

Textile Pollution Reduction: Circular Economy in the Textile Industry

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Abstract—Today, searching alternative methods to achieve the pollution reduction in the world has become a key to increasing quality of life. Textile industry is a big contributor to the increase in soil, water and air pollution because the production model most used in this industry is what is known as fast fashion. To reverse the current situation, the textile industry should comply with the United Nations' Sustainable Development Goals, since one of them emphasizes the need for sustainable consumption and production patterns. To achieve this goal and thus reduce textile contamination, it is important to promote circular economy. The principal purpose of this paper is to discuss the inclusion of circular economy in textile industry to reduce the waste generated by reduction, recycling and reuse. To achieve this, this work is organized as follows. First, there is a description of the problem related to fast fashion, the causes that give its origin and consequences that can generate. Secondly, the model of production called circular economy is going to be described. Once explained, three types of circular economy that are presented in the industry are going to be introduced, namely, downcycling, upcycling and cradle to cradle. Finally, an analysis and discussion about its feasibility in relation to this problem is introduced with the objective that make aware about the need to reduce textile pollution and its environmental impact implementing this economic model. This paper is expected to contribute to the analysis of the problem of textile contamination and the promotion of circular economy in the field of electromechanical engineering.

Keywords: Textile Pollution Reduction; Circular Economy; Downcycling; Upcycling; Cradle-to-Cradle

Resumen— Actualmente, la búsqueda de métodos alternativos para reducir la contaminación en el mundo se ha vuelto una la clave para mejorar la calidad de vida. La industria textil es un gran contribuyente en la contaminación de suelos, agua y aire debido a que el modelo de producción utilizado actualmente en la industria es el conocido como moda rápida. Para revertir esta situación, la industria textil debería cumplir con Objetivos de Desarrollo Sostenible de las Naciones Unidas, ya que uno de ellos enfatiza la necesidad de patrones de consumo y producción sostenibles. Para lograr este objetivo y reducir la contaminación textil, es importante promover la economía circular. El propósito de este trabajo es discutir la inclusión de la economía circular en la industria textil para reducir la contaminación generada por medio de la reducción, el reciclaje y la reutilización. Para lograr esto, este trabajo se organiza de la siguiente forma. En primer lugar, hay una descripción del problema relacionado con moda rápida, las causas que le dan origen y sus consecuencias. En segundo lugar, el modelo de producción llamado economía circular será descrito. Una vez explicado esto, se introducirán tres tipos de economía circular que se presentan en la industria, las cuales son infrarreciclado, suprarreciclado y reciclado de la cuna a la cuna. Finalmente, se introduce un análisis y discusión sobre su viabilidad con

relación a esta problemática con el objetivo de concientizar sobre la necesidad de reducir la contaminación textil y su impacto ambiental implementando este modelo. Se espera que este trabajo contribuya al análisis del problema de la contaminación textil y la promoción de la economía circular en el campo de la ingeniería electromecánica.

Palabras claves: Reducción de la Contaminación Textil; Economía Circular; Infrarreciclaje; Suprarreciclaje; Reciclado de la Cuna a la Cuna

I. INTRODUCTION

Today, searching alternative methods to achieve the pollution reduction in the world has become a key to increasing quality of life. Textile industry is a big contributor to the increase in soil, water and air pollution [1] because the production model most used in this industry is what is known as fast fashion. This model is based on the large production of low-cost, low-quality clothing, which implies a greater consumption of natural resources, greenhouse gas emissions, and the generation of textile waste.

To reverse the current situation, the textile industry should comply with the Sustainable Development Goals (SDGs) proposed by the United Nations. Sustainable consumption and production are part of SDG No. 12, which emphasizes the need to “Ensure sustainable consumption and production patterns” [2, p.55]. This goal aims at increasing “net welfare gains from economic activities by reducing resource use, degradation and pollution along the whole life cycle, while increasing quality of life; in other words, industries are expected to do more and better with less”. [2, p. 55]. More precisely, target 12.5 highlights that it is necessary to “By 2030, substantially reduce waste generation by prevention, reduction, recycling and reuse” [2, p. 56]. That is, this target aims to reduce waste generation by means of different methods and strategies.

To achieve the target 12.5 and thus reduce textile contamination, it is important to promote circular economy. This is a type of economy which aims to keep products that have reached the end of its life in the economy by reusing and recycling. Thus, the product considered as waste can be turned into a resource that can be productively used again, so as to create further value and reduce waste to a minimum. [3].

With the application of the circular economy, the amount of textile waste generated will be reduced. To do this, it is necessary to design durable garments, promote the rental and exchange of garments, and recycle textile waste so that it can be transformed into raw material again. By applying these

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activities, the amount of waste that ends in landfills or incinerators will be minimized. In this context, the circular economy can have a great impact on the textile industry, reducing its pollution produced and improving its sustainability.

The purpose of this paper is to discuss the inclusion of circular economy in textile industry to reduce the waste generated. To achieve this aim, this work is organized as follows. In the first place, a description of the problem related to fast fashion, the causes that give its origin and consequences that can generate are going to be described. In the second place, the model of production and consumption called circular economy is going to be described. Once explained, different types of circular economy that are presented in the industry are going to be introduced. Finally, an analysis and discussion about its feasibility in relation to this problem is introduced with the objective that make aware about the need to reduce textile pollution and its environmental impact implementing this economic model. This paper is expected to contribute to the analysis of the problem of textile contamination and the promotion of circular economy in the field of electromechanical engineering.

II. TEXTILE PRODUCTION POLLUTION

In the 1990s, a new production model was introduced in the textile industry allowing for the launch of new collections within a matter of weeks, reducing production times but likewise drastically increasing pollution. This model, known as fast fashion, is based on mass production at low costs. However, this large-scale production and rapid fashion changes result in a significant amount of textile waste. Day by day, this has been increasing, making textile pollution a major contributor to environmental contamination. Additionally, the intensive use of water, the utilization of chemicals in garment manufacturing, and employment of synthetic materials contribute to environmental pollution [4]. As the consumption of textile products increases, especially in emerging economies, the environmental impact of textile industry could expand greatly. In Fig. 1, it is possible to observe the increase in environmental impact if the emerging markets inside textile industry achieve Western per capita consumption levels.

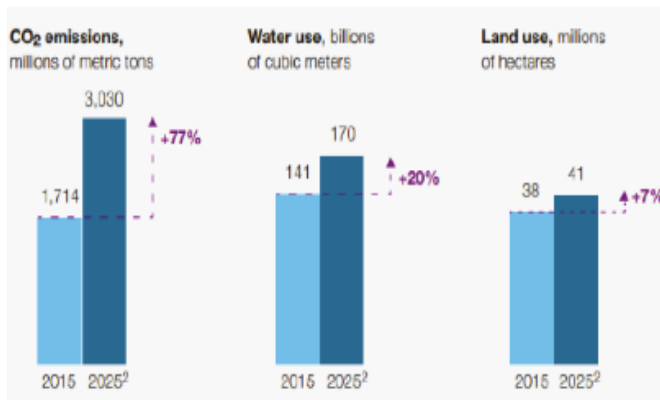


Fig. 1. Environmental impact of the textile industry in emerging markets [5]

In this way the environmental impact generated by the textile industry is shown and the future consequences that it

can cause if measures are not taken in this regard are evident. To solve this problem, in other words, to mitigate the environmental impact in the future, a sustainable economic model must be implemented in the textile industry.

III. CIRCULAR ECONOMY

Textile industry is one of the oldest and fastest growing industries in the world. Also, it is essential for society and industry in a variety of ways. First, it is an important source of employment as a result of its great demand for labour. Second, its exponential growth is a source of capital to finance investments in technology-intensive industrial activities.

In the last years, the production of clothing has almost doubled as a result of the growth of the fast fashion industry. This has generated large amounts of waste and caused great environmental, economic and social consequences. To avoid, it is necessary to develop environmentally friendly processes at all stages, from the production of raw materials to the management and design of flow of waste. This requires the transition from a linear model to a circular model, which is based on resource restoration and rational consumption [3]. Fig. 2 shows a traditional production life cycle in textile industry.

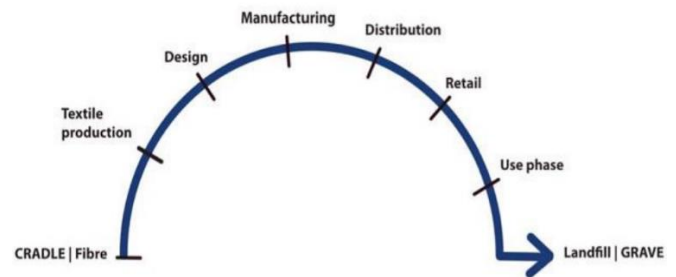


Fig. 2. Stages of a linear production in the textile industry [10].

The circular economy model is more effective than the traditional linear economy model in terms of sustainability. The linear model is based on producing a product, using it, and disposing of it. On the other hand, the circular model promotes opportunities that generate a large environmental and economic impact such as the reduction in the use of resources (energy, water, land, and materials) that helps mitigate greenhouse gas generation and risks associated with the supply of raw materials, such as price volatility, availability and import dependency [3]. That is to say, the use of products and materials are stored and maintained in closed-loop cycles and associated waste, energy and emissions are minimized and gradually phased out.

In the textile industry, the circular economy focuses on reducing material waste and pollution through the design of reusable and recyclable products. This makes it possible to create a sustainable cycle of production and consumption of garments, extending the useful life of the clothing and taking advantage of the materials at the end of their use. Thus, a more sustainable management of resources is promoted and the environmