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Reducing Textile Waste Through Quality Control of Zero-Waste Pattern

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ABSTRACT

The fashion industry, evolving over the past 150 years, has become one of the largest contributors to the global economy. However, this rapid growth has also led to significant environmental challenges, particularly in the form of textile waste. The rise of fast fashion has accelerated production cycles and increased consumption, resulting in excessive waste generation and resource depletion. Although consumer awareness regarding sustainability has grown and encouraged recycling initiatives, many of these efforts remain insufficient to address the scale of the problem. This study aims to explore the application of zero-waste principles as a sustainable approach in fashion design and production. The zero-waste concept focuses on optimizing fabric utilization by minimizing or eliminating leftover materials during the pattern-making and cutting processes. Techniques such as flat pattern cutting and draping are emphasized as key strategies to achieve efficient fabric use. In addition, the integration of quality control throughout all stages of production—from material inspection to finishing—is essential to ensure product durability and reduce defects that may contribute to waste. Through a descriptive-analytical literature review, this research highlights the importance of combining zero-waste design techniques with effective quality control practices to support sustainable development in the fashion industry.

Keywords: quality control, textile waste, zero waste pattern

1. INTRODUCTION

Development of garment waste awareness in the fashion industry

Fashion industries have been around for more than 150 years, where historically fashion industries started from a small local business that turned into an industry. Through the years, the fashion industry has developed into a massive industry that can be found on every continent, and eventually, it became one of the largest economic contributors in the world (Nursari & Hervianti, 2018; Statista, 2022). Due to that title, garment production grew to become more than just basic needs, which pushes the fashion industry to make a massive production that overshadows the waste that one company could produce, and has eventually resulted in a global problem. Over the years of negligence, the topic of textile waste became a mainstream news topic all around the world in 2017 (Csulauniversitytimes, 2017). As the result, the fashion and textiles sector has been chastised by consumers as their awareness arises upon the realization that Fast

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or massive production Fashion has a huge negative environmental impact (e.g., waste generation, resource consumption, and carbon footprint) across its supply chain of operations (Beall, 2020; Niinimamp et al., 2020). The fashion industry reacted against consumer awareness by promising to recycle to placate buyers' consciousness. However, such statements are simply false pretenses as the output of the massive or fast fashion product exceeds what the fashion industry could recycle (Documentary, 2021).

In response to the growing criticism, various stakeholders within the fashion industry, including designers, manufacturers, and policymakers, have begun to reconsider conventional production systems and explore more sustainable alternatives. This shift is marked by the emergence of concepts such as circular fashion, slow fashion, and zero-waste design, which aim to reduce environmental impact from the early stages of production. Furthermore, increased transparency and accountability are being demanded across the supply chain, encouraging companies to adopt more responsible practices. Despite these efforts, the transition toward sustainability remains a significant challenge due to economic pressures, consumer behavior, and limitations in technology, highlighting the need for more innovative and practical solutions to effectively reduce textile waste.

The incapability of the fashion industry to decrease waste

Fashion companies became the largest material waste with their massive production, unsold products, and burned clothes. Although customers share some of the blame for the increase in waste in the fashion industry, at least they are slowly realizing the consequences of the massive production for their continuous purchase behavior that is used in the fashion industry. But it is also evident that the fashion industry hasn't done much to reduce waste across the value chain (Sonofatailor, 2019). Even Though there are some companies that have launched sustainability actions, such as reducing the amount of CO2 that has been released in the air during the footprint or sourcing recycled material, there were not many improvements during the coming years. Especially in the year 2000 when the amount of clothes or garment production has been doubled (Remy et al., 2016). Furthermore, numerous studies have revealed that recycling options are limited and that technology is falling behind (Ellen MacArthur Foundation, 2017). In the end, the majority of the fabric used in manufacturing ends up as used clothing as the last minority of textile fabric is lost throughout the value chain due to cut-outs, overproduction, and purchases without usage (Sonofatailor, 2019).

