Customized clothes – a sustainable solution for textile waste generated by the clothing industry

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ABSTRACT – REZUMAT

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The textile industry plays an important role in Romania's economy and its products are a necessity in people's lives, not only in the form of apparel but also in the automotive industry, construction, computers, agriculture etc., due to the expansion of their fields of use. Numerous studies have shown that this industry is, after oil, the second most polluting industry in the world. In addition to the multitude of chemicals used in the production process and a large amount of water and energy consumed, the textile industry generates considerable waste. This paper aims to identify the main sources of textile waste in Romania and it proposes the alternative of customized clothes using textile waste in order to rethink, reuse or recycle waste in the production stage. This strategy can be successfully integrated into the vertical value chain by strengthening the creation department, and clothing design and by involving the marketing and sales divisions. In the clothing industry, the strategy of integrating design and retail can lead to a more flexible design process and therefore to high product performance.

Keywords: *linear economy, circular economy, environment, textile, waste*

Îmbrăcăminte personalizată – o soluție durabilă pentru deșeurile textile generate de industria de îmbrăcăminte

Industria textilă joacă un rol important în economia României, iar produsele sale sunt o necesitate în viața oamenilor, nu doar sub formă de îmbrăcăminte, ci și în industria auto, construcții, calculatoare, agricultură etc., datorită extinderii domeniilor lor de utilizare. Numeroase studii au arătat că această industrie este, după petrol, a doua cea mai poluantă industrie din lume. Pe lângă multitudinea de substanțe chimice utilizate în procesul de producție și o mare cantitate de apă și energie consumată, industria textilă generează deșeuri considerabile. Această lucrare își propune să identifice principalele surse de deșeuri textile din România și propune alternativa de îmbrăcăminte personalizată folosind deșeuri textile pentru a regândi, reutiliza sau recicla deșeurile în etapa de producție. Această strategie poate fi integrată cu succes în lanțul valoric vertical prin consolidarea departamentului de creație și design vestimentar și prin implicarea diviziilor de marketing și vânzări. În industria de îmbrăcăminte, strategia de integrare a designului și retailului poate duce la un proces de proiectare mai flexibil și, prin urmare, la o performanță ridicată a produsului.

Cuvinte-cheie: *economie liniară, economie circulară, mediu, textile, deșeuri*

INTRODUCTION

As it is known, textiles are a necessity in people's lives, both for the realization of clothing products and due to the expansion of their fields of use – automotive industry, construction, computers, agriculture, etc. With the increase in textile consumption, the problems related to the scarcity of raw materials and environmental damage increase too. During the entire cycle of making textile products, they generate multiple sources of pollution in the air, water and soil. At the same time, considerable volumes of waste are created that can mainly be classified into three groups: production waste, preconsumer waste, and post-consumer waste.

Production waste is composed of fibre, yarn, cloth scraps, flock, sweeping, fabric cut-offs, fabric roll ends and selvedge generated by fibre producers, weavers, knitting companies and apparel manufacturers. Preconsumer waste consists of products that are manufactured with design mistakes, fabric faults, or the wrong colours being produced for sale and consumption and postconsumer waste consists of any types of household articles or garments made from fabricated textiles that the owner does not require any more and has decided to discard. Consumers may discard these articles when they are worn out, damaged, outgrown, or out of fashion.

At present, a part of the textile waste resulting from the production processes is used for the production of vigour yarns, non-woven textiles, upholstery wool for furniture and cars, insulating materials, geotextiles, the creation of collections of clothing products made entirely or partially out of different kind of textile waste etc. This led to a significant decrease in waste from the Romanian manufacturing industry of textiles, wearing apparel, leather and related product: from 33,309 tons in 2004 to 10,394 tons in 2012.

Since 2012 this waste began to grow continuously, reaching 25,791 tons in 2018 (figure 1) [1].

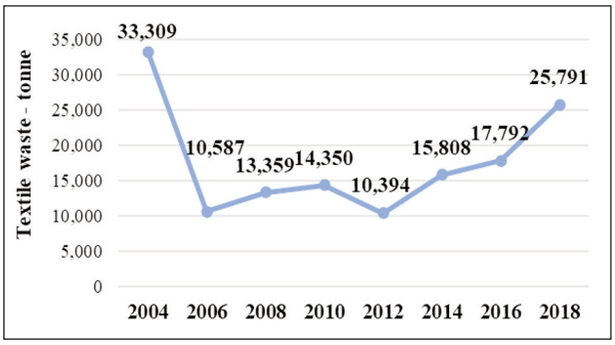

Fig. 1. The evolution of the quantity of textile waste generated by the Romanian industry of manufacture of textiles, wearing apparel, leather and related products

Analysing the sources of origin of textile waste in Romania, it is noticeable that they come mostly, 62.68%, from the industry of textile manufacturing, wearing apparel, leather and related products to which is added textile waste generated by other industries and households in different proportions (figure 2). The small amount of waste generated by households in Romania is due to the fact that there are very few people who throw textile waste in the trash, most of them give it to friends or relatives or donate it to charities [2].

BACKGROUND AND CONTEXT FOR THE STUDY

Linear economy versus circular economy

Much of the literature that analyses the issue of waste generated by industry highlights the advantages of moving from the linear production model to the circular one. The linear production model consists of extracting materials from resource-rich countries and then manufacturing products using those virgin resources [3]. The four stages of a usual product life cycle are extraction and processing of raw materials, manufacture, use and end of life. Stahel says that a linear economy flows like a river, turning natural resources into base materials and products for sale, through a series of value-adding steps. At the selling point, the customer is liable for risks and waste. They decide whether old things will be reused, recycled or dumped [4].

Because of this linear production model, resources are lost unnecessarily in different ways: waste in the production chain, end-of-life waste, use of excessive energy and erosion of ecosystems [5]. Materials that reach the end of their lives are considered waste and they are either sent to landfills or incinerated. This kind of economy has a major impact on the environment, namely – land-use change, climate change, resource scarcity, biodiversity loss, loss of biosphere integrity, an overload of nitrogen and phosphorus in biogeochemical cycles and increasing levels of pollution.

Even the elimination of these materials results in hazardous waste. When compared to pre-industrial levels (1850–1900), without modifying the usual business approach, it is predicted that the average temperature of the global surface will suffer an increase, from 3.7°C to 4.8°C in 2100 [6]. The upper limit of change in temperature is estimated to be roughly 2°C; exceeding this limit will most probably affect ecological systems, human health, and societies [7]. MacArthur shows that even at the microeconomic level it was found that the linear economic system increases its exposure to risks, most notably through volatility in resource prices and vulnerability to supply restrictions [8].

In these conditions, the transition to a circular economy is considered a viable solution that will have the main effect of reducing our global sustainability pressures. Geissdoerfer et al. define the Circular Economy is a “regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing material and energy loops”. They also consider that this can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling” [9].

The circular economy emerges as a potential strategy for the development of business practices based on environmental concerns [10]. A study of seven European nations shows that a shift to a circular economy would reduce each nation's greenhouse-gas

