

# **Implementing Zero Waste Pattern Cutting for Sustainable Fashion Collection**

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## **Abstract**

The study aims to maximise the usage of the fabric and minimise the pre-production waste through the sustainable practice of zero waste pattern making and cutting technique. The entire process of designing and production of garments are now being challenged as the industry has been contributing as one of the most polluting industries, where the whole production loop needs to be looked at, from the design, manufacture, usage, to disposal stage. This research applied an exploratory research method by having exploration on pattern making technique on pre-production stage of garment making. Trials and errors using geometric pattern arrangement were conducted in the zero-waste approach while considering seam allowances and finishing technique in minimising the fabric waste. Paper folding technique was also implemented to support the design visualisation and further to ensure the garment fit. A fashion collection was made in response to introducing zero waste cutting as an alternative practice to create creative patternmaking with fabric efficiency considerations. Overall, this study offers economic and ecological benefit that helps in utilising the fabric on garment production, at the same time adding value to leftover fabric. The study also sees the potential improvement in doing more zero waste pattern cutting as part of the design process in the future.

## **Keywords**

zero waste pattern, sustainable fashion, pattern cutting, paper folding technique, garment

## **1. Introduction**

Sustainable lifestyle or what we called 'being green' is widely popular with many fashion brands joining the bandwagon of being sustainable and environmentally responsible. In Indonesia, it is also not something new, both brands and consumers are getting aware of this environmental issue and trying to find what can be done from their sides. Taking an opportunity over the growing 'green' demands, international and local brands have started voicing out 'sustainable' or 'eco-friendly' as part of their marketing strategy. By doing so, they manage to grab customers' attention. But on the downside, this leads to greenwashing practice that might affect consumers' brand trust in the long run.

Fashion industry itself has long been known as one of the most polluting industries, especially with clothing industry ends up wasting fabrics during the production. As a result, fashion brands need to find sustainable alternatives that they can do to avoid the marketing spin of greenwashing yet stay environmentally responsible. Additionally, to achieve sustainability in fashion, they must consider the life cycle beyond solving the waste problem. The production loop that a product went through has to be looked at, all stages from design, manufacturing, use, to disposal. By doing so essentially natural resources can be utilised sustainably.

One of the approaches is to do zero waste pattern cutting as to limit the inefficiency in garment production. Here, designer as the key player needs to be creative in maximising the use of a single fabric for a garment. They need to utilise the aesthetics, production, and cost while thinking about the impact to the environment. Additionally, the art of paper folding aligns with the creative zero waste pattern cutting. The implementation of folding introduces a new kind of aesthetics that could enhance the visual appeal of a garment that also maximises the use of a one big piece of fabric. Creases and corners as the result of the paper folding technique truly resemble the flat pattern of a zero waste pattern cutting. It inspires the pinching and folding of the fabric to fall nicely on body.

In response to greenwashing practices in the fashion industry, this research focuses on the development of zero waste pattern cutting while incorporating paper folding technique into the creation of a sustainable fashion collection.

### **1.1 Objectives**

The study aims to maximize the potential creativity to reduce textile waste through a zero waste pattern cutting technique applied for womenswear collection of 25-30 years old. It also explores possibilities in producing a collection with as little pre-production waste as possible and raise the awareness of zero waste pattern cutting as a sustainable alternative for creators to be environmentally conscious. At the same time, the study intends to inform consumers about sustainability in fashion industry so they will be more aware about greenwashing and the actions that they can take part in the sustainable practice. Inherently, this research intends to demonstrate the potential of using zero waste pattern cutting as an acceptable common technique in the industry while balancing the people, planet, and profit.

## **2. Literature Review**

With the growing environmentally aware segments, consumers' expectations rise towards the promoted eco-friendly and here greenwashing misleads them with simply a marketing claim that do not meet the expectation at all regarding environmental benefits (Tateishi 2017; Fitrianingrum 2020; Szabo & Webster 2021). Although companies are promoting their so-called green offerings without any accountability, they still affect consumers who are not yet aware of the environment by exposing them to green alternatives that eventually raise their environmental awareness. While there are good things in a way, the negative impact of greenwashing still outweighs the good. In fact, greenwashing does not only mislead consumers with false information about green products but also encourages companies to overuse the term 'green' which later would lead to trust crisis (Guo et al. 2017). Further, consumers would also doubt companies' credibility in their messages leaving the consumer to be sceptical about anything environmentally friendly and eventually mislead consumers to contribute in doing the opposite of their intention (Tsui 2020; Mysirli & Axarli 2021).

Clothing industry is believed to be highly polluting, producing around 20% global wastewater with 85% textiles end up in landfill and mostly can be reused (UN Climate Change News 2018; Müller 2020). Adding to the facts, greenwashing does happen here especially in the fast fashion industry. Many fast fashion companies are trying to appear more sustainable to gain customers' attention and appear to be the company who cares and is responsible to the environment, when it is doubtful. In some campaigns, many brands are labelling their products with various 'green' related terms that are vague, such as 'sustainably made' or 'eco-friendly' (Sinisalo 2020). For example, fast fashion retailer H&M that utilises greenwashing tactics in their advertisements by launching the H&M Conscious collection. The main issue of this collection is that there is insufficient information and details like how much recycled or organic materials used in the piece. This then falls into the greenwashing sin of no proof based on Terra Choice's theory (2007) in which the company keeps releasing new collection under this line every few weeks claiming the environmental aspect of the product without evidence nor reliable certification (Dimitrieska et al. 2017). This strategy will not only affect consumers but also brings negative impact to other brands who genuinely care about the issue.

### *Sustainable Fashion*

Between customers, environmental awareness has grown that leads to the bandwagon of companies offering sustainable products and the whole business operations are expected to be sustainable and socially responsible. As a result, the growing demand further drives firms to develop the green marketing or the so-called greenwashing to create that good corporate image (Zhang et al. 2018). The practice can be applied in many categories in business including fashion. Sustainability in fashion is pictured like a three-legs stool in which all three legs have to be solid in supporting the sustainable platform. People, planet, and profit – all three have to be taken into considerations in a sustainable manner, not only economically (De Jong et al. 2018; de Freitas Netto et al. 2020).

These days, the industry has to shift their way of environmental thinking to achieve a sustainable balance in the use of social, economic, and environmental resources. Sustainability here is no longer used to merely solve waste problems within the production loop but it is also used to care about the life cycle thinking which includes all stages that a product went through, from design, manufacturing, retail, use, to disposal. This results in the direction of the fashion industry's supply chain into a more circular one. It is believed that the industry would be benefited by applying circular economy in order to utilise natural resources sustainably closing the loop of materials and making everything interconnected (Ellen McArthur Foundation, n.d.). Moreover, the theory of having fashion circular would help tackling the root causes of global challenges like biodiversity loss and pollution.

There are several principles that fashion designers could consider in doing sustainable fashion (Sheikh et al. 2021): (1) design the entire clothing life cycle, (2) waste reuse, (3) recycle and upcycle, (4) clothing repair, remodel, and redesign, (5) eco-materials use, (6) use new technology, (7) standardised materials, (8) long lasting product creation, and (9) design a multifunctional clothing. Furthermore, approaches to sustainability fashion varies in many different forms, namely circular fashion, collaborative fashion consumption, ethical fashion, fair trade fashion, minimalist wardrobe, organic fashion, slow fashion, vegan fashion, and cradle to cradle (Sustainable Fashion Terminology, n.d.).

With the sustainable buzzword, we can see the increased acceptance these days with large companies have begun to involve their customers in the acclaimed message, like Zara and Nike with their transparent sustainability reports of their action. This encourages small fashion enterprises to also adopt the sustainable fashion into their business by adding sustainable products while considering the overall product life cycle. In this case, designers have a key role to consider the environmental impact when designing to increase sustainability in the phases of the garment life cycle beyond the primary process like material, finishing, and dyeing (Kozlowski et al. 2019). The expanding sustainable market forces a shift in consumer purchasing behaviours that they keep in mind the environmental issue when they are buying and demand products that have as little environmental impact as possible. Eventually this leads to the increased interest in environmentally conscious fashion known as eco-conscious fashion. Although it is termed as 'eco-conscious fashion,' but there is a need for designers to use their creativity to balance the functionality, aesthetics, and ethics in the contemporary eco clothing design that it will not be just old-fashioned clothing (Wagner et al. 2017).

### *Zero waste*

Addressing the inefficiency of the fashion manufacturing process, zero waste is defined as the process of creating garments without eliminating any fabric as the off-cut waste and therefore it allows maximising the whole fabric to create one garment where the pattern pieces are placed and planned to interlock. (Rissanen & McQuillan 2016; Saeidi and Wimberley 2018). It has been the solution since 2008 for fashion and textile industry to optimise the availability of materials with lesser pre-production waste (Nursari & Djamal 2019). Zero waste fashion design allows articulation of new workflows to reduce waste as part of the sustainable practice (McQuillan 2020). For majority of brands, they are utilising aesthetic, cost, and production without thinking its impact on the environment, however, as consumers increasingly demand some eco-friendly things, the entire process are now being challenged. The industry is forced to think of tools that will enable the production runs smooth while addressing the environmental issues. (Figure 1)

Looking back to the early history, zero waste fashion technique was already used widely at the time when 'fashion designer' was not even pictured as an occupation. Ancient Greece's himation, namely, was created by draping a length of cloth on the body and going to the East, Japanese kimono also a few of traditional garments that are created without wasting any fabric. During the time, fabric was not something easy to obtain and so people were trying to utilise the fabric as effective as possible. Today, this technique focuses on doing experiments to achieve new forms while reducing the amount of pre-production fabric waste. Several points to consider when implementing the zero-waste technique include: garment and fabric type, fabric width, silhouette, fixed areas, construction and finishing, specific features, and pattern pieces (Rissanen & McQuillan 2016). By considering these in producing garments especially with large quantity, the application of zero waste creative pattern cutting enables designers to explore creativity in using materials at the same time becoming more sustainable (Rissanen & McQuillan 2016; Gam & Banning 2020). In creative pattern cutting, designers move from the conventional process and use a flexible method to alter or combine the basic principles in pattern making like contouring and dart manipulation for example (Nursari & Djamal 2019).



Figure 1. Zero waste pattern cutting by Holly McQuillan (McQuillan, 2019)

Despite using one big piece of fabric, cost and garment fit will have to still be balanced in achieving the zero waste fashion at the same time introducing new kinds of aesthetics that enhance the garment's appearance (Nursari & Djamal 2019; Mansour 2020). Therefore, paper folding can be one technique to implement in order to achieve the visually pleasing outcome. Historically speaking, paper folding is an art of folding paper into objects that comes from Japan with the term *origami* and *papier falten* from Germany. Back then papier folding comprised a series of handiwork activities for children that included weaving, stitching, and folding (Nishida 2019). If this technique then to be applied to garment making, it will enable creative pattern cutting without having to cut and waste many fabrics.

### 3. Methods

Aiming on the zero-waste design approach, this research used an exploratory research method with the application of experimentation on pattern making and cutting to reduce waste. The study applied pattern exploration by draping on mini mannequin, flat pattern making, and sewing mini samples. Rough sketches were also created to visualise the design and silhouettes. Fabric manipulations were then added before having toile experimentation on real size mannequin. Figure 2 explains the process flow of this research. (Figure 2)

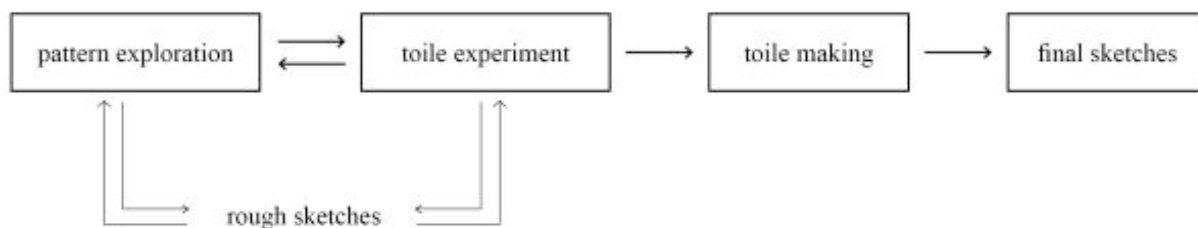


Figure 2. Process Flow

This project used geometric pattern pieces for the zero-waste pattern approach, thus the flat pattern would look like a series of rectangles, squares, and trapezoids arranged as if it were a big piece of fabric, see Figure 3. A combination of draping and this geometric pattern arrangement will ensure the perfect fit of the garment on the real size body.



Figure 3. Geometric (rectangular) pattern arrangement on fabric

Fabric manipulation such as smocking was added in the creative pattern making for decorative purposes. In addition, it recreates the folding designs that are inspired by the paper folding – *papier falten* – technique highlighting the beauty of symmetry. The back side of the smocked fabric for example creates a row of triangles forming folded designs representing the corners of *papier falten* squares and folds. Furthermore, formed cutting lines were taken from the fold marks of *papier falten* tries. To emphasise the cutting lines more, bias binding and piping were used to neatly visualise the effect of folded fabric and cutting lines. Here, toile experiments were multiple times created ensuring the zero-waste approach was achieved on each design with *papier falten* inspired technique.

### 4. Data Collection

At the beginning, creative pattern experiments were executed by draping on small size mannequin to try on the pattern manipulation before having rough sketches to help visualising the design and silhouette. By doing this pattern exploration directly on the mannequin, it allows the creating of the paper folding details easier, although in the result, the details were not that apparent on some designs. Therefore, more trials were conducted on the smocking creation

to create the paper folding details. To emphasise more the clean lines on the garment, bias binding tape was used to finish the neckline, sleeve, and hem.

Once the desired design and silhouettes were achieved, the experiment then continued to toile creation. Two looks were created in full size body, see Figure 4. Taking inspiration from the crease marks and lines of the papier falten, looks were designed with lots of diagonal lines. Also, the line up was made with a combination of loose and fitted silhouette for a more flattering silhouette.



Figure 4. Pattern exploration then made rough sketches

Reflecting upon the earlier trials, the pattern exploration was executed now by having rough sketches first before draping it on half size mannequin. More trials and errors were conducted with the geometric pattern arrangement. Figure 5 shows the experiment on cutting rectangles into triangles to create more variations on the cutting lines of the garment. From there, seam allowance and finishing technique of each piece must be considered before cutting the fabric for real size measurement. Once the desired looks were achieved using the mini sample, measurement and pattern plan were then created. This is to get more understanding whether the piece is doable or not to be made on a real size measurement. Also, this can prevent more waste when cutting the fabric for the real size body, see Figure 7. However, not all designs would work by following the pattern plan. Some design required direct explorations on mini mannequin.

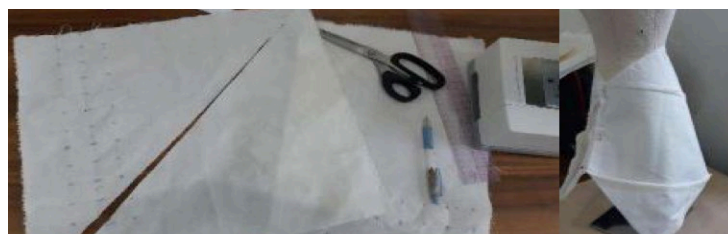


Figure 5. Pattern exploration: geometric pattern arrangement

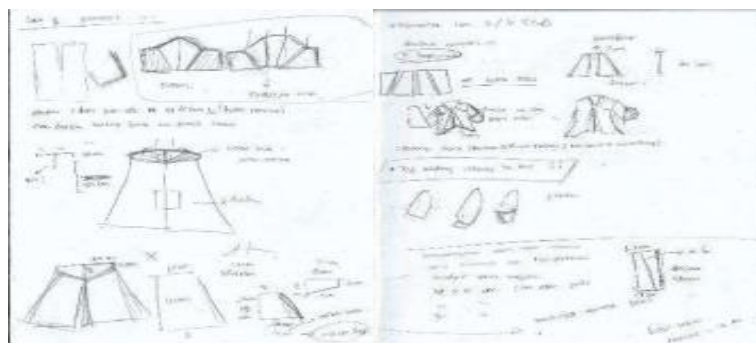


Figure 6. Pattern construction plan

Aside from considering the garment fit, the experiment needed to also consider on the application of the fabric manipulation. Smocking or the paper folding details were tried on small mannequins as well at first to see how the folds work and how those would affect the whole look of the garment (Figure 7). Darts were also incorporated to remove the excess fabric and to make sure the pattern fit perfectly on body curves. Lots of trials were conducted – from sketches, draping, mini samples, pattern plan to toile creation – in order to get the desired design outcomes. During this exploration, each pattern and fold creations were documented to ensure the zero-waste approach in minimising fabric waste.



