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EVALUATING THE EFFECTS THAT THE ZERO WASTE SEWING PATTERNS HAVE ON AN APPAREL ITEM'S ENVIRONMENTAL IMPACT

BY

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Abstract. The effects of climate change are more and more visible nowadays, and global warming has taken its toll lately. Those effects are but a result of the massive and irresponsible production capacity, fueled by the greed for consumption. Within the apparel sphere, this overwhelming manufacturing rate has been manifesting itself in tremendous amounts of fabric waste, designed for landfill disposal, which contributed over the years to climate change. The damage that has been done can only be fixed by rethinking and restructuring the conventional ways garments are produced, as well as becoming more aware of the need for a structural change within the fashion industry. Considering the major impact the apparel industry has upon the environment, this study aims to identify what are the steps to be followed, and by how much can a clothing item be less hazardous, by addressing the consequences of regular and sustainable apparel upon global warming, eutrophication and acidification.

Keywords: apparel industry, ecodesign, fabric consumption, global warming, patterns.

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1. Introduction

The negative impact that the apparel industry has upon the environment can be translated by 10% of global carbon emissions, as well as 20% of global wastewater (UNEP, 2019). As the apparel consumption is expected to face a drastic increase of 63% by 2030 (European Commission (2020; 2022a)), the negative effects that fashion already has on the planet are sure to be more devastating. Urgent measures need to be taken, mostly from an ecodesign approach, which calls for various ways of engineering a garment item, aiming to reduce its environmental impact (Ecodesign Directive 2009/125/EC). The collective concern in regard to fashion's water footprint has depicted an increase over the last 5 years. (Bailey *et al.*, 2022) The apparel industry has its role in contributing to environmental pollution, throughout the life cycle of a product. The state of the art presents a number of research that have been developed, particularly aiming to integrate the entire fabric surface within the final product. This study aims to analyse the improvements that can be attained regarding the garment's environmental impact, by developing a comparison of the life cycle assessments for two similar garment items. Thus, it was possible to identify the role that zero waste patterns have upon the product's carbon (CF), sulphur (SF), and phosphorous (PF) footprint.

2. Apparel ecodesign

Ecodesign represents a way of thinking which needs to be adopted gradually, yet swiftly, in order for designers and apparel manufacturers to keep up with the EU requirements, on providing durable, sustainable and easily disassembling garment items to the consumers (European Commission, 2022b).

From a pattern drafting perspective, a sustainable approach for designing sustainable apparel involves generating a jigsaw type of layplan, in which all patterns are placed similar to the pieces of a puzzle. By doing so, complete integration of a given fabric surface is being attained. The optimal usage of the fabric is measured by the marker's efficiency [%], and indicates the amount of used fabric, as well as the amount of waste textile material.

The drafting process of the geometrical, or zero waste, patterns was conducted by using the Gemini Pattern Editor. This process consisted in re-shaping an already existing pattern set, and alter the geometry of the pieces in such way, that by placing them together, a jigsaw-like layplan will be attained.

The initial pattern set (Fig. 1) was able to generate a fitted long sleeve blouse, which was following the body shape thoroughly. The intent concerning the zero waste garment item designed, was to maintain the approximate garment fit, specifically on the waistline. Given the new and extremely geometric shape of the patterns (Fig. 2), this requirement can only be attained by integrating several rows of elasticated stitch lines, on the particular area of the product. As a technological solution, this also represents a method by which the product can be modelled, and gathered on the waistline in accordance with the given body measurements, within specific size set. Considering the fact that the gathering dimensions will vary from one size to another, it is conclusive that applying this solution, the same pattern set can be used for mass production.

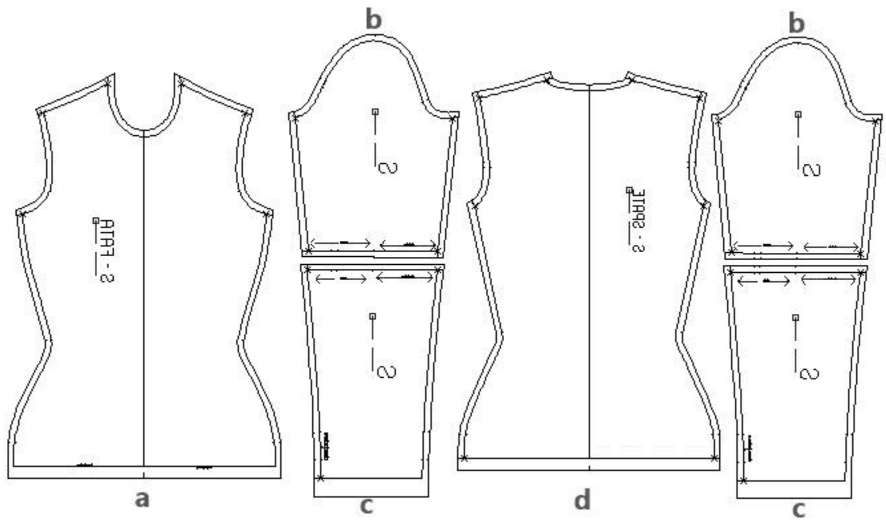

Fig. 1 – The initial pattern set: a – front bodice, b – sleeve, c – cuff, d – back bodice.

Another detail that underlines the previous statement can be acknowledged by analysing the reshaped shoulder line – the new dimensions for this measurement exceed the initial ones, which again call for applying the same modelling principle as before. By doing so, not only will the product be dimensioned accordingly on the shoulder line, but the sleeve length will also be impacted. This impact upon the sleeve pattern will not be applied to the patterns, but to the overall fit: if the shoulder line is gathered too much, it will consequently "pull" the sleeve up, thus resulting as a shorter sleeve within the final product.

It is imperative to observe how drafting the patterns, from a sustainable perspective, results in a process that combines and requires both engineering and aesthetic attributes, as one cannot work without another.

It's worth mentioning that in order to ensure an efficient fabric consumption, new pattern pieces needed to be developed, which were attributed functional characteristics (patch pockets). Another amendment that was done consists in expanding the cuff pattern, thus generating a cuff that will have a folding line.

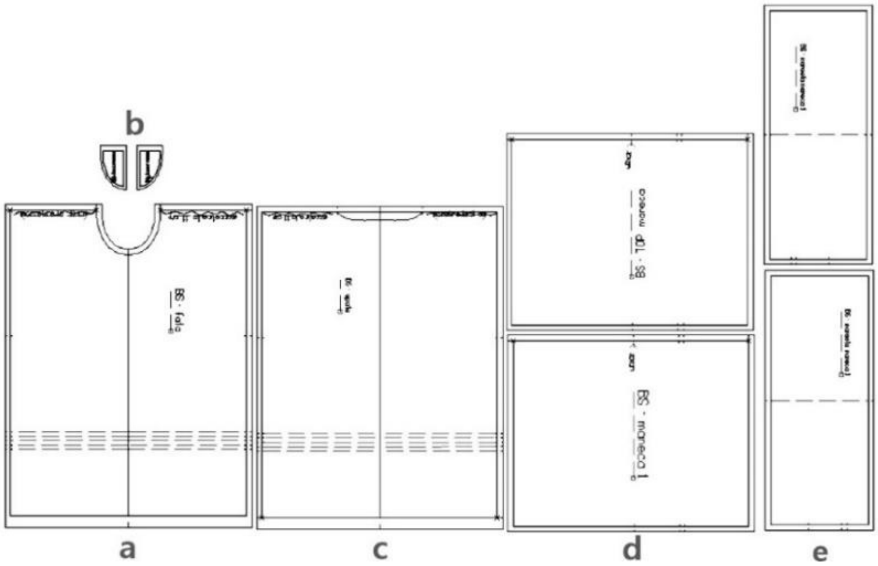

Fig. 2 – The zero waste pattern set: a – front bodice, b – patch pockets, c – back bodice, d – sleeve, e – cuff.

Once drafted, the patterns were tested in order to validate if they meet the criteria – close to none fabric waste generated, and fitting within the fabric's usable width. This stage was performed by using the Gemini Nest Expert software, which provided the needed output in terms of layplan efficiency and fabric rating. It's important to mention that both simulations were made by using the same fabric width as an important dimensional parameter. The gathered pieces of information will be used as input data in the following stages of generating the life cycle assessment for the studied garment pieces.

By analyzing the layplans generated for both pattern sets (Fig. 3), it is possible to identify the rectifications in regard to the fabric usage that have been attained by using the zero waste patterns (Table 1). Those improvements are expressed through an increased marker efficiency and a slightly smaller fabric consumption.

Table 1

Fabric consumption indicators

Data generated	Classical patterns	Zero waste patterns
Fabric rating, [m]	1.03	0.94
Fabric usage, [%]	68.6	99.72
Fabric waste, [%]	31.4	0.28

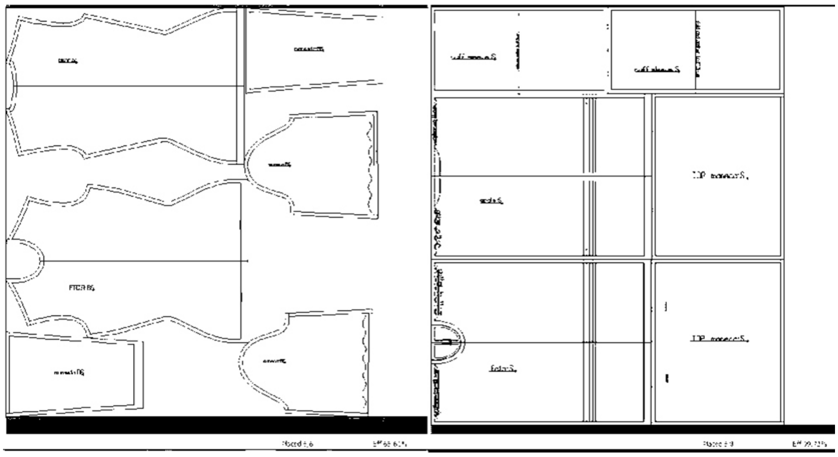

Fig. 3 – Layplan for classical patterns set (left) and layplan for the zero waste patterns (right).

None the less, the final products were generated, for both types of garment items (Fig. 4), within the virtual environment of CLO 3D software.

Fig. 4 – The virtual prototype corresponding to the classical pattern set (left) and to the zero waste pattern set (right).

2.1. The Life Cycle Analysis

Once the garment items have been thoroughly defined, in terms of fabric rating, fabric waste generation, and technical aspects, the life cycle analysis has been developed, aiming to generate a comprehensive comparison between the studied items. Nevertheless, the effects that the new pattern geometry has upon the product's environmental impact were a topic of high interest throughout the entire study. For the purpose of this research, and in a hypothetical manner, it has been decided that both garment pieces will be produced out of the same fabric, following the same production line, in the same factory, distributed on the same marketplace, and follow identical use and end of life stages. Sharing those similarities allowed for the footprint discrepancies sources to be better emphasised.

Thus, previously collected data has been integrated and used to establish the inventory analysis within this section. It is imperative to mention that albeit sharing identical raw materials, due to the zero waste product's design, the elastic sewing thread needed to be taken into account.

The sewing thread consumption, for each garment, has been calculated by identifying the types of stitches that are used to assemble and finish the products (Table 2), as well as following the given equation, illustrated as it follows:

Eq. (1), followed in identifying the thread rating for straight stitch:

$$l_{301} = 2P+2G + f(F) \qquad (1)$$

Eq. (2), for identifying the thread rating for the lock stitch:

$$l_{504} = 3P+4G+2T+2\sqrt{P^2 + T^2} + f(F) \qquad (2)$$

Eq. (3), for identifying the thread rating for the cover stitch:

$$l_{602} = 6P+4G+T+ 3\sqrt{P^2 + T^2} + f(F) \qquad (3)$$

where: $f(F)$ is the thread's diameter [mm]; P is the stitch length [mm]; G is the assembled fabric's thickness [mm]; T is the stitch's width [mm].

Table 2

Total thread usage [m] for the classic garment item

Thread rating for the stitch length [cm]		Stitch length per cm	Thread rating [cm] for 1 cm of stitch	Total stitch length within the product [cm]	Thread rating within the product [cm]	Total thread rating within the product [m]
504	4.39	3	13.17	448.6	5.909	112.5
602	5.41	5	27	197.4	5.329	

Table 3

Total thread usage [m] for the zero waste garment item

Thread rating for the stitch length [cm]		Stitch length per cm	Thread rating [cm] for 1 cm of stitch	Total stitch length within the product [cm]	Thread rating within the product [cm]	Total thread rating within the product [m]
301	0.52	3	1.56	84.6	131.9	1.31 elastic thread
	0.48		1.44		121.8	82.4 cotton thread
504	4.39	3	13.17	298.3	3.93	
602	5.41	5	27	155.4	4.19	

The next step was to identify the numeric values which served in dimensioning the amount of fabric that is needed for producing the garment items.

Within this step, it's worth mentioning that the fabric's density value has been provided by the virtual prototyping software CLO 3D, by accessing the virtual fabric's property table (Tables 3 and 4).

Table 4
Fabric total rating

Surface indicators	Classic patterns	Zero waste patterns
Layplan dimensions L x W, [m]	1.03 x 1.12	0.94 x 1.12
Layplan surface, [m^2]	1.15	1.05
Fabric density, [g/m^2]	260.1	
Density of the used fabric, [g/m^2]	299.1	273.1
Fabric weight, [kg]	0.32	0.3

Once the inventory analysis concerning the raw materials has been established, the life cycle stages have been simulated for both apparel items. With the use of Ecochain Mobius platform, and by using the Ecoinvent 3 database, the carbon (Fig. 5), sulphur (Fig. 6) and phosphorous (Fig. 7) footprints have been generated.

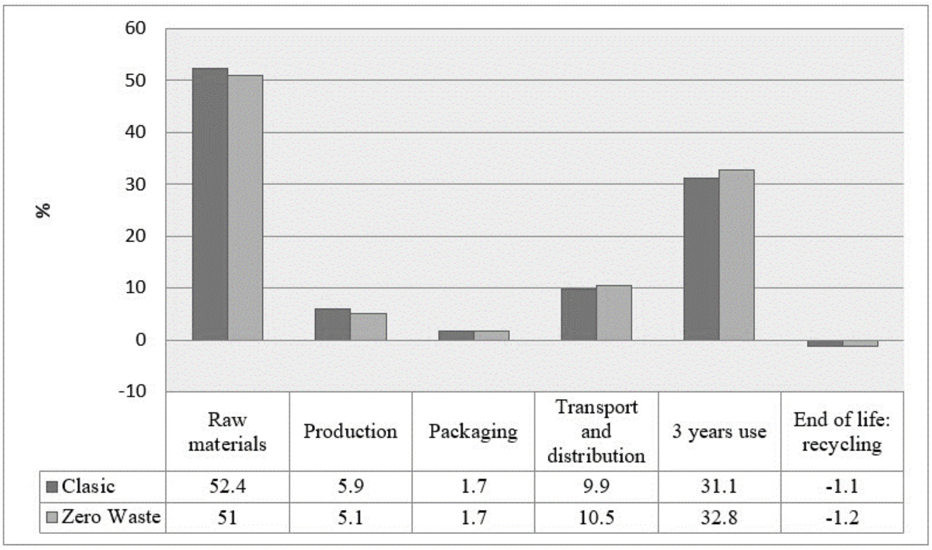

Fig. 5 – The CO_2 emissions [%] generated by both products, throughout their life cycle.

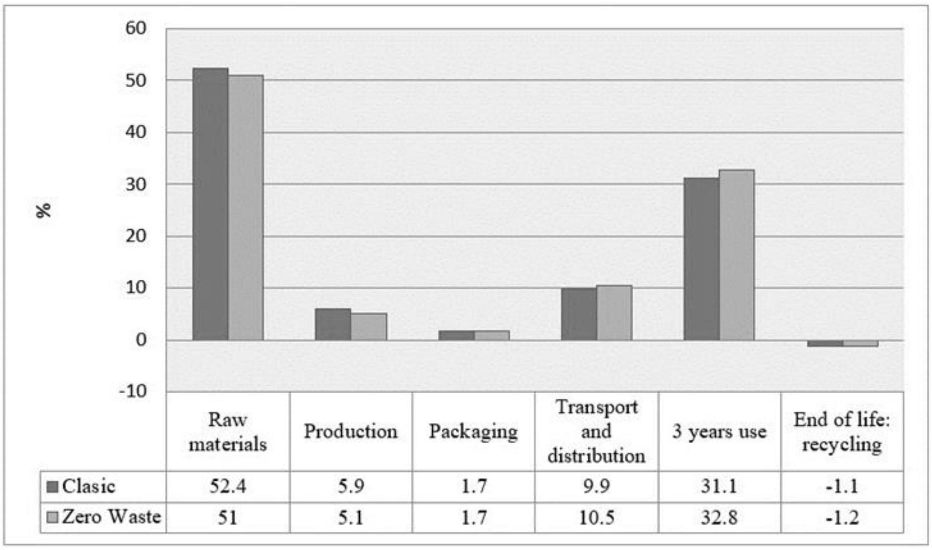

Fig. 6 – The SO_2 emissions [%] generated by both products, throughout their life cycle.

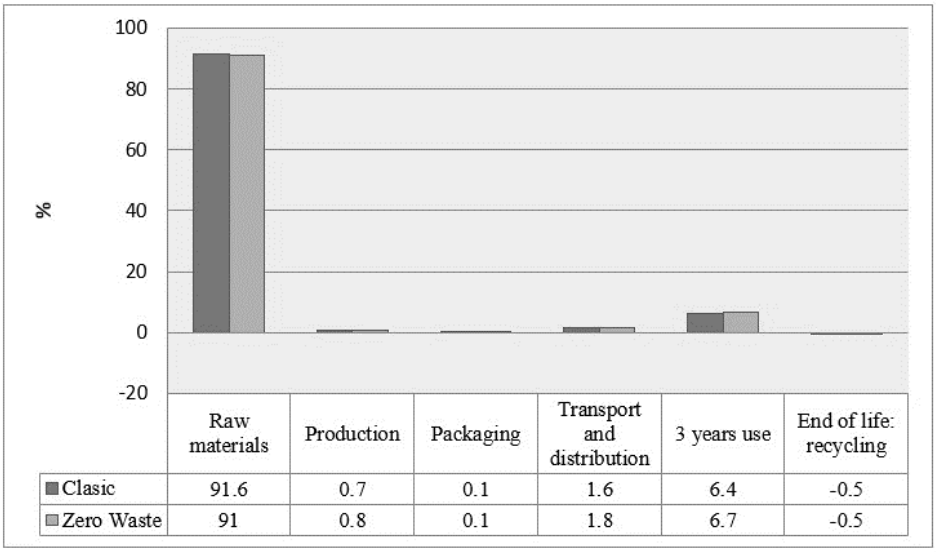

Fig. 7 – The PO_2 emissions [%] generated by both products, throughout their life cycle.

3. Conclusions

The results highlight the major environmental impact that the extraction and production of the raw materials has, within the apparel industry. It is understandable that this life stage alone has the most significant influence upon the product's environmental footprint. Therefore, it is no surprise that the concerns and interest regarding pursuing Ecodesigned clothing has raised over the last few years. This new approach of creating clothing items contributes to shifting the paradigm concerning fashion industry.

The textile fabrics are depicted as valuable resources for the garment industry, and it is strongly advisable to use them wisely, and to avoid waste as little as possible, if none at all. The slightest amount of pre-consumer fabric waste has the capacity to pollute twice – for it generated a certain environmental footprint while being produces, and it continues to influence the environment while being inefficiently disposed. Therefore, it is important to consider adopting new methods which will ensure the efficient consumption of the raw materials (textile fabrics).

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EVALUAREA EFECTELOR TIPARELOR DE CROITORIE ZERO WASTE ASUPRA IMPACTULUI PE CARE UN ARTICOL VESTIMENTAR ÎL ARE ASUPRA MEDIULUI

(Rezumat)

Efectele schimbărilor climatice sunt din ce în ce mai vizibile în zilele noastre, iar încălzirea globală și-a luat tributul în ultima vreme. Aceste efecte nu sunt decât un rezultat al capacității de producție masive și iresponsabile, alimentată de lăcomia de consum. În sfera produselor de îmbrăcăminte, această rată copleșitoare de producție s-a manifestat în cantități uriașe de deșeuri textile, concepute pentru eliminarea la gropile de gunoi, care au contribuit de-a lungul anilor la schimbările climatice. Prejudiciul care a fost făcut poate fi reparat doar prin regândirea și restructurarea modalităților convenționale de producere a produselor vestimentare, precum și prin conștientizarea necesității unei schimbări structurale în industria modei. Având în vedere impactul major pe care industria modei îl are asupra mediului, acest studiu își propune să identifice care sunt soluțiile pentru dezvoltarea unui articol de îmbrăcăminte mai puțin periculos, abordând consecințele pe care un produs vestimentar obișnuit și unul sustenabil o au din prisma emisiilor de carbon, fosfor și sulf. Se urmărește obținerea unei analize prin care să se poată observa care dintre stagiile de viață ale unui produs au ponderea cea mai mare asupra impactului total pe care acesta îl are asupra mediului.