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Potential Application of The Zero Waste Fashion Method to Optimize Fabric Usage

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ABSTRAK

Industri fashion termasuk dalam bisnis bidang ekonomi paling besar secara global, memiliki dampak signifikan terhadap lingkungan dan masyarakat. Perbandingan diantara teknik pola zero waste fashion dan teknik pola konvensional menjadi fokus utama dalam upaya mencapai keberlanjutan dalam industri fashion. Pola zero waste fashion dapat menekan jumlah sampah yang berasal dari industri pakaian yang dibentuk selama proses pembuatan pakaian. Metode tersebut juga dapat lebih ramah lingkungan dibandingkan dengan pola busana konvensional. Ada dua pendekatan proses desain dari pola konvensional yaitu pola konstruksi dan pola draping. Begitu pula pendekatan proses desain zero waste fashion yaitu 'dari desain ke pola' dan dari 'pola ke desain'. Dari semua pendekatan tersebut dikomparasi untuk mengetahui proses desain, potensi, perbandingannya, serta penerapan dan dampaknya di industri fashion. Dalam konteks ini, Pola zero waste fashion yakni suatu teknik pembuatan pola pakaian yang bertujuan untuk memproduksi pakaian dengan limbah tekstil kurang dari 15%. Kajian ini menerapkan teknik kualitatif yakni kajian studi literatur dan simulasi yang bertujuan untuk memahami dan mengevaluasi perbedaan antara pola zero waste fashion dan pola konvensional di industri fashion. Hasil dari penelitian ini dalam mencapai keberlanjutan di industri fashion, dapat dibuktikan bahwa metode pola Zero-Waste muncul sebagai alternatif yang lebih berkelanjutan. Dapat memberikan dampak positif terhadap lingkungan dan potensi pembangunan sosial yang lebih signifikan dengan semakin meningkatnya pemahaman terhadap pola fashion zero-waste, diharapkan industri fashion dapat mengalami transformasi positif menuju praktik yang lebih berkelanjutan secara keseluruhan.

***Kata kunci*:** Zero Waste, Fashion, Pola, Tekstil, Limbah

ABSTRACT

The fashion industry is one of the largest economic sectors globally, having a significant impact on the environment and society. Comparison between zero waste fashion pattern techniques and conventional pattern techniques is the main focus in efforts to achieve sustainability in the fashion industry. The zero waste pattern cutting can reduce the amount of waste originating from the clothing industry which is formed during the clothing manufacturing process. This method can also be more environmentally friendly than conventional fashion patterns. There are two approaches to the design process from conventional patterns, namely construction patterns and draping patterns. Likewise, the zero waste fashion design process approach is 'from design to pattern' and from 'pattern to design'. All these approaches are compared to understand the design process, its potentioal, comparison, as well as its application and impact in the fashion industry. In this context, the zero waste fashion pattern is a technique for making clothing patterns which aims to produce clothing with less than 15% textile waste. This study applies qualitative techniques, namely literature studies and simulations which aim to understand and evaluate the differences between zero waste fashion patterns and conventional patterns in the fashion industry. The results of this research in achieving sustainability in the fashion industry, can be proven that the Zero-Waste pattern method has emerged as a more sustainable alternative. Being able to have a positive impact on the environment and the potential for more significant social development with increasing understanding of zero-waste fashion patterns, it is hoped that the fashion industry can experience a positive transformation towards more sustainable practices as a whole.

***Keywords*:** Zero Waste, Fashion, Pola, Textile, Waste

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1. INTRODUCTION

A process of turning creative ideas into clothing styles that create popular trends in society is the concept of Fashion Industry (Sunjoto, K. G., 2020). According to Thamrin (2019), a study by the Copenhagen Fashion Summit reveals that each year, the Earth generates a total of 92 million tons of textile waste. As reported in 2022 by the National Waste

Management Information System (Sistem Informasi Pengelolaan Sampah Nasional or SIPSN) under the Ministry of Environment and Forestry (Kementerian Lingkungan Hidup dan Kehutanan or KLHK), textiles contributed approximately 2.54% to the total national waste based on its type, with an estimated amount of 1.7 thousand tons per year. In this modern era, various approaches have appeared in designing and producing clothing. The fashion industry stands as one of the globe's most substantial economic domains, exerting notable influence on both the environment and society. Despite its prominence, the fashion industry exhibits adverse effects on the environment, particularly through its significant contribution to waste. Over the years, conventional clothing production has been one of the significant contributors to textile waste and has negatively affected the global ecosystem. Generally, the industry currently employs two production approaches: the zero-waste fashion process and conventional patterns.

The main difference between Zero Waste Pattern Cutting and conventional patterns lies in the focus on fabric efficiency. In the Zero-Waste Pattern Cutting method, efforts are made to reduce textile waste by designing garments in such a way that no fabric pieces are discarded, making it more environmentally friendly. According to Rissanen, in 2016, zero-waste fashion is a pattern-making method aimed at producing clothing with less than 15% waste. In this context, Zero Waste Fashion, an innovative approach to the design and production of clothing, has emerged as a potential solution to reduce harmful environmental impacts. This method considers fashion design using efficient fabric disposal strategies (Faza & Nursari, 2021). In Zero Waste Fashion patterns, all pattern pieces and fabric remnants have a function and can be combined and reused (Faza & Nursari, 2021). Meanwhile, Conventional Fashion Patterns are a commonly used pattern-making method in the fashion industry. The conventional method often employs simple pattern-making techniques, resulting in a lot of fabric waste during garment pattern-making (Hanantiani & Nursari, 2019). Hence, this method generates a significant amount of fabric waste. Prevention is better than cure: It is better to avoid the generation of waste than to manage it (Gertsakis & Lewis, 2003).

Textile waste is categorized into two distinct types: pre-consumer textile waste, which originates during the manufacturing processes of fibers, yarns, fabrics, and clothing, and post-consumer textile waste, which emerges from consumers in the form of discarded clothing and household textiles (Rissanen, 2013). Waste in the industry in the form of textiles is highly complex and global, with 80% of its environmental impact occurring during the production phase (Sandin et al., 2019). The Zero Waste Fashion pattern technique generates a beneficial outcome by minimizing the volume of textile waste during the production process. On the other hand, conventional pattern methods often result in more textile waste because garment patterns are not always designed with efficient fabric usage as a primary priority. This means that many unused fabric scraps become waste, negatively impacting the environment. Less efficient material usage in conventional methods also results in higher consumption of natural resources and increased ecological impact in textile factories. Townsend & Mills (2013) proves this by showing that only 80-85% of fabrics are utilised effectively.

This research aims to demonstrate the potential of zero-waste fashion patterns compared to conventional patterns in the fashion industry. This research centres on identifying environmental impacts, evaluating the efficiency of material use in both methodologies, and investigating the potential of Zero Waste Fashion patterns as a sustainable solution to address the environmental and social challenges facing the fashion industry. The expected outcome of this research aims to increase the understanding of how the fashion industry can implement more sustainable practices and reduce its adverse impacts.

2. RESEARCY METHODOLODY

The research methodology used in this study was qualitative, involving literature review and simulation. Through literature review, the qualitative method was used to gather data and information about conventional design processes and Zero Waste Fashion from books, journals, and articles. The literature review conducted by the researcher involved an examination of sources such as the book "Zero-Waste Fashion Design" by Timo Rissanen (2013) and previous studies to collect data related to zero-waste pattern cutting, conventional methods, design processes, and fabric waste. The final outcome was a comparison of the two methods. Additionally, simulations were conducted to visualize and analyze the practical application of both zero-waste and conventional patterns. These simulations provided deeper insights into the efficiency, sustainability, and aesthetic outcomes of each method, thereby enhancing the comprehensiveness of the study.

3. RESULTS AND DISCUSSION

3.1. Conventional Fashion Design

The definition of "pattern" in fashion refers to paper or woven material pieces used as an example or guide in cutting fabric before sewing it into clothing (Masyhariati & Dwijanti, 2013). Patterns are used as examples to avoid mistakes when cutting fabric (Ampera & Bahri, 2022). There are several approaches to pattern-making in the fashion industry, including the conventional pattern. This pattern refers to guidelines or instructions used in garment making with traditional or classical methods. These guidelines provide instructions on arranging and sewing fabric pieces to create a specific clothing design. The process of making clothing using conventional fashion

patterns involves steps such as taking body measurements, creating patterns on paper, cutting the fabric according to the pattern, and then assembling it with stitches. Conventional fashion patterns can be created for various styles and types of clothing, including shirts, dresses, blouses, skirts, pants, and so on (Ni Putu et al., 2022). In conventional fashion design, there are only three main criteria for designing conventional clothing: appearance, fit, and the cost of a garment (Rissanen, 2013). The creation of conventional fashion patterns can be divided into several types and has developed into various systems. The technique of making fashion patterns can be done in several ways, including (Masyhariati & Dwijanti, 2013):

a. Draping or Draping Pattern
   This is a pattern-making technique by shaping and cutting the fabric directly on the model (three-dimensional)
b. Construction Pattern (Drafting/Flats Pattern)
   Patterns are drawn on paper or on fabric. These patterns are created by drawing on pattern paper or directly on fabric using the measurements of the model's body that have been prepared beforehand.
c. Combination Pattern
   This involves making patterns by combining draping and construction techniques, achieved by drawing and cutting directly on the fabric (drafting and draping)

3.2. Zero Waste Fashion Design

Industrial activities generate waste that must be processed as one of the concepts of sustainable development (Susanto et al., 2021). Zero-waste fashion patterns are a design approach that aims to create clothing with a fabric waste level below 15% (Rissanen & McQuillan, 2016). According to Rissanen and McQuillan (2016), there are five main criteria or aspects that need to be considered in the zero-waste fashion design process. First, the appearance, which refers to the visual aesthetics of the garment. Second, the fit, indicating that the garment's size conforms to the body shape and is comfortable to wear. Third, the cost, ensuring that the selling price aligns with the design. Fourth, sustainability, which involves determining the type of fiber and the impact of garment use. Lastly, manufacturability, ensuring that the garment can be mass-produced. Those criteria can vary depending on the situation and the design process steps being undertaken. The criteria for waste-free clothing should include the mentioned aspects, but this also depends on the context of the garment design criteria itself (Nursari & Djamal, 2019). Nevertheless, efforts to reduce fabric waste should never be a reason to sacrifice aesthetic or comfort elements, nor should they result in unnecessary production cost increases, such as from unnecessary complex constructions. According to Rissanen and McQuillan (2016), there are several considerations that a designer must take into account in the process of zero-waste fashion design. These considerations include the type of garment being designed, the width of the fabric, and the type of fabric used. Additionally, the designer must consider the silhouette of the garment, any fixed areas, and specific features. Furthermore, the construction and finishing techniques, as well as the pattern pieces, are also important aspects that need to be addressed.

3.3. Waste Calculation Simulation for Conventional Shirt Design Patterns and ZWFD

This study explores conventional men's shirt design patterns to observe and understand typical men's shirt designs. The exploration of shirt patterns using the zero-waste fashion technique by Holly McQuillan will be compared with conventional shirt patterns. Additionally, a simulation will be conducted to demonstrate how to calculate fabric waste in zero-waste fashion patterns and conventional patterns. The comparison aims to highlight the differences in efficiency and sustainability between the two approaches. By analyzing the amount of fabric waste generated, the study seeks to provide insights into the environmental impact of each method. This will not only help in understanding the potential benefits of zero-waste fashion but also offer practical examples for designers looking to reduce waste in their design processes. The criteria set in the zero-waste fashion pattern cutting process require that the garments produced must exhibit a fabric waste rate below 15%. The calculation of fabric waste was derived from the research (Putri, 2022) using the formula:

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

The research used a conventional approach with a plotting system, where a sketch was first created before developing the pattern. To carry out this design process, factors such as fabric dimensions, plotting systems, silhouettes, and fashion design lines influenced the waste outcomes (Putri, 2022). Calculating fabric waste can be done in various ways, depending on how a designer chooses to approach it. However, in most previous studies, the calculation of waste is done by using the formula of waste area divided by the total fabric area, where both areas can be manually calculated using mathematical formulas or by employing a grid system. Therefore, this research will provide a simulation example for calculating fabric waste and examining the comparison between zero-waste fashion and conventional patterns.

Figure 1 is the pattern of a conventional men's shirt using a fabric width of 150cm x 150cm. The waste from this pattern is manually calculated using mathematical formulas to determine the area of the remaining fabric, forming shapes such as squares, rectangles, triangles, circles, trapezoids, and others, adjusted to the shape of the remaining fabric. An example simulation illustrates the method of calculating waste in a conventional men's shirt pattern shown in Table 1.

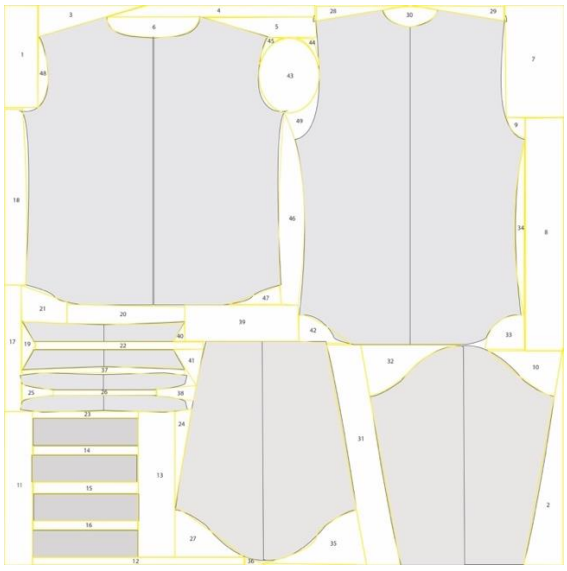

Figure 1. Example of Conventional Shirt Pattern (Personal Documentation)

Table 1. Formula and Results of Waste in Conventional Pattern

No	Formula	Results
1.	27.4×9	246 cm²
2.	$\frac{1}{2} \times 10 \times 58$	290 cm²
3.	$\frac{1}{2} \times 8.5 \times 28$	119 cm²
4.	$\frac{1}{2} \times 3.1\ (50 \times 550\ )$	157,5cm²
5.	$\frac{1}{2} \times 5.4\ (13 + 29)$	109,2cm²
6.	$\frac{3{,}14 \times 24.5}{2}$	38,4cm²
7.	30×15.5	465cm²
8.	62.5×10	625cm²
9.	$\frac{1}{2} \times 5 \times 5.4$	11,25cm²
10.	$\frac{1}{2} \times 20 \times 13.2$	123cm²
11.	41×7.5	307.5cm²
12.	56×2	112cm²
13.	39×9.8	382.2cm²
14.	28×2.3	64.4cm²
15.	28×2.9	81.2cm2
16.	28×2.3	64.4cm²
17.	33×5	165cm2
18.	48×4.8	230.4cm²
19.	$\frac{1}{2} \times 13 \times 3.7$	24,05cm²
20.	30×5	150cm²
21.	$\frac{1}{2} \times 5\ (13 + 12)$	37.5cm²
22.	45×2	90cm²
23.	$28{,}3 \times 1{,}7$	48.11cm²
24.	$\frac{1}{2} \times 4.4 \times 26$	57.2cm²
25.	$\frac{1}{2} \times 3{,}5 \times 8{,}3$	18.6cm²
26.	$27{,}6 \times 1{,}6$	35.88cm²
27.	$\frac{1}{2} \times 18 \times 12$	108cm²
28.	$\frac{1}{2} \times 4 \times 24$	48cm²
29.	$\frac{1}{2} \times 4 \times 24$	48cm²
30.	$\frac{3{,}14 \times 15}{2}$	23,5cm²
31.	$9{,}1 \times 60$	546cm²
32.	$\frac{1}{2} \times 13.9 \times 27$	187.6cm²
33.	$\frac{3.14 \times 15}{2}$	14.1cm²
34.	$\frac{3.14 \times 3}{2}$	4.7cm²
35.	$\frac{1}{2} \times 27.5 \times 15$	206.2cm²
36.	$\frac{1}{2} \times 5.4 \times 2.7$	7.2cm²
37.	44×2	88cm²
38.	$\frac{1}{2} \times 1.6\ (10 \times 9.8\ )$	15.8cm²
39.	30.5×9.6	292.8cm²
40.	$\frac{1}{2} \times 3 \times 4.8$	7.2cm²
41.	$\frac{1}{2} \times 14 \times 6$	42cm²
42.	$\frac{3.14 \times 8}{2}$	12,5cm²
43.	3.14×16	50,2cm²
44.	$\frac{1}{2} \times 9 \times 1.8$	8.1cm²
45.	$\frac{1}{2} \times 9 \times 1.8$	8,1cm²
46.	$\frac{1}{2} \times 50 \times 5$	125cm²
47	$\frac{1}{2} \times 6 \times 5$	15cm²
48.	$\frac{3.14 \times 3}{2}$	4.7cm²
49.	$\frac{1}{2} \times 7.5 \times 9$	33.7cm2
	Total	5,795cm²

Data Source: Personal Documentation, 2023

Figure 2. Result of Conventional Men's Shirt Prototype

The results from Table 1 indicate that the fabric remnants from the conventional shirt pattern have an area of 5,795cm², while the total fabric area is 150cm x 150cm = 22,500cm². Then, these values are input into the formula to calculate the waste result, which is:

$$\frac{5{,}795}{22{,}500} \times 100 = 25.7\ \%$$

The conventional men's shirt pattern produces waste, totaling 25.7%. Figure 2 is the result of the prototype from the conventional pattern using muslin fabric. From the results obtained, it can be concluded that the conventional pattern results in a significant amount of waste. In conventional garment processes, 15% to 20% of fabric is lost (Abernathy et al., 1999).

Figure 3 is the pattern of a zero-waste fashion shirt with a conventional approach using a Holly McQuillan technique. Creating a zero-waste fashion pattern requires utilizing fabric efficiently, resulting in waste

below 15%. Calculating a zero-waste fashion pattern can be done manually using the same mathematical formula as in Table 1.

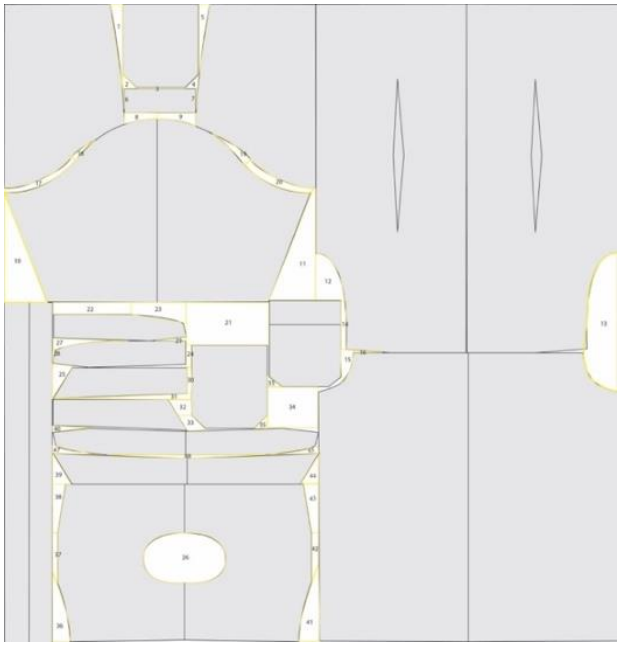

Figure 3. Example of Zero Waste Fashion Shirt Pattern (Personal Documentation)

Table 2. Formula and Results of Waste in Zero Waste Fashion Pattern

No	Rumus	Hasil
1	$\sqrt{17.95\ x\ (1795-16.8)\ x\ (17.95-16.6)x\ (17.95-2.5)}$	19.1 cm²
2	$\frac{1}{2}$ 2.8 cm × 2.6 cm	3.64 cm²
3	$\frac{1}{2} \times (9.3+9.5) \times 0.25$	4.7 cm²
4	$\sqrt{4.45 \times (4.45-3.8) \times (4.45-2.4) \times (4.45-2.7)}$	5.4 cm²
5	$\sqrt{14.85 \times (14.85-2) \times (14.85-13.8) \times (14.85-13.9)}$	15.2 cm²
6	$\sqrt{4.1 \times (4.1-0.2) \times (4.1-4.1) \times (4.1-3.9)}$	0.5 cm²
7	$\sqrt{4.25 \times (4.25-0.2) \times (4.25-4{,}3) \times (4.25-4)}$	0.6 cm²
8	$\frac{1}{2} \times (6.5+2.1) \times 5.28$	22 cm²
9	$\frac{1}{2} \times (6.5+2.1) \times 5.28$	22 cm²
10	$\sqrt{26.2 \times (26.2-8.4) \times (26.2-21) \times (26.2-23)}$	49.6 cm²
11	$\sqrt{26.2 \times (26.2-8.4) \times (26.2-21) \times (26.2-23)}$	49.6 cm²
12	$\frac{3{,}14 \times 5}{2}$	7.8cm²
13	$3.14 \times \frac{13{,}5 \times 2}{2}$	42.9cm²
14	9.5 cm × 0.9 cm	8.5cm²
15	$\sqrt{7.9 \times (7.9-2.5) \times (7.9-6.5) \times (7.9-6.8)}$	8cm²
16	$\frac{\sqrt{3}}{4}(5.)^2$	10.8cm²
17	14 cm × 1 cm	14cm²
18	$\sqrt{6 \times (6-1.4) \times (6-5.4) \times (6-5.2)}$	3.7 cm²
19	$\sqrt{10 \times (10-1.5) \times (10-9.5) \times (10-9)}$	6,5 cm²
20	14 cm × 1 cm	14 cm²
21	15 cm × 8.3 cm	124.5 cm²
22	15 cm × 2.3 cm	34.5 cm²
23	$\frac{1}{2} \times 2.3\ (10+\ 10.1)$	23.1 cm²
24	4.3 cm × 1 cm	4.3 cm²
25	$\sqrt{9.15 \times (9.15-4) \times (9.15-6.8) \times (9.15-7.5)}$	15.04 cm²
26	3,14 × 16,2	50.8 cm²
27	$\sqrt{15.85 \times (15.85-2) \times (15.85-14.7) \times (15.85-}$	16.6 cm²
28	$\sqrt{3.1 \times (3.1-1) \times (3.1-2.4) \times (3.1-2.8)}$	1.3 cm²
29	$\frac{\sqrt{3}}{4}(5.)^2$	10.8 cm²
30	5 cm × 1 cm	5 cm²
31	$\frac{1}{2} \times 1 \times 27$	13.5 cm²
32	$\frac{1}{2} \times (4.5+2.6) \times 1.833$	6.5 cm²
33	$\frac{1}{2} \times 2{,}6 \times (3{,}5+4)$	9.7cm²
34	9 × 7	63cm²
35	$\frac{1}{2} \times 2 \times 2$	2cm²
36	$\frac{1}{2} \times 3 \times 13$	19.5cm²
37	$\frac{1}{2} \times 1 \times (7{,}6+9{,}8)$	9.7cm²
38	$\frac{1}{2} \times 1 \times (9.5+9.6)$	9.5cm²
39	$\frac{1}{2} \times 3.5 \times 6$	10.5cm²
40	$\frac{1}{2} \times 1.2 \times 7$	4.2cm²
41	$\frac{1}{2} \times 4 \times 14$	28cm²
42	$\frac{1}{2} \times 1.3 \times (6+9.7)$	10.2cm²
43	$\frac{1}{2} \times 1.3 \times (9.6+9.4)$	12.3cm²
44	$\frac{1}{2} \times 3.4 \times 5.6$	9.5cm²
45	$\frac{1}{2} \times 1.4 \times 10$	7cm²
46	$\frac{1}{2} \times 2 \times 2$	2cm²
47	$\frac{1}{2} \times 1.5 \times 9$	6.7cm²
48	$\frac{1}{2} \times 31 \times 0.5$	7.7cm²
	Total	825.4cm²

Data Source: Personal Documentation, 2023

Table 2 is the result of the remaining fabric area from the zero-waste fashion pattern, which has an area totaling 825.4 cm². The fabric area measures 120cm × 125cm = 15,000cm². The obtained values of fabric area and waste area are then input into the formula, which is:

$$\frac{825.4}{15{,}000} \times 100 = 5.5\%$$

Figure 4. Result of Prototype Men's Shirt in Zero Waste Fashion

From this data, the waste result of the zero-waste fashion pattern is obtained at 5.5%. Therefore, it can be proven that the zero-waste fashion method can minimize fabric waste below 15%. Since 2008, the textile and fashion industry has implemented the zero-waste concept as a solution. This approach focuses on optimizing the nature and availability of materials, resulting in less than 15% pre-production waste during the garment manufacturing process (Nursari & Djamal, 2019). Figure 4 shows the prototype result of the zero-waste pattern using calico fabric to assess the garment's suitability when worn.

Calculating fabric waste manually using mathematical formulas can result in accurate calculations but may take a bit longer. In contrast, calculating fabric waste using a grid system only requires counting the boxes on the unused fabric. In the grid system, it is necessary to determine the box ratio to ascertain the size of each box. Here is an example of calculating fabric waste using the grid system as shown in Figure 5.

Figure 5 shows the zero-waste fashion pattern for a men's shirt using a grid system. It has a fabric width of 120cm × 125cm, with each grid measuring 5cm × 5cm. Thus, the total number of grids on one fabric is 600. Afterward, counting the number of grids from the remaining fabric, which amounts to 33 grids, will determine the waste. Therefore, the waste formula using the grid system is:

$$\frac{Total\ Number\ of\ waste\ grids}{Total\ number\ of\ grids} \times 100 = Waste\ (\%)$$

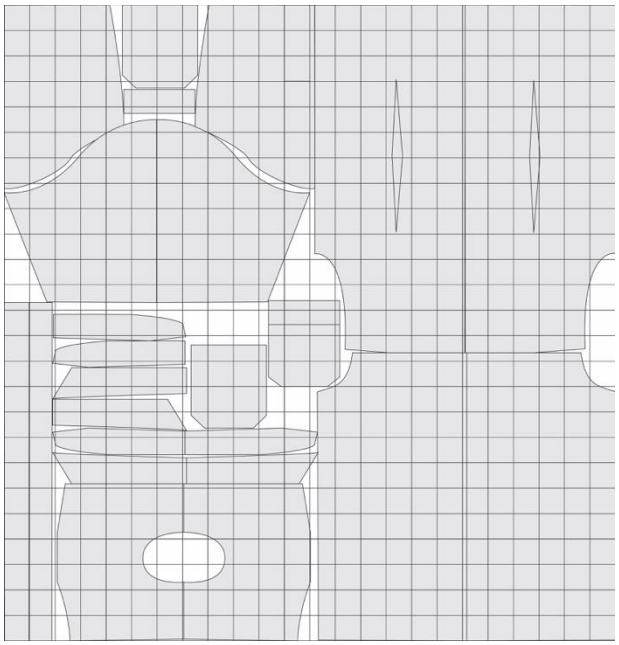

Figure 5. Zero Waste Fashion Men's Shirt Pattern using a Grid

When the number of grids from the remaining fabric and the total number of grids are determined, they can be input into the waste formula:

$$\frac{33}{600} \times 100 = 5.5\ (\%)$$

The result obtained from the zero-waste fashion pattern using the grid system is 5.5%. Calculating waste using the grid system can be considered very practical and fast, but the data generated is not as accurate as using the manual system.

3.4. Comparison of Zero Waste Fashion and Conventional Methods

In the fashion industry, conventional patterns are the commonly used and established standard for clothing design and production processes. The primary tool in conventional fashion design is sketching (Rissanen, 2013). Because in conventional design, the efficiency of material usage is not a highly prioritized aspect or is more flexible. The achievement of the conventional design process is focused on appearance or visual aspects. Zero-waste fashion design can be defined as 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 (Rissanen & McQuillan, 2016). However, many people are still unfamiliar with zero-waste fashion, unlike conventional patterns commonly used in the fashion industry. Therefore, there is a need for a comparison between zero-waste fashion and conventional methods to make it more widely known and potentially become a new approach in the fashion industry.

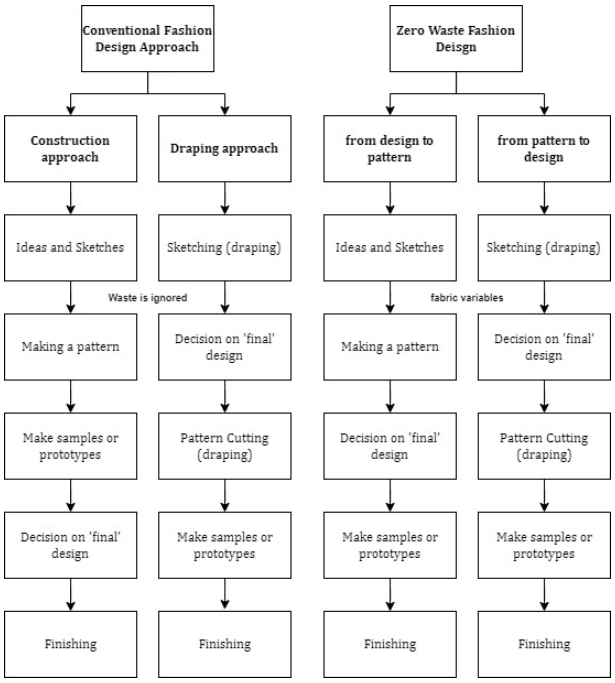

Figure 6. Comparison of Conventional and Zero Waste Fashion Methods (Personal Documentation)

The result of Figure 6 shows two approaches to conventional fashion design methods, namely construction and draping. This conventional design process is an adaptation from Timo Rissanen and Holly McQuillan (2016), Widjiningsih & Khayati (1994), and the previous research method by Putri S (2022). Construction Pattern is a pattern created based on measurements of body parts calculated mathematically and drawn on paper to illustrate the front and back of the body, skirt, sleeves, collar, and so on (Widjiningsih & Khayati, 1994). The construction technique creates a fashion pattern based on an individual's body measurements. In contrast, draping involves creating a fashion pattern directly on a human body replica (dummy, dress form, mannequin). Both approaches have become common methods used in the fashion industry. However, both approaches prioritize visual aspects and often result in unused fabric scraps, leading to significant waste and ultimately having a negative impact on the environment.

Additionally, Zero-Waste Fashion Design requires thinking beyond conventional methods by creating garments without waste, considering key design elements including aesthetics, fit, cost, manufacturability, and creating appealing clothing for both the industry and consumers (Rissanen & McQuillan, 2016). The Zero-Waste Pattern Cutting process is an adaptation of previous work by Timo Rissanen, Holly McQuillan, Julian Roberts, and earlier research (Lei & Li, 2021). In the realm of fashion design, there are two approaches employed to attain zero waste. One of these is the 'From pattern to design' technique, which entails crafting clothing styles derived from pre-existing zero waste patterns. Conversely, designers employing the 'From design to pattern' approach seek innovative ways to generate desired fashion designs in alignment with zero waste principles. In this method of zero-waste fashion design, the initial phase involves conceptualizing ideas and creating sketches. This approach determines the style first; then, the garment pattern is transformed into a zero-waste form. Assembling ready-to-wear garment pattern pieces into a rectangular shape presents difficulties. Nevertheless, dissecting the pattern into smaller pieces enhances the theoretical probability of achieving a rectangular form. Therefore, the fundamental principle is to improve intelligent cutting in the basic pattern (Lei & Li, 2021). Zero waste techniques within the 'From design to pattern' approach include methods like jigsaw and the Holly McQuillan technique.

The method of zero waste pattern cutting 'From pattern to design' involves an innovative approach to minimizing textile waste and creating garments with high fabric usage efficiency. The initial phase of the procedure entails manipulating a rectangular fabric piece, either through minimal cutting or by cutting along a striped shape that seamlessly repeats one or more interconnected patterns. In this systematic approach directed towards zero waste, clothing is subsequently designed to make full use of the entire fabric piece (Lei & Li, 2021). The zero-waste fashion method in this strategy, such as subtraction cutting, was innovated by Julian Roberts (2008), a designer who devised a technique centered on manipulating negative space in clothing, allowing the human body to pass through various openings in the fabric. While this technique aids in generating unforeseen and imaginative silhouette concepts and accomplishes zero waste through uncomplicated stitching, the resulting garments might not be highly practical for daily use. The geometric cut technique utilizes a design-from-pattern approach, relying on the use of geometric shapes like squares, triangles, and circles. This method has historical influences, as seen in designs such as the kimono (Niinimäki, 2013). Additionally, in the 'from pattern to design' approach, an alternative zero-waste pattern cutting technique is the modular and tessellated method. In a study conducted by McQuillan (2011), The procedure entailed iteratively applying and assessing a pattern shape on a fabric piece. Afterward, the fabric was cut following the pattern shape and then reassembled to construct a three-dimensional garment.

From the comparison results, it can be observed that the design processes of conventional patterns and zero-waste fashion have slightly different stages. In the conventional design process, the consideration of fabric scraps or waste is neglected. Meanwhile, starting from the initial stage of determining the idea or pattern, the zero-waste fashion design process already considers waste and utilizes fabric variables for efficiency. Achieving zero-waste fashion design requires comprehensive expertise and skills that include pattern making, draping, design, and garment construction. Therefore, in zero waste fashion, any

construction change that becomes one piece will affect the others (ElShishtawy et al., 2022).

In addition to the environmental impact, the Zero Waste Fashion pattern method also has relevant social implications. By pushing innovation in design and creativity in creating environmentally friendly solutions, this method opens opportunities for designers and workers in the fashion industry to develop new skills. The role of a fashion designer is pivotal in determining both the materials and designs for each garment in a collection. In addition to possessing a keen sense of style and taste, designers must also comprehend the intricacies of pattern-making and sewing processes (Nursari & Djamal, 2019). This can create jobs and training opportunities in the production of more sustainable clothing. In contrast, conventional pattern methods often focus more on following fashion trends and producing clothes according to rapidly changing market demands. This situation can exert pressure on production employees to fulfill stringent production goals, potentially resulting in social problems like inadequate salaries, extended working hours, and unfavorable working conditions.

From the research above, it is evident that the Zero Waste Fashion method has significant potential for ensuring sustainability in the fashion industry. The rapidly changing market demands and fashion trends often result in a high turnover of clothing, leading to increased waste and environmental degradation. By adopting zero-waste techniques, designers can create garments that maximize fabric use and minimize waste. This approach not only addresses environmental concerns but also aligns with the growing consumer demand for sustainable and eco-friendly products. Implementing Zero Waste Fashion requires designers to rethink their processes, from the initial concept to the final product, ensuring that every piece of fabric is utilized effectively. This method can also foster innovation and creativity, as designers explore new ways to achieve zero waste in their designs. Furthermore, by promoting sustainable practices, the fashion industry can contribute to a more sustainable future, reducing its ecological footprint and setting a positive example for other industries to follow.

4. CONCLUSION

The conclusion of this research is that the fashion industry has two methodological approaches: conventional patterns and zero-waste fashion patterns. These two methods have different impacts on the fashion industry, both in terms of industry practices and the environment. In conventional patterns, fabric remnants are disregarded and often discarded. In contrast, zero-waste fashion patterns carefully consider fabric usage to minimize fabric waste to less than 15%. However, this method is not widely known among many people. Therefore, a comparison was made to understand both methods' design, production, and comparison processes. The results showed that these two patterns have different stages. Conventional patterns involve two design approaches: construction and draping. The waste from both approaches is often overlooked. On the other hand, zero waste patterns also have two approaches: 'from design to pattern' and 'from pattern to design.' To calculate fabric waste in the zero-waste fashion method, both manual mathematical formulas and grid systems can be used, depending on the needs.

The Zero Waste Fashion pattern method, which focuses on efficient material usage and textile waste reduction, has great potential for creating more sustainable clothing. This involves reducing textile waste, lower resource consumption, and using sustainable materials. Additionally, this method encourages innovation in environmentally friendly clothing design and manufacturing.

In the effort to achieve sustainability in the fashion industry, the Zero-Waste pattern cutting method emerges as a more sustainable alternative, with positive impacts on the environment and more significant potential for social development. However, this change may require a shift in industry culture, investment in training and technology, and increased awareness of sustainability's importance throughout the fashion supply chain. Zero-waste fashion indeed has the advantage of reducing fabric waste. However, this method has a time limitation, namely its process that cannot be instant because it involves more complex design and production to ensure efficient use of materials. Therefore, with the increasing understanding of zero-waste fashion patterns, it is hoped that the fashion industry can undergo a positive transformation towards more sustainable practices overall.

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