Figure 7. Smocking trials

## 5. Results and Discussion

### 5.1 Results



Figure 8. Line up

A six-looks line up (Figure 8) was created in this study by implementing zero waste pattern approach. The technique involves arranging geometric shapes looking as if it is a big piece of fabric, see Figure 9. It then was draped onto a mini mannequin for pattern exploration before transferring into a real size pattern. At this stage, fabric manipulations like smocking and pleats were incorporated for garment fit purposes. At the beginning of the research, it was done by draping first before sketching it and sewing the mini samples to explore the pattern. Sketches here helped visualising the design and in creating the pattern construction plan. But turns out by sketching first the design, it also helped in imagining the silhouette to be the ground base of the pattern creation before really putting it on the mannequin. This way helped minimising more fabric leftover.



Figure 9. Zero waste pattern for A line skirt

Papier falten or the paper folding technique was involved in the pattern exploration as to form the silhouette and the overall design development incorporating mostly geometric lines. Like on Figure 10, the top was created by using a one square fabric made of four rectangular pattern pieces which then folded to create the silhouette that looked like a letter 'X'. Still inspired by the papier falten, two long rectangular strips were joined and folded to cover the shoulder area replacing the supposed to be sleeves and turned it into a drop shoulder. Since it is more of a loose top, the main consideration during the pattern exploration was the ease of the fabric for the garment opening. At the end, it was decided to be a slip-on top without an opening therefore, the neckline and armhole width are very crucial for the garment fit. Bias binding tape was added to finish the edges and at the same time to highlight the lines.

Figure 11 shows the creation of a dress by combining papier flatten and fabric manipulation. The dress was detailed with asymmetrical hemline and diamond smocking on the shoulders. Using the zero-waste approach, trapezoid shapes were assembled for the pattern creation. Darker tones piping was added into some of the sewing lines to add interesting features while highlighting the paper folding's lines and shadow. The dress comes with a self-tie fabric belt that gives the wearer the option to incorporate it into the look or not. For the opening, a detachable zipper was used to allow the dress to be worn versatily as a dress or as a sleeveless outer.



Figure 10. Papier flattens inspired top - pattern fitting on mini and full-size mannequin



Figure 11. Dress – papier falten & smocking

After many explorations, it is believed best to combine both orders, going back and forth between sketching, draping, and sewing mini samples during the pattern explorations. Moreover, by doing mini samples first on mini mannequin it ensures fabric is used the most out of it and ensures the garment would fall nicely on body curves. This eventually helps in planning out the flat pattern creation for the final real size pattern (Figure 12). Although the main technique used here is draping, but seam allowance of each pattern piece must be thought carefully and the position of the opening on the final garment should also be considered.



Figure 12. Final garments

The whole process of the preproduction is shown on Figure 13. It started from preparing the fabric base, in this project, author gathered the geometric shapes together as an inspiration from the paper folding, then the process went to pattern exploration with draping techniques on mini mannequin, continue to sketching, back and forth with the pattern exploration. The steps continued with the construction plan in order to plan ahead the toile development on real body size so fabric well utilised and consumption can be minimised. Then, the process went to toile development with draping techniques in real body size. The fifth step was to produce the flat pattern for the production, translating the draping into 2D pattern, then goes to the final production with real fabric.

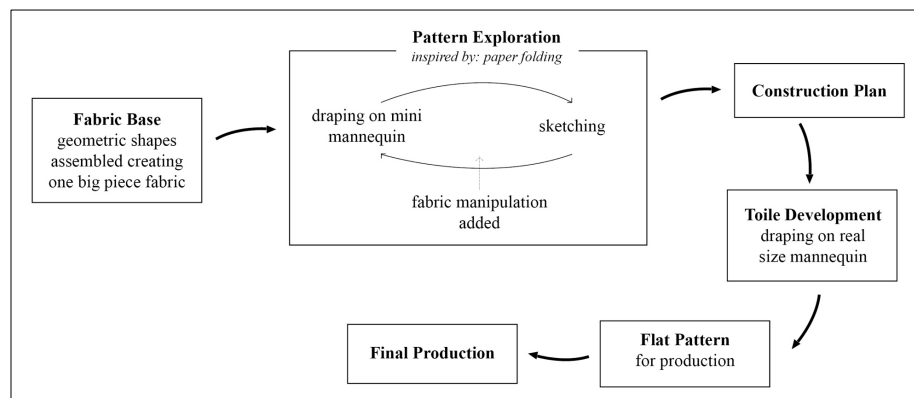


Figure 13. Exploratory zero waste pre-production process

## 5.2 Proposed Improvements

Based on the process, there is a proposed improvement for further study. This research is done by applying 6 steps of the preproduction of the zero-waste pattern cutting technique approach which can be seen on Figure 13, however, to make it more efficient, the process of the toile exploration on mini size mannequin can be removed from the process to have shorter process which minimises the fabric waste further and shorten the whole production time. It is recommended to test the design directly onto the real body size mannequin with draping technique. Detail figure can be seen on Figure 14.



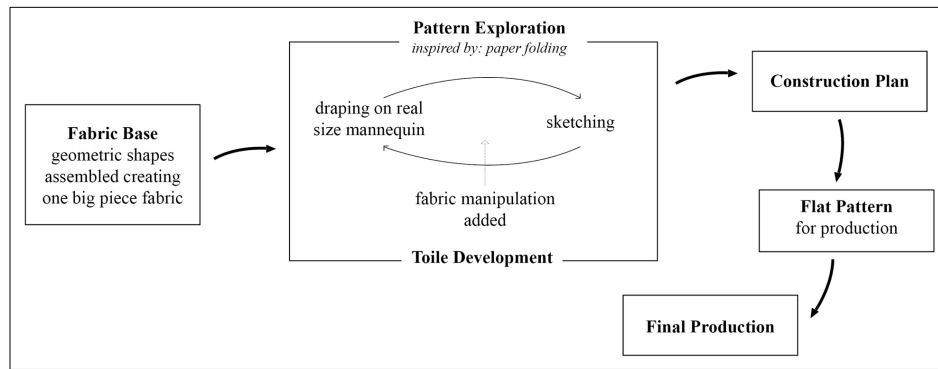


Figure 14. Proposed zero waste pre-production process

As of current, the study of zero waste pattern cutting is still limited, and this research contributes to the exploration and possibility of using the technique as a sustainable alternative in fashion. The overall exploration might benefit from applying zero waste technique to different garment style and fabric types to further test the idea of utilising fabric sustainably.

## 6. Conclusion

As the sustainable issue rises, more people are becoming more aware of environmental issues. The buzzword of eco-friendly and save the earth is widely seen everywhere. The same thing happens in fashion industry, sustainable fashion is increasingly available with brands claiming to be environmentally responsible. However, this leads to the increased greenwashing practices as part of the company's marketing strategy in promoting their products, in which in the long run it will impact brand trust. Therefore, it is highly suggested that customers need to be more mindful and selective during the pre-purchase stage.

A collection was made in response to the greenwashing practice and as a sustainable alternative in minimising textile waste that is believed to have been highly polluting. Further, this study aims to raise the awareness of being transparent to the consumers about the sustainable practice in building the positive public image as opposed to the greenwashing practice. In this study, zero waste pattern cutting was chosen to be the approach in achieving sustainability in fashion. Although zero waste pattern cutting has not been a common thing in the industry especially in Indonesia, but it is believed that the approach might work well in utilising resources sustainably and in minimising the inefficiency in production. The approach was then combined with the idea of paper folding. Paper folding technique was added to help in visualising the design with a combination of pleats, folds, and darts. At the same time, these fabric manipulations would help ensuring the fit and fall of the fabric on body curves.

Overall, zero waste pattern approach proves to offer economic and ecological benefit as compared to conventional approach that it helps in utilising the fabric during and after the production that it minimises the fabric consumption and at the same time adding value to existing leftover textiles. Instead of doing the greenwashing, this study might be beneficial for the creation of competitive advantage in the midst of tight competition in fashion industry. Further, this study sees the potential in doing more zero waste pattern cutting as part of design process in the future.

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## **Biographies**

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