Zero waste as the new challenge for future designers

To handle the amount of textile, waste the fashion industry's practitioners and academics came up with a "zero waste" method where all the waste should be optimized during pattern making and cutting by minimizing it. The concept of zero waste also known by the acronym ZWDY has been widely known and studied in the realm of fashion by future designers who are interested in the concerns of waste pre-production and its impact on the environment (B The Change, 2022). In the eyes of future designers, zero

waste is an approach that believes wasted fabric is wasted money and a danger to the environment, and zero waste itself is a challenge for designers to view current design techniques from a more sustainable perspective. Namely flat pattern cutting and draping techniques (Greenorb, 2021; Nursari & Djamal, 2019). At many phases of the garment production process in factories, such as cutting, stitching, and so on, a large amount of textile waste is generated. Understanding these processes will aid in the elimination of waste-producing activities during the design stage, saving a major percentage of textiles from becoming unusable garbage (Fibre2Fashion, 2020).

2. RESEARCH METHODS

This research is a descriptive-analytical literature review. The purpose of this study is to identify, evaluate, and synthesize relevant scientific literature on production waste management systems and the application of zero waste principles in the fashion industry, especially in the ready-to-wear product line.

This study applies a qualitative approach through a systematic literature review to obtain comprehensive insights into the implementation of zero-waste concepts and quality control in garment production. The data used in this research are secondary data derived from scientific journals, books, industry reports, and credible online sources. The selection of literature focuses on publications discussing textile waste, sustainable fashion, zero-waste pattern cutting, and quality control systems. This approach allows the researcher to understand patterns, relationships, and gaps within existing studies while ensuring that the data collected is relevant and up to date (Ellen MacArthur Foundation, 2017; T. I. Rissanen, 2013).

The process of data collection was conducted through several stages, including keyword identification, database searching, and literature screening. Keywords such as "textile waste," "zero waste fashion," "pattern cutting," and "quality control in garment industry" were used to gather relevant sources from academic databases and publications. The collected literature was then filtered based on inclusion criteria such as relevance to the research topic, publication credibility, and recency. Articles that did not directly address the relationship between waste management and design or production processes were excluded. This systematic filtering process ensures the reliability and validity of the selected references (Commonobjective, 2019; Niinimamp et al., 2020).

Furthermore, the data analysis technique used in this study is descriptive-analytical, where the selected literature is examined, compared, and interpreted to identify key themes and findings. The analysis focuses on understanding how zero-waste techniques are applied in fashion design, how quality control contributes to reducing textile waste, and how both aspects can be integrated effectively. The findings from different sources are then synthesized to build a comprehensive understanding of sustainable practices within the fashion industry. This method also allows the researcher to highlight similarities and differences among previous studies (Beall, 2020; Nursari & Hervianti, 2018).

To ensure the credibility of the research, triangulation of sources is applied by comparing findings from multiple types of literature, including academic research, industry practices, and institutional reports. This method helps minimize bias and strengthens the validity of the conclusions drawn. In addition, the study emphasizes transparency in the selection and analysis process, allowing the research to be replicable and academically accountable. By combining systematic literature review techniques with analytical interpretation, this research provides a structured and reliable foundation for understanding the role of zero-waste design and quality control in reducing textile waste (Fibre2Fashion, 2020; Sonofatailor, 2019).

3. RESULTS AND DISCUSSION

Fashion Industry Zero Waste Concept and Technique Implementation as a method that is initiated by small one-off companies, zero waste has gained momentum acceleration within the fashion industry (Aishwariya, 2018). To implement zero waste, there are several techniques that can be experimented with by adding dimensions to the fabric. Traditionally, the designing process of a designer will be kept with their edges systematically discarded because of the difference between middle and the tighter weaves. On the other hand, designers can incorporate the selvages into the clothes as a zero-waste technique by keeping sustainability in mind designers often add a 1,5-2,5 cm margin range in conventional garments along with an occasional reduction up to 0,7 cm. Which could result in the fray in the seam after one or both washes, indicating that the garment has lost its sewing value after only a few years of use. Especially when the limited or small seeing value has also made retouching and repairing process the garment more difficult. The stitching value of a zero-waste design is increased, ensuring that the entire fabric surface is covered and the garment is sturdy and flexible (EPA, 2020; Greenorb, 2021).

One of the most unique techniques apart from flat pattern and draping is the origami technique (Aplat, 2022). The origami technique is particularly unique in that it encourages fabric folding rather than cutting. This is where the designer should think through the awareness and recyclability of all materials that are utilized in the garment, as well as clarity on the manufacturing process, in order to eliminate any waste-producing processes through folds. Since the concept of zero waste also known by the acronym ZWDY has been widely known and studied in the realm of fashion. Zero waste Techniques can be found in traditional clothes. For example, the saree incorporates the best zero waste garment that is embellished with a variety of yarns. Similarly, other examples for zero waste technique are none other than the traditional clothes in Japan, Kimono. Where Kimonos are made by sewing rectangular pattern pieces together which leaves no fabric remaining. Other examples would be garments such as Chitons, Kalasiris, Shenyi and Hanbok are some of the most efficient use fabrics on garment silhouette (Fibre2Fashion, 2020).

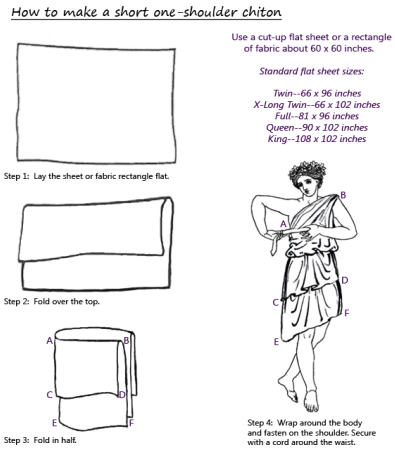


Figure 1. Example of zero waste chiton garment
Source: (Favpng.com, 2022b)

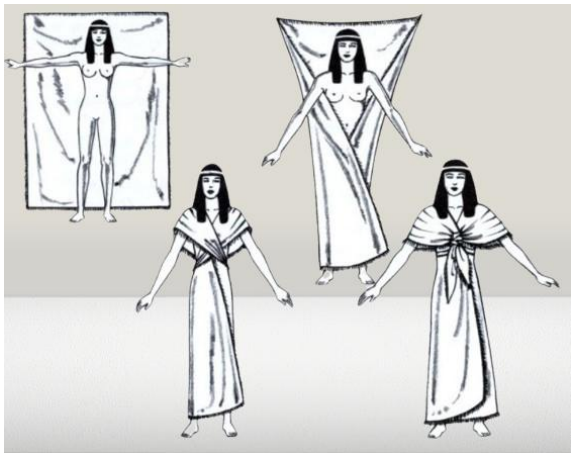


Figure 2. Example of zero waste kalasiris garment
Source: (Favpng.com, 2022a)

Considerations of textile characteristics with the zero waste garment designs

As a designer, there are a few considerations that have to be taken upon when processing the design of a zero-waste garment. For starters, the garment type. The type of garment will affect its fundamental shape with the influence that is based on how designers execute the zero-waste concept by changing the basic garment's visual appeal appearance. After deciding the type of fabric, the designer must consider the fabric width where in most cases, the length of the fabric will be influenced by how the designer or pattern maker decides on how to implement it. Next is by deciding on a fabric type. The designer or pattern maker should be aware of the fabric's characteristics and how they will affect the garment's visual appearance which will affect the silhouette of the design but still manage to maintain an appropriate block that could be utilized for high efficiency of the zero-waste pattern. After considering the silhouette of the design, the pattern maker determines the number of fixed areas in the pattern plot that are not being complicated during.



Figure 3. Creative Pattern Cutting
Source: (Iszoro, 2016)

Draping method for zero waste garment in fashion industry

The Draping method is used by designers as a practice of placing the fabric on a human form and adjusting it to create a specific shape. Because of gravity and fabric characteristics, humans are unable to control the drape, flow, and fall of the fabric, the outcome is frequently unclear (Nursari & Djamal, 2019). In general, this method begins with a calico fabric draped on the mannequin or body and then progresses to a constructive pattern / flat pattern when the outcome of draping is translated to pattern paper. Models can be replaced with dress forms or sewing dolls of the same size or close to the model size to simplify the manufacturing procedure patterns, models can be replaced with dress forms or sewing dolls of the same size or close to the model size to simplify the manufacturing procedure patterns, models can be replaced with dress forms or sewing dolls of the same size or close to the model size to simplify the manufacturing procedure patterns, models can be replaced with dress forms or sewing dolls of the same size or close to. However, this method is only considered in a small amount of production in the fashion industry due to the amount of human power that needs to be involved (Nursari & Hervianti, 2018).

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In other words, find a flexible area where the designer or pattern maker can manipulate or cut the fabric with ease. Due to the fabric characteristics, the designer or pattern maker must take notice upon which specific features or detail would suit the garment well based on constructions and finishing that has been determined. Details on closure and other supporting details will need further consideration in order to comply with the zero-waste concept of a design. Lastly that a designer has to look into consideration is the pieces of the pattern that will be developed in a design mechanism for documenting pattern parts in order to ensure the design process's long-term viability so the creator's product could be valued more (Beall, 2020; T. I. Rissanen, 2013)

Pattern cutting method for zero waste garment in fashion industry

The flat pattern-cutting technique involves ensuring that all the pattern pieces of a garment are fitted together like a giant jigsaw puzzle so there is no wastage between the pattern pieces that could be implemented in Fashion Industries, as in traditional lay plans (Commonobjective, 2019). Designers mostly use Creative pattern cutting as a method of putting the zero-waste fashion design principle into practice when making a garment. Instead of the conventional process, creative pattern cutting strives for flexibility as a method that allows the designer or pattern maker to alter, manipulate, or combine the basic principles of pattern making method, additional fullness, and dart manipulation (T. Rissanen & McQuillan, 2020). Other than that, designers can also use a flat pattern cutting method, draping, or a combination of the two techniques, which is also the drawing process (T. I. Rissanen, 2013).



Figure 4. Example of draping zero waste
Source: (Ewstfashionlab, 2022)

The application of quality control in the fashion industry

Quality control refers to the process of evaluating the quality of all products in a given industry. It refers to methods for assuring a service or product's quality. Actually, quality control is a strategy for ensuring and maintaining a desired level of quality in an existing product or service by careful planning, the use of appropriate equipment, ongoing inspection, and, if necessary, corrective action (Chain, 2020). However, Quality control (QC) itself is also defined as all attempts to ensure that the implementation outcomes are in accordance with the plan that has been decided and satisfies consumers or customers especially in the context of zero waste where its goal is to prevent non-conforming items from occurring with the desired quality standard or second quality on a continual basis, and to be able to monitor, choose, and analyze quality in order to keep customers bear the product longer.

Quality control is not only required at the conclusion of an industrial process. It is also required at periods throughout the process, so that each process reduces the number of faults at the end of the process caused by the proceeding process, saving time and money (Hermanson, 2016). Reasons why the Quality Control (QC) in the garment industry is important, is to determine the quality of materials that are within tolerance limits before being processed into mass production of the garment industry in order to decrease fabric defects that will turn into fabric waste. This is where Fashion industries should check their fabric length and width, the thickness of the weft and warp yarn, and record all fabric defects on the inspection sheet. If more than 3 (three) points of fabric faults are identified in a single location, use a pin-tag label to identify it. Where the total of fabric defect points will be classified into 3 grades, namely grade A, B, and C. Other than Fabric qualities, processes such as cutting, sewing, and finishing have their own procedures of quality inspections. At the cutting process, the company industry must inspect and match the pattern component with another corresponding pattern that could be found in a marking paper with a complete record of all findings, written down on the inspection sheet. This process is necessary to make it easier on finding cutting errors. Meanwhile, the sewing process is mainly about fabric puckers, mean labels, adjustments to size chart standards, trimming, and cutting per component according to sample and tolerance. Lastly, the finishing process of Quality Control (QC). The Finishing process itself involves Ironing, clothe grouping, inspections on stitch and size. Other than that, is the separation between minor and major defects that will be recorded and accounted for the number of garments that will be accepted and informed to the Company boss so the qualities could improve for the next production (Hermanson, 2016).

4. CONCLUSION

With the development of the times, technology has also developed. In addition to the development of technology, it has also become a trend in the world. The development of this trend can be seen on social media. With the development of the trend that is getting faster fashion. Fast fashion is a rapid fashion change, and many are sacrificed to meet market demand. Fast fashion has a negative impact on the world, one of which is

environmental damage, such as water and air pollution. Fast fashion occurs in ready-to-wear, because the greatest needs of society are clothes that are directly worn or ready to wear. Clothing waste is one of the largest in the world. This is due to human negligence. Therefore, designers began to create the concept of zero waste applied to fashion products. Zero waste mode tries to minimise the influx of textiles. This system is said to be environmentally friendly because the resulting waste will be little or even no waste. Zero waste is part of a sustainable mode. There are also ways of cutting patterns that are applied to support the zero-waste method. In addition, you must be careful in the selection of materials to be used and certainly not present at any party. So, in designing, there are several things that must be done to support the zero-waste method.

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