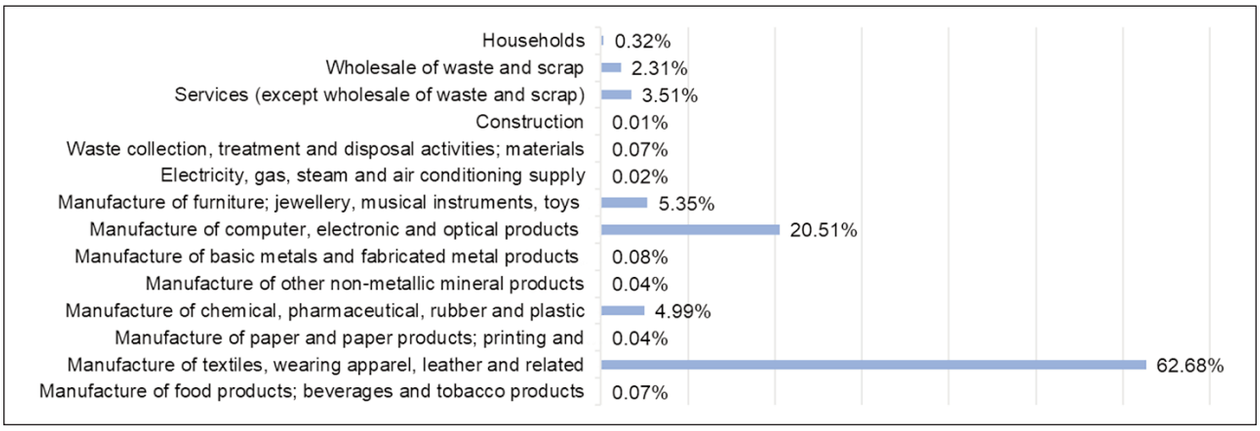

Fig. 2. The sources of textile waste in Romania, in 2018

emissions by up to 70% and grow its workforce by about 4% – the ultimate low-carbon economy [4].
Today, most authors agree that the circular economy refers to an industrial economy that is restorative and regenerative by intention and design [8]. Stahel compares a circular economy with a lake and highlights that the reprocessing of goods and materials generates jobs and saves energy while reducing resource consumption and waste [4]. In Sariatli's opinion, the strong points of the circular economy are considered to be: efficiency in the material flow cycle given by eliminating of waste from the value chain, development of higher quality and more durable products through incorporating the attributes of CE in the R&D phase, growth of the less exposed economy to price fluctuations of the materials, and better use of resources [11].
In a circular economy, not only the aspects of sustainability are essential for shaping the performance of companies, but also the relationships among these and other social and economic agents [12].
According to the European Commission (EC), the EU's competitiveness could be stimulated by the circular economy. This type of economy promotes businesses' protection against deficiency of resources and volatile prices, contributing to the creation of new business opportunities and innovative, more efficient ways of producing and consuming. Also, it will save energy, create local jobs for all skill levels and opportunities for cohesion and social integration and help avoid the irreversible damage caused by using up resources at a rate that exceeds the Earth's capacity to renew them [13].

The place and role of the textile industry in the Romanian economy

The textile industry plays an important role in the Romanian economy, both in terms of the significant number of people working in this field and in terms of the value of production and exports.
In the textile and clothing industry, there are currently employed about 3.8% of the total number of employees in Romania, namely 161,060 people, in 6,680 companies. Most people work in wearing apparel manufacturing – 128,366 people and 32,694 people in textile manufacturing. The low wage level, the structure of the production flow and especially the increasing pressure of other sectors in a deficit of labour are just some of the reasons why it is extremely difficult to stabilize the labour force in these sectors. Clothing production offers the lowest salaries in the manufacturing industry, with the average net salary in December 2018 being 1,698 lei, this representing 57.42% of the average net salary in the Romanian economy, in the same period. In the textile industry, the salary was 2,280 lei [1].
The value of production achieved in 2018 was 2197.7 million euros in the manufacture of wearing apparel and 1488.5 million euros in the manufacture of textiles – continuing the upward trend recorded in recent years (EUROSTAT – database). The main products made in Romania in 2018 are cotton yarns and cotton type – 16,756 tons, wool yarns and wool type – 28,057 tons, fabrics – 91,458 thousand sqm, non-woven textiles – 31,691 thousand sqm, knitwear – 14,222 thousand pieces, garments textile materials – 9,741,907 thousand lei [14].
Romania exports in 2019 clothing products totalling 2,703 million $ and textile products totalling 1,507 million $. As it can be seen from figure 3, garment exports decreased much compared to 2006, when they occupied the second position in the top of garment exports products of the manufacturing industry. They represented 17.39% of the products of the manufacturing industry. In 2019, these exports represented only 4.30% of the exports of the manufacturing industry. Regarding Romania's exports of textile products, they register an ascending trend, doubling compared to how they were in 2006 and reaching 1,508 million $ in 2019 (figure 4) [15].

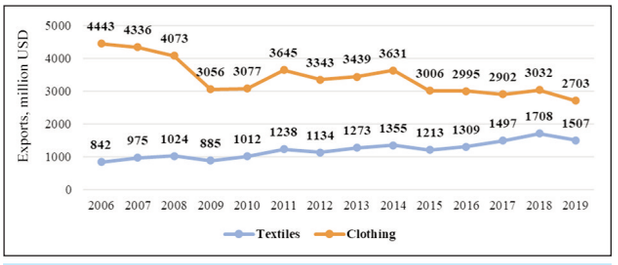

Fig. 3. The evolution of Romanian exports (textile, clothing), 2006–2019

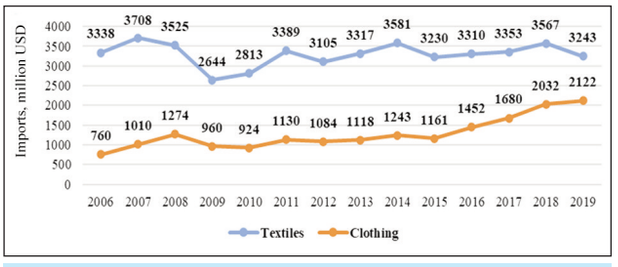

Fig. 4. The evolution of Romanian imports (textile, clothing), 2006–2019

Imports of textile products vary slightly around 3,300 million $, more precisely in 2019 they were 3,243 million $ – the trade balance remains negative this year as well. Imports of clothing products have increased significantly in recent years, reaching 2,122 million $ in 2019 [15].

EQUATIONS CUSTOMIZED CLOTHES USING TEXTILE WASTE – SUSTAINABLE SOLUTIONS FOR THE TEXTILE INDUSTRY

At present, the predominant production model in the Romanian garment industry is the linear one. Due to the multiple advantages of the circular economy, we consider that it is particularly important to make the transition to this type of production in all economic sectors and especially in the textile industry. Many authors consider that the transition from the linear to the circular economy is much more difficult in the fashion industry [16–18]. This is due to current business

models such as fast fashion and large-scale production [19]. Another reason is the increase in consumption due to falling prices and the diminishing quality of clothing [20]. This overconsumption is stimulated by design through fast fashion, resulting in short-term use of clothing products, psychological obsolescence and premature disposal [21].

Despite all these difficulties, there are many companies that have understood the importance of the transition of this industry to a circular system and have taken various measures in this regard. Cristina Osterman et al. presents 10 business models from the fashion industry that through different resource use strategies have managed to reduce materials use and consumption or closed-loop. The value creation processes of the all cases presented involve recycling of products, materials, and waste; upcycling; material design; supplier and customer connection; product-based access to services and results; access to product functionality; and meeting excessive capacities with insufficient capacities [16].

Another example is a group of 90 companies (including large companies) representing 12.5% of the global fashion market that in 2018 signed a commitment called “2020 Circular Fashion System commitment”. Through this commitment, they aim to achieve at least one of the lines of action in order to accelerate the transition of the fashion industry to a circular fashion system. The 4 lines of action included in the commitment are: implementing design strategies for cyclability, increasing the volume of used garments and footwear collected, increasing the volume of used garments and footwear resold and increasing the share of garments and footwear made from recycled post-consumer textile fibres [22].

Fischer and Pascucci analyse how requirements for transitioning to a circular economy create new organizational forms in inter-firm collaborations, and ultimately how they stimulate the emergence of new institutions enhancing sustainability. They identify two pathways to transition into the circular economy and to manage circular material flows, one focusing on optimizing materials and raising industry standards and another focusing on cascading and shifting in ownership [23].

Making customized clothes from textile waste in the clothing industry could be a solution to reduce waste in the textile industry [24]. In this article, the solution proposed by the authors is in line with what the literature proposes as opportunities for a more sustainable clothing industry, but also brings consumer involvement in this endeavour [25–27]. One of the solutions to reduce waste could be to include the patterns of other clothing items in the initial marker. The efficiency of the marker-making depends on the type of product, its model, the type of material, the number of framed products, etc. The new products can be made entirely of a single type of material or different combinations of materials can be used. In order to obtain the highest possible marker efficiency, we propose the creation of models of clothing items whose landmarks can be inserted in the existing marker.

In order to help the customer with the necessary support in choosing and designing the desired product and for him to be able to view the product on the computer before it is executed, the design of several clothing items was made in different combinations of materials.

To show how the combinations will glance in the final products of clothing, the program Inkscape ver. 0.92 were used (https://inkscape.org). Inkscape utilizes Scalable Vector Graphics (SVG), an open XML based W3C standard, as the main file format.

The models were created with the assistance of the online tools Art of Where Plain Lab (https://artofwhere.com).

The created models are full-bodied shroud type skirts with thick improving groups. Botanical themes were utilized, which can be considered by implication as geometric components. The model was made utilizing floral motifs with 45º rotation. Skirts will match with easy-going and dressy tops for adaptable styling alternatives. A creased plan with a good fit makes a lovely outline. The model can be overhauled with a belt, which will carry definition to the look.

The created designs are fitting for skirts, yet for different garments as well. Fitted sleeveless tops were designed as well. They make an extraordinary expansion to an easy-going assortment. They have a rib-sew structure, which gives a finished completion of the item. Squandered texture with a trace of stretch offers an adaptable fit for the day solace of the user. It tends to be matched with an assortment of bottoms and layering pieces for flexible styling (figure 5).

Fig. 5. The material combinations in the completed garment

The models can be presented to the customers and once they chose the desired product, the product realization can be taken into account, in the size requested by the customer.

Gemini CAD program was used for the pattern design, cutting plan and marker optimization of garments whose designs were made.

Initially, the marker contained only the parts of two dresses, sizes 40 and 42. As it can be seen in figure

6, between the parts of the two dresses there are large free spaces that will generate a significant amount of waste after the cutting plan. Due to these large free spaces, the maximum nesting efficiency was just 66.28%.

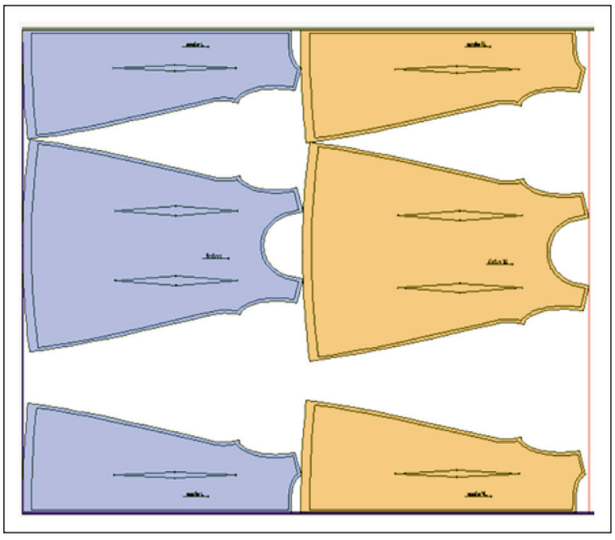

Fig. 6. The marker of the dresses for 40 and 42 size

The main objective was to find a minimum-waste arrangement of the parts to be cut without overlap. In order to reduce the empty spaces and to efficiently nest a variety of parts in these spaces, between the dress's parts were inserted the parts of two sleeveless tops and skirts. In the Gemini Cut Plan application, we set the number of pieces made for each model and size and some general settings regarding cutting: the preferred spreading length, the maximum number of sheets in the lay and the fabric's width (in case not all parts of a product can be inserted on a single sheet they can be placed on another sheet).
Through this operation, the amount of waste resulting from the cutting was significantly diminished, as can be seen in figure 7. By introducing the patterns of the sleeveless tops and skirts among the two dress patterns, the high nesting efficiency was 76.81% respectively 84.13% (compared to 66.28% as it was initially).

CONCLUSIONS

Textiles play an important role in the Romanian manufacturing industry, contributing considerably to economic growth and job creation. On the other hand, current production models generate a negative impact on the environment, an impact that has continued to grow in recent years.
Promoting a circular economy is one of the biggest challenges that our societies face. The transition to a circular textile system requires a fundamental systemic change throughout the textile value chain supported by appropriate policies. Along with technological innovation to improve efficiency and reduce environmental impact, new business models and policies must be adopted.
The model proposed by us comes to complete the numerous solutions for reducing textile waste by involving the consumer in this approach. As numerous studies show that, more and more consumers are interested in customizing their clothing products [28] and that they are willing to purchase products made through sustainable technologies [29] leads us to believe that this type of product will have a share in the future and that they will be among the consumer preferences.
In addition, the implementation of this model will bring numerous benefits to the company. The manufacturing of customized clothes using textile waste implies the decrease of the company's expenses with the acquisition of necessary materials in order to produce them. Moreover, the amount of production waste will entail cost reduction in waste management. All this will be reflected in the product's selling price and in the company's profit.
In the medium and long term, by promoting the products whose realization contributes to the decrease of the pressure exerted on the environment, the company will improve its image and will thus be able to increase its market share, thus increasing its economic benefits.

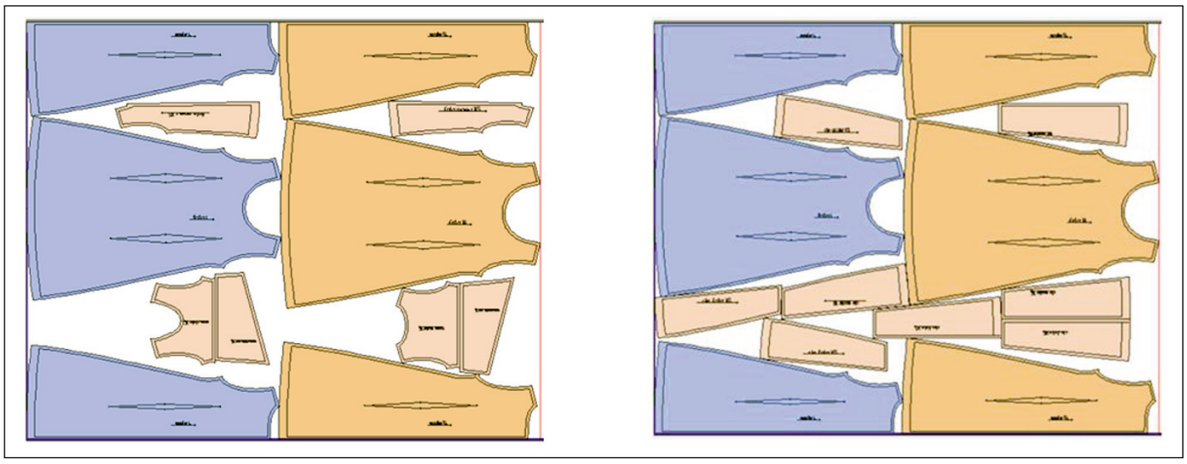

Fig. 7. The marker of the dresses, t-shirt pattern and skirts pattern

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