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# Exploring potential of zero waste fashion design in fashion industry: a case study in men's shirt

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**Abstract.** The background of this research investigates the application of Zero Waste Fashion Design (ZWFD) in the men's shirt industry, aiming to minimize textile waste and enhance sustainability. Using a qualitative methodology, the study conducts in-depth interviews with fashion designers and directly observes the design and production processes, focusing on the case study of Men's Shirts. Three emerging designers experiment with ZWFD techniques, resulting in successful explorations that produce textile waste well below 15%. Despite methodological variations, all efforts meet ZWFD criteria, demonstrating the efficacy of ZWFD in waste reduction and the creation of unique garment designs. The results of this study underscore the potential of ZWFD in men's shirt production and advocate for its broader adoption in the fashion sector to promote environmental and social sustainability. The conclusion is that to maximize the impact of ZWFD, further understanding of techniques and strategies for mass production implementation is crucial for reducing textile waste and advancing sustainable product development. Recommendations for future research and implications for industry practice are discussed, emphasizing the importance of sustainable fashion initiatives in addressing environmental challenges.

**Keywords** : Fashion, Men's Shirts, Patterns, Zero Waste, Design

## Introduction

Fashion has indirectly played a significant role in the economic advancement of Indonesia, particularly in the creative industry sector (Hidayati et al., 2024). The fashion industry in Indonesia has been rapidly growing. Fashion enthusiasts warmly embrace various models and styles of clothing that continue to emerge. One such example is men's clothing, which men use to cover their bodies, whether directly touching the skin or not. An example of this is men's shirts, which are often worn in various situations, including everyday wear, formal occasions, and leisure. Shirts are garments that have always been present throughout time and continuously serve as timeless fashion trends (H Shahsmitha, 2016). Shirts themselves have various parts that can be varied for the shirt model, including the collar, sleeves, pockets, cuffs, yoke, and pleats. Shirts are one of the types of clothing commonly used by men (H Shahsmitha, 2016). Therefore, men's shirts, as one of the most iconic products in the fashion industry, are the focus of this study due to their significant potential environmental impact. Waste from the fashion industry, including men's shirts, has drawn attention due to its adverse environmental effects (Pristiandaru, 2023). Addressing this issue by implementing the Zero-Waste Fashion Design (ZWFD) method for this type of clothing has the potential to reduce textile waste and produce more sustainable products. ZWFD serves as inspiration for several designers in designing men's shirts using the ZWFD technique.

Essentially, the theory of ZWFD explores ways to design fashion products by minimizing material wastage and reducing the amount of waste generated during the production process. In this study, the ZWFD technique developed by Timo Rissanen and Holly McQuillan serves as two approaches to developing Zero Waste men's shirt fashion. This approach aims to ensure that no textile waste is generated throughout the entire garment design and production process, to reduce the fashion industry's negative environmental impact and promote changes in clothing production cycles. An important step in realizing Zero-Waste Fashion Design is involving fashion designers in a more sustainable design process. Timo Rissanen (2013) revealed that the percentage of fabric discarded during the cutting process often exceeds 15% in each production. In the design process, Timo Rissanen's ZWFD technique follows a different design flow compared to Holly McQuillan's ZWFD technique. In Timo Rissanen's technique, the ZWFD design process starts with two things: the human body and the fabric. He believes that fashion design is about exploring the potential relationships between them (Rissanen, 2013). On the other hand, Holly McQuillan's design process starts with sketches, conventional pattern development, geometric approaches, or fabric dimensional approaches. However, in fashion design using ZWFD techniques (both Timo Rissanen's and Holly McQuillan's techniques), there are different workflows, thus making the ZWFD design process not yet effective for mass production implementation. Therefore, it's necessary to understand the potential of both techniques when applied to the fashion industry and the strengths and weaknesses of each technique. These methods have time limitations; the process cannot be instantaneous as it involves more complex design and production to ensure efficient material usage. There's a need for a strategy to implement ZWFD in mass production through exploration activities involving several designers, with a case study of the Prepp Studio brand.

The continuous growth of the fashion industry has led to the emergence of many fashion brands in Indonesia (Fajar & Saraswati, 2023). One of these brands is Prepp Studio, a fashion company that will take steps to implement the principles of Zero-Waste Fashion Design in their production of men's shirts. Prepp Studio is one of the local fashion brands offering fashion products suitable for everyday activities. Their clothing is characterized by basic and simple yet not dull styles (Prepp Studio, 2020). In this context, Prepp, which emphasizes classic style and high quality, serves as a focal point for implementing ZWFD techniques. The main objective of exploring ZWFD theory in the men's shirt industry is to achieve a more sustainable and efficient production process, with Prepp Studio as the starting point for reflection. By understanding and applying ZWFD principles, it is hoped that textile waste can be reduced, material usage optimized, and innovation stimulated in clothing design. Therefore, this research will identify the potential and challenges in implementing ZWFD in the fashion industry with the ultimate goal of creating a more environmentally friendly production environment and encouraging more environmentally friendly methods of clothing production overall.

This research aims to evaluate the implementation of Zero-Waste Fashion Design (ZWFD) in the men's shirt industry and its impact on the production environment. The research method employed is a qualitative approach through interviews with fashion designers and direct observation of the design and production processes. A case study is conducted at Prepp Studio, collecting data related to material efficiency and environmental impact. The case study analysis will assess the effectiveness of ZWFD in reducing textile waste, optimizing materials, and the environmental impact on men's shirt production. The research findings will identify the potential and advantages of ZWFD techniques by Timo Rissanen and Holly McQuillan and provide recommendations to enhance the effectiveness of ZWFD implementation in the fashion industry. This research is limited to the men's shirt industry and the ZWFD techniques by Timo Rissanen and Holly McQuillan. The research conclusions will be presented in a report detailing the findings and implications of ZWFD implementation in the men's shirt industry, with the hope of promoting the development of more environmentally friendly clothing production.

## Methods

This research method adopts a qualitative approach through in-depth interviews with fashion designers and direct observation of the design and production processes. The study will focus on a case study approach to men's shirts to gather additional data on the performance of ZWFD in these products. Additional data collected will include the efficiency of material usage and the environmental impact of implementing ZWFD in men's shirt production. Findings from the research will be used to identify the potential and advantages of the ZWFD technique developed by Timo Rissanen and Holly McQuillan. Additionally, the research will provide recommendations for enhancing the implementation of ZWFD in the fashion industry, including training, collaboration, and further development in the field of ZWFD, as well as adopting a case study approach focused on men's shirts to investigate the application of ZWFD principles. The aim of this research is to gain a deep understanding of how ZWFD principles are applied in the men's shirt industry and to evaluate their effectiveness. The limitation of this research lies in its focus on the men's shirt industry and the ZWFD technique developed by Timo Rissanen and Holly McQuillan.

### Timo Rissanen`s Techniques

Timo Rissanen, a designer, artist, and professor from Finland, currently teaching at the University of Technology, Sydney (UTS) in Australia, employs the ZWFD approach in pattern making. This approach involves pattern sketching and draping as initial steps in his process. Rissanen integrates pattern cutting and draping, as well as incorporating pattern sketching and garment layout as part of his design process. His techniques can be seen in figure 1 below


**Fig 1.** Zero waste fashion design techniques by Timo Rissanen

Essentially, Rissanen's design process lacks specific guidelines but rather focuses on the placement of geometric shapes on patterns and utilizing the remaining space to create garment designs and details. In Timo Rissanen's pattern design technique, design variations depend on how the initial pieces are placed on the fabric width and which ones are chosen to design from the resulting leftover shapes. Further variations are achieved by using basic pattern shapes on two different fabric widths. Varying fabric widths necessitate new placements for basic pattern shapes, creating new leftover areas for designing garment details (Rissanen, 2013).

### Holly McQuillan`s Techniques

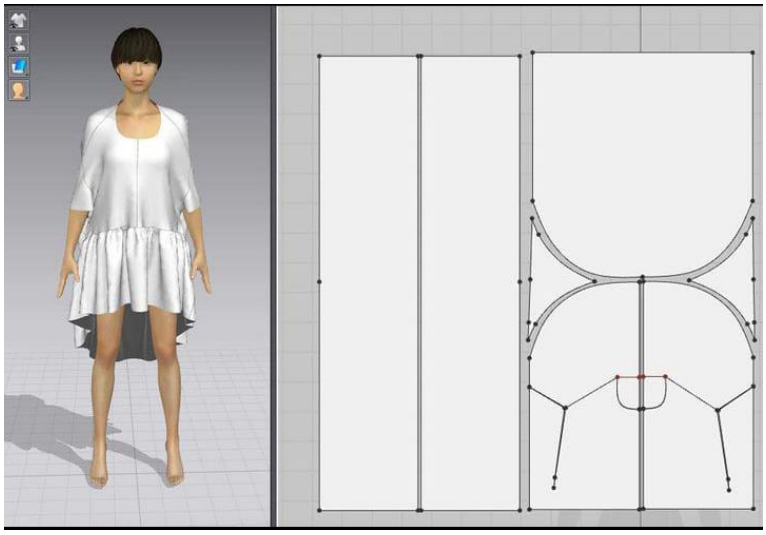


**Fig 2.** Zero waste fashion design techniques by Holly McQuillan

The pattern design technique using Holly McQuillan's method is almost similar to Timo Rissanen's technique, but the difference lies in the pattern creation process. In Holly McQuillan's technique, the zero waste pattern creation starts from a conventional pattern, which is then developed and modified until it becomes a zero waste pattern. As seen in the figure 2 above, McQuillan creates her zero waste pattern using a conventional pattern approach, as evidenced in the torso pattern section above. McQuillan's ZWFD pattern design also involves the development of fields emerging from waste-free garment designs, particularly through the development and articulation of new methods and perspectives for cutting and assembling.

## Result and Discussion

The rapid development of the fashion industry has had negative impacts on the environment and society, one of which is the suboptimal management of production waste (Arumsari, 2020). Waste refers to unused materials in production, which, when discarded, can contribute to environmental pollution (Tsaltsalbila et al., 2023). Waste from the fashion industry, including men's shirts, has drawn attention due to its adverse environmental impacts (Pristiandaru, 2023). One approach to address this issue is by implementing sustainable fashion practices, particularly through the adoption of zero-waste patterns. Implementing zero-waste patterns in the production of men's shirts holds great potential for reducing the amount of waste generated during the manufacturing processes. By employing the Zero Waste Fashion Design (ZWFD) approach, producers of men's shirts can minimize material waste, utilize fabric scraps optimally, and mitigate the environmental impacts of the fashion industry as a whole. Thus, the implementation of zero-waste patterns can serve as a solution to reducing the environmental impact of the fashion industry while also opening opportunities to create more environmentally friendly fashion products with distinctive design lines.

### Men's Shirt

Shirts are one of the upper garments for men (Purmatasari, 2021). The definition of a shirt is an outer garment worn by men on the upper body and has openings at the front, sleeves, collar, with or without a collar stand, each with certain measurements (Setyorini, 2005). Shirts have essential elements such as collar, opening, placket, yoke, sleeves, cuffs, and pockets. Shirts are one of the commonly used types of clothing for men as everyday attire; both patterned and

plain shirts with various colors. Therefore, the production of men's shirts continues to increase annually. Conventional men's shirt production generates a large amount of waste, more than 15%, and this waste is not recycled (Eria & Nursari, 2020). Hence, there is an opportunity to utilize the ZWFD method in men's shirt production. The types of shirts include:

1. Camp shirt:
   a simple short-sleeved shirt or blouse with front pockets and a side collar. This shirt is usually chosen to look neat but not stiff or semi-formal.
2. Dress shirt:
   a shirt with a formal (slightly stiff) collar, typically with a full opening from the collar to the bottom and buttoned, having sleeves with cuffs. This is the type of shirt used for formal events.
3. Inner shirt:
   a shirt specifically designed to be worn with men's evening wear, such as a black tie or white tie.
4. Winchester shirt:
   a shirt with striped or colored patterns but with white collar and cuffs variations. This shirt is commonly worn by office workers as it appears neat yet dynamic.
5. Guayabea:
   a shirt with embroidery or embroidery and four pockets. This model is commonly used by male Muslim clothing makers, commonly known as "baju koko," but the difference is that "baju koko" does not have a folded collar.
6. Poet shirt:
   a shirt with a loose body or blouse with full bishop sleeves, usually with excess or additional fabric at the front and cuffs.
7. Polo shirt:
   a very popular type of shirt used by young people. This clothing can give a casual and trendy impression with more comfortable and sweat-absorbent materials.
8. Sleeveless shirt:
   a shirt without sleeves or commonly known as a tank top.

## Zero Waste Fashion Design

Zero-waste fashion focuses on minimizing textile waste or fabric remnants generated during garment production at the cutting stage (Nursari, 2019). This technique is a method of pattern-making aimed at producing clothing with less than 15% waste. The application of ZWFD patterns is similar to conventional patterns and can be applied to all types of garments (Putri, 2022). Designing ZWFD garments involves a departure from conventional design approaches, as in zero waste design, any changes in one construction affect other parts (Carrico & Kim, 2014). In designing ZWFD, designers must consider several criteria that define the boundaries or scope of their design process. A fashion designer plays a crucial role in determining the materials and designs of each garment in a collection. In addition to having good taste and style preferences, designers must also understand pattern-making and sewing processes (Nursari, 2019). According to Timo Rissanen & McQuillan (2016), five main criteria must be considered in ZWFD design: appearance, fit, cost, sustainability, and manufacturability. In designing ZWFD, aesthetic design, and comfort should not be overlooked, and there should be no unnecessary increase in costs due to complex production processes. Timo Rissanen also suggests that during the zero-waste clothing design process, several considerations must be overseen by a designer, such as garment type, fabric width, fabric type, silhouette, fixed areas, specific features, construction and finishing, and pattern pieces. Utilizing waste as reusable materials can help reduce environmental pollution (Anindita et al., 2017). Moreover, ZWFD designs must also be sustainable in terms of the amount of waste generated, physical durability, visual durability,

fibers used, and it must be ensured that the design can be reproduced (Rissanen & McQuillan, 2016).

## Exploration

In the exploration of men's shirts using the ZWFD technique by three novice designers, there is a significant effort to apply the principles of Zero Waste Fashion Design (ZWFD) in the fashion industry. Table 1 presents the processes of three different explorations, aimed at reducing textile waste and introducing more sustainable practices in the production of men's shirts. Through the combination of ZWFD techniques from Timo Rissanen and Holly McQuillan, the designers have developed an innovative approach to shirt design, focusing on more efficient use of materials and minimizing production waste. The analysis of these explorations provides valuable insights into the potential application of ZWFD in the broader fashion industry, as well as laying the groundwork for understanding and developing more environmentally friendly solutions in the production process of men's shirt garments. The basic structure of a shirt, namely the collar, front opening with a row of buttons, long/short sleeves, and cuffs (Yuningsih et al., 2020), serves as the focal point in this research to identify how each element can be optimized using ZWFD principles.

In this study, the calculation of fabric waste is conducted using the grid method. Calculating fabric waste with the grid system involves counting the squares on the unused fabric. In the grid system, a square ratio needs to be determined to ensure the size of each square. Therefore, the formula for calculating waste using the grid method is:

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

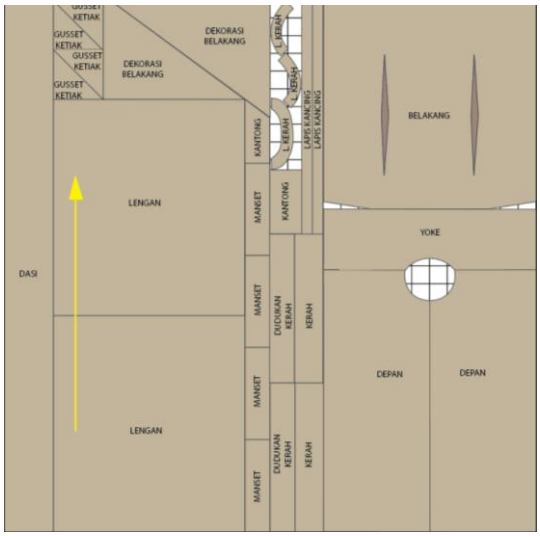


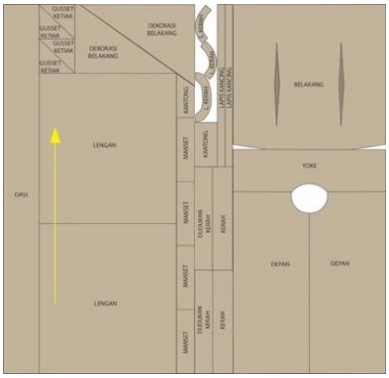
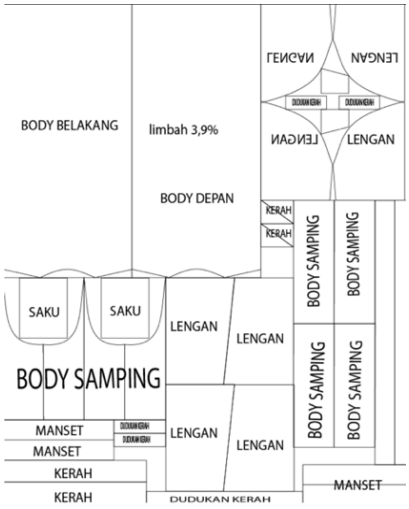
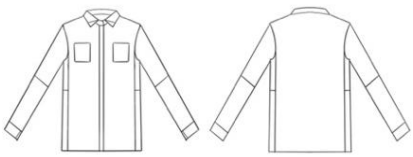

**Fig 3.** Example of Waste Calculation using a grid system

Figure 3 depicts the zero waste men's shirt fashion pattern using a grid system. It has a fabric width of 150cm × 150cm, with each grid measuring 5cm × 5cm. Therefore, the total number of grids on one fabric is 900. Next, the number of grids from the remaining fabric, which amounts to 17 grids, is calculated. Thus, when inserted into the formula:

$$\frac{17}{900}\ x\ 100 = 1{,}8\%$$

Then, the waste generated from the ZWFD pattern is 1.8%. In this exploration, designers will calculate waste using a grid system because it is easier and more practical than using manual calculation methods.

**Table 1.** ZWFD Men's Explorations

| No | Eksploration | ZWFD Technique | Waste | Design Process |
|---|---|---|---|---|
| 1. | **Designer 1**<br>Fabric size : 150cm x 150cm<br>  <br>  | Timo Rissanen | $\frac{17}{900}\ x\ 100 = 1{,}8\%$ | Idea – Pattern Exploration on fabric - Arrangement - Pattern - 2D Sketch – Prototype – Finishing |
| 2. | **Designer 2**<br>Fabric Size : 120cm x 150cm<br>  <br><br>  | Timo Rissanen | $\frac{28}{720}\ x\ 100 = 3{,}9\%$ | Understanding Timo Rissanen's Pattern and conventional pattern – Design Idea – Pattern Making – 3D Sketch - 2D Sketch - Prototype - Finishing |

| | | | | |
|---|---|---|---|---|
| 3. | **Designer 3**<br>Fabric Size : 125cm x 125cm | Holly McQuillan | $\frac{33}{600}\ x\ 100 = 5{,}5\%$ | Ideas and Sketches – Making a pattern – Decision on 'final' design – Prototype - Finishing |

Source : Personal Documentation, 2024

From Table 1, there are three explorations of men's shirts using the ZWFD technique by three novice designers. The design process of the first exploration begins with the idea of a zero-waste pattern garment, namely a kimono garment consisting of a few geometric lines with a non-fit-to-body visualization and fabric waste well below 15%. Meanwhile, the desired fashion sketch idea is a men's shirt with an old money style impression, prompting the addition of tie accessories within the zero-waste garment pattern. These ideas are then combined using Timo Rissanen's pattern technique, as the zero-waste patterns used are patterns formed by geometric lines. The pattern exploration is conducted on a 150cm x 150cm paper. In the exploration, several paper shapes are obtained to support other accessories in the form of triangular fabric pieces arranged on the shirt's yoke, exposing more of the back area of the shirt. After the zero-waste shirt pattern exploration, the fabric waste calculation is performed, resulting in 1.8% waste using the grid calculation technique. Then, it proceeds to the 2D shirt sketch stage to determine the shape of the shirt to be realized. Subsequently, an exploration in the form of a prototype is carried out on a 150cm x 150cm canvas, which is then sewn. The prototype result of a shirt with a kimono pattern idea and old money style shirt is successfully realized, where the garment pattern is complemented with a tie and other pattern accessories on the yoke to enhance the user's back visual.

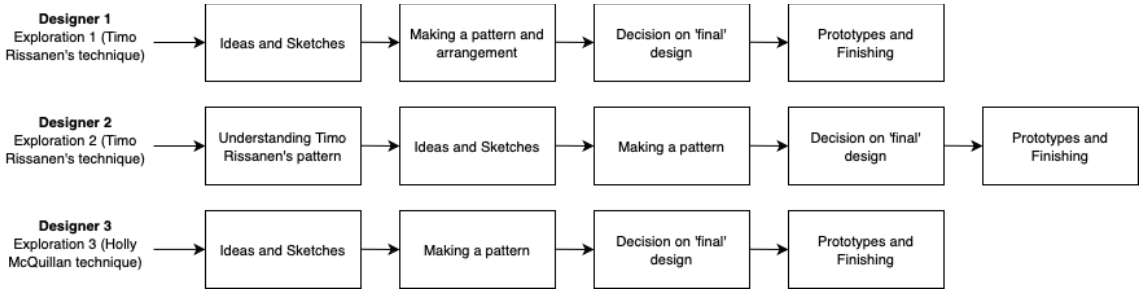



**Fig 4.** Results of the ZWFD design process stages from the three explorations

The design process of the second exploration employs the same ZWFD technique by Timo Rissanen as the first exploration, albeit with slight differences in the design process. In the second exploration, the designers begin the design process with the development stage of the shirt, which includes understanding both Timo Rissanen's patterns and conventional patterns as a foundation for the design ideas to be developed. Once this understanding is established, the next step is to create a shirt pattern that aligns with the planned concept. This process involves creating a 3D sketch to visualize the design in more detail, followed by the arrangement of 2D sketches, which serve as the basis for making the shirt pattern. During the pattern arrangement, fabric waste calculation of 3.9% is also performed. After the pattern is completed, the next stage is the creation of a shirt prototype based on the pattern that has been developed. Once the prototype-making process is finished, the final stage is finished.

In the third exploration, the design process utilizes the ZWFD technique by Holly McQuillan. The process begins with the stage of Ideas and Sketches, where initial ideas for the shirt design are planned and illustrated in the form of sketches. This step marks the starting point in expressing the desired design concept and vision. Once these ideas are formed, the next stage is Making a Pattern. The shirt pattern is created based on the selected sketches and designs. This process involves mathematical and technical calculations to produce accurate patterns that are in line with the specified measurements. The resulting waste is 5.5%, which falls below the 15% threshold. After the pattern is completed, a Decision on the 'final' Design is made, where the shirt design to be used as the final version is decided upon. This decision may involve considerations of aesthetics, functionality, and design practicality. The next step is Prototype Making, where the created pattern is applied to the actual fabric to create the first physical shirt. This process allows designers and manufacturers to evaluate the accuracy of the pattern, fabric selection, and the suitability of the design with the initial expectations. For all three explorations, the final stage is finishing, and the garments are worn to assess comfort and suitability when worn, ensuring that the developed design meets expectations and provides an optimal user experience.

Based on the descriptions of the three explorations, it is evident that men's shirts utilizing the Zero Waste Fashion Design technique have been successfully applied by novice designers with fairly good results according to ZWFD criteria, with fabric waste below 15%. Those three explorations can be seen in diagram on figure 4 above. Although each exploration has different approaches and techniques, the results show that the implementation of Zero Waste Fashion Design techniques is quite effective in reducing fabric waste. The first exploration demonstrates that by using geometric patterns from the ZWFD technique, designers managed to produce shirts with fabric waste below 15%, specifically 1.8%, which is quite efficient. The second exploration also succeeded in producing shirts with fabric waste amounting to 3.9%, by combining an understanding of Timo Rissanen's and conventional patterns. Meanwhile, the third exploration shows that by using Holly McQuillan's ZWFD technique, designers were able to create shirts with fabric waste of 5.5%. Although there are differences in the level of fabric waste among the three explorations, the results indicate that ZWFD techniques can be effectively applied in the fashion industry. With a deep understanding of these techniques, the fashion industry can utilize them to reduce textile waste and introduce more environmentally friendly practices in the clothing production process. Therefore, from these three explorations, it can be concluded that men's shirts with the ZWFD technique have the potential to be more widely implemented in the fashion industry.

To enhance the implementation of ZWFD in the fashion industry, several solutions and recommendations can be considered. Firstly, there is a need for broader training and education on ZWFD techniques for designers and manufacturers in the fashion industry. This can help improve understanding and awareness of the importance of environmentally friendly practices in the clothing design and production process. Additionally, collaboration among designers,

manufacturers, and other stakeholders can accelerate the adoption of ZWFD techniques in the fashion industry. With good cooperation, it will be easier to identify challenges and seek innovative solutions in implementing ZWFD. Furthermore, it is important to continue conducting research and further development in the field of ZWFD, including the exploration of alternative materials that are more environmentally friendly and the development of more efficient production technologies. By continuously developing and refining ZWFD techniques, it is hoped that the fashion industry can become more sustainable and make a more positive contribution to the environment and society.

## Conclusion

In conclusion, this study highlights the utilization of Zero Waste Fashion Design (ZWFD) in designing men's shirts as an effort to reduce textile waste and enhance the sustainability of the fashion industry. Through a qualitative approach involving interviews with fashion designers and direct observation of the design and production processes, this research evaluates the effectiveness of ZWFD in reducing textile waste, maximizing material usage, creating distinctive design lines, and assessing the environmental impact of men's shirt production. Out of three explorations conducted by novice designers using ZWFD techniques (Timo Rissanen and Holly McQuillan's techniques), the results indicate that the application of these techniques can produce shirts with significantly less fabric waste, below 15%. The findings of this research suggest that implementing ZWFD techniques in the men's shirt industry has great potential to reduce textile waste and promote environmental sustainability. This demonstrates that ZWFD is effective in optimizing material usage and generating unique garment designs.

The implications of these findings are that ZWFD techniques can be applied more widely in the fashion industry to mitigate the environmental impacts of garment production. With a deeper understanding of these techniques, designers and manufacturers can adopt them for mass production to create more sustainable products. The challenges faced during the research process, such as the time-consuming nature of exploring ZWFD patterns, underscore the complexity of shifting traditional paradigms in the fashion industry. Implementing ZWFD techniques requires a profound understanding of garment patterns and construction, as well as skills in efficiently utilizing space and leftover materials. Additionally, entrenched cultural norms and established production processes pose additional challenges. Overcoming these complexities requires researchers to be creative and persistent in finding solutions aligned with ZWFD principles while considering time and resource constraints.

Recommendations for future research and industry practices include broader training on ZWFD, collaboration between designers and manufacturers, and the development of more efficient and environmentally friendly production technologies. Thus, this research makes a significant contribution to promoting more sustainable and environmentally friendly fashion practices. Consequently, it can be concluded that men's shirts using ZWFD techniques have the potential for wider application in the fashion industry as a step towards environmental and social sustainability.

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