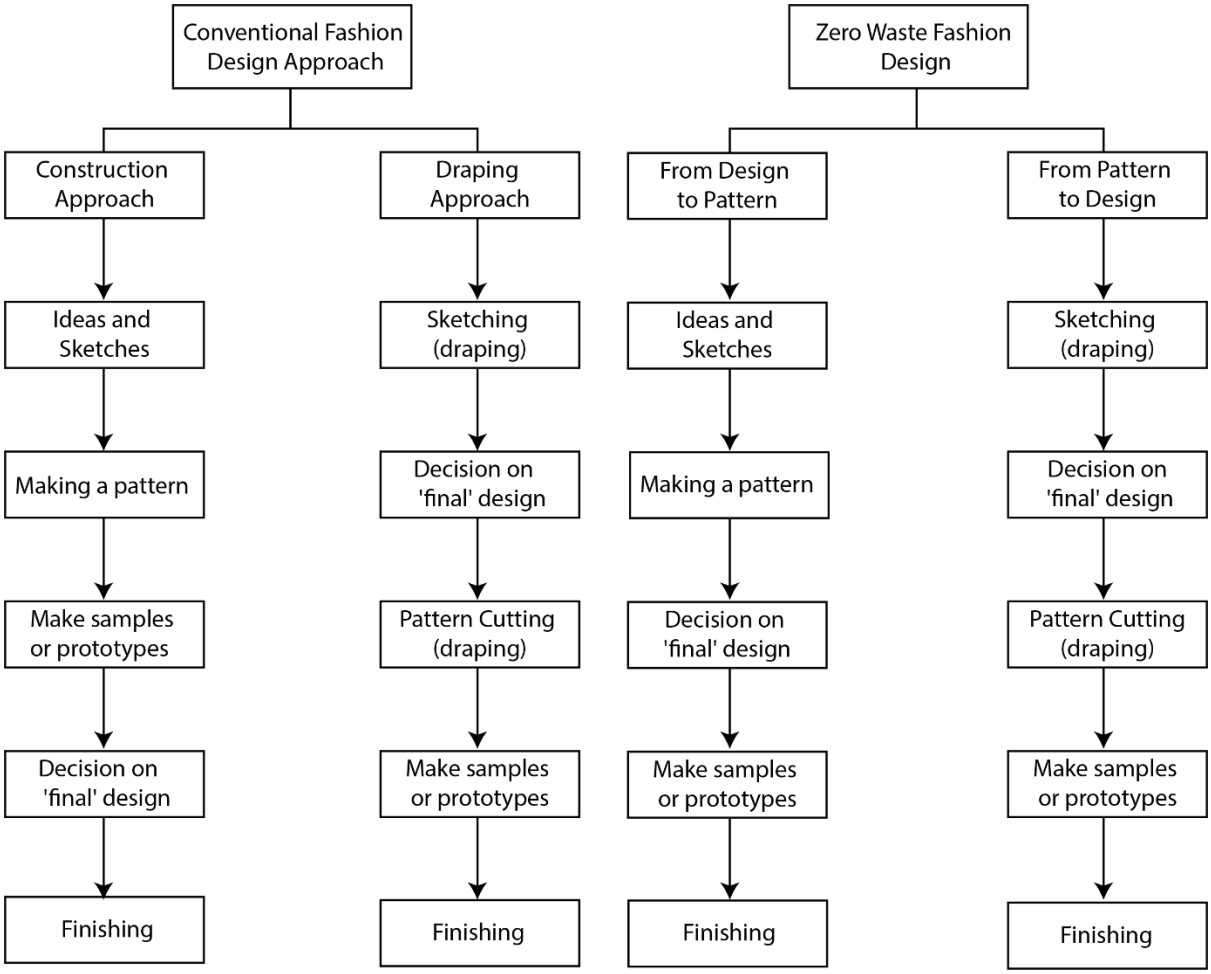

Fig.6. Comparison of Conventional and Zero Waste Fashion Methods (Personal Documentation)

Two approaches to traditional fashion design techniques construction and draping are depicted in Figure 6. This traditional design methodology is a modification of Timo Rissanen and Holly McQuillan, Widjiningsih & Khayati, and Putri's earlier study approach (Fadhilaturrahmah et al., 2024). A construction pattern is a drawing on paper that depicts the front and back of the body, a skirt, sleeves, a collar, and other body parts based on mathematical proportions. The construction method uses a person's body measurements to generate a fashion template. Draping, on the other hand, entails directly producing a fashion pattern on a human body imitation (dummy, dress form, mannequin). In the fashion sector, both strategies are now frequently employed. Both strategies, however, place a premium on aesthetics and frequently produce leftover fabric scraps, which results in substantial waste and eventually has a detrimental effect on the environment.

By concentrating on the production of clothing that produces no waste, Zero-Waste Fashion Design goes beyond conventional techniques. This method ensures that the finished clothing is both useful and appealing to both consumers and the fashion industry by incorporating important design factors like fit, cost, manufacturability, and aesthetics. The goal of the improved Zero-Waste Pattern Cutting approach is to eliminate fabric waste during the garment production process by integrating many design strategies.There are two methods used in fashion design to achieve zero waste. One of these is the 'From pattern to design' method, which involves creating garment designs based on zero waste patterns that already exist. On the other

hand, designers that use the "From design to pattern" method look for creative ways to produce desired fashion designs that adhere to zero waste standards. The first step in our zero-waste clothes design process is ideation and sketching. This method initially establishes the style, after which the garment pattern is converted into a zero-waste shape. It is challenging to put together parts of ready-to-wear clothing patterns into a rectangle shape. However, breaking the pattern down into smaller parts increases the likelihood that a rectangular form will be produced. Thus, improving intelligent cutting in the basic pattern is the main premise. The Holly McQuillan method and jigsaw are examples of zero waste techniques used in the "From design to pattern" approach (Lei & Li, 2021).

The 'From pattern to design' method of zero waste pattern cutting is a novel approach to the reduction of textile waste and the production of garments with a high fabric usage efficiency. In the preliminary phase of the procedure, a rectangular fabric piece is manipulated by cutting along a patterned shape that seamlessly repeats one or more interconnected patterns or by utilizing minimal cutting. Clothing is subsequently designed to maximize the utilization of the complete fabric piece in this methodical approach to zero waste. Julian Roberts, a designer, developed a zero-waste fashion method in this strategy, which involves manipulating negative space in clothing to enable the human body to travel through various openings in the fabric (Rissanen & McQuillan, 2023). This method, known as subtraction cutting, is utilized in this strategy. Despite the fact that this method facilitates the creation of unforeseen and imaginative silhouette concepts and achieves zero waste through straightforward stitching, the resulting garments may not be highly practicable for daily use. The geometric cut technique is based on the use of geometric shapes such as squares, triangles, and circles, and it follows a design-from-pattern approach. There are historical influences in this method, as evidenced by designs like the kimono. Furthermore, the modular and tessellated method is an alternative zero-waste pattern cutting technique in the 'from pattern to design' approach. McQuillan conducted a study in which the procedure involved the iterative application and evaluation of a pattern shape on a fabric piece (McQuillan, 2019). The fabric was subsequently cut in accordance with the pattern design and reassembled to create a three-dimensional garment.

It can be seen from the comparison data that the stages of the design process for traditional patterns and zero-waste fashion are slightly different. During the normal planning process, fabric scraps or waste are not taken into account. The zero-waste fashion design method, on the other hand, starts with coming up with an idea or pattern. This is where waste and fabric variables are already taken into account for efficiency. To do zero-waste fashion design, you need to know a lot about a lot of things, like how to make patterns, drape clothes, create clothes, and put clothes together. So, in a zero-waste way, any change to the building that affects one piece will also affect the others.

The Zero Waste Fashion pattern method has significant social ramifications in addition to its effects on the environment. This approach gives designers and employees in the fashion industry the chance to learn new skills by encouraging innovation in design and creativity in developing eco-friendly solutions. Fashion designers have a crucial part in choosing the fabrics and styles for every item of clothing in a collection. Designers need to understand the complexities of pattern-making and sewing techniques in addition to having a strong sense of style and taste. Employment and training possibilities in the manufacturing of more environmentally friendly apparel may result from this. Conventional pattern techniques, on the other hand, frequently concentrate more on adhering to fashion trends and making clothing in response to quickly shifting consumer demands. output workers may be under pressure to meet strict output targets as a result of this circumstance, which could lead to societal issues like low pay, long hours, and bad working conditions.

The data presented above shows that the Zero Waste Fashion method has tremendous promise for assuring sustainability in the fashion industry. Rapidly shifting market demands and fashion trends frequently result in significant apparel turnover, which contributes to increasing waste and environmental degradation. Designers can utilize zero-waste strategies to make clothing that maximize fabric utilization while minimizing trash. This method not only addresses environmental concerns, but also meets the growing customer demand for sustainable and environmentally friendly products. Zero Waste Fashion needs designers to rethink their methods, from concept to finished product, to ensure that every piece of fabric is used properly. This strategy can also promote innovation and creativity as designers look for new ways to attain zero waste in their creations. Furthermore, by supporting sustainable practices, the fashion industry can help to create a more sustainable future by decreasing its environmental impact and establishing a good example for other industries to follow.

CONCLUSION

The study concludes that conventional patterns and zero-waste fashion patterns are the two methodological methods used by the fashion industry. Regarding industrial practices and the environment, these two approaches have distinct effects on the fashion business. Fabric remnants are ignored

and frequently thrown away in traditional patterns. On the other hand, zero-waste fashion patterns limit fabric waste to less than 15% by carefully considering fabric utilization. However, not many people are familiar with this technique. In order to comprehend the design, manufacturing, and comparison processes of both approaches, a comparison was made. The findings demonstrated the distinct stages of these two patterns. Two design strategies are used in conventional patterns: draping and construction. Both methods' trash is frequently disregarded. However, there are two methods for zero waste patterns as well: "from design to pattern" and "from pattern to design."" Manual mathematical calculations can be used to determine fabric waste in the zero-waste fashion process.

The Zero Waste Fashion pattern method, which focuses on making better use of materials and lowering textile waste, has a lot of promise for making clothes that are better for the environment. This means using sustainable materials, cutting down on textile trash, and using fewer resources. This way also encourages new ideas in designing and making clothes that are better for the environment.

If the fashion industry wants to be more environmentally friendly, the Zero-Waste pattern cutting method stands out as a better option. It has good effects on the environment and more room for social growth. But for this to happen, the fashion industry might need to change the way it works, spend money on training and technology, and make everyone in the supply chain more aware of how important sustainability is. Zero-waste fashion does cut down on cloth waste, which is a good thing. But this method has a time limit: the process can't be instant because it needs more complicated design and production to make sure that materials are used efficiently. As more people learn about zero-waste fashion patterns, it is hoped that the fashion business can change for the better and start using more environmentally friendly methods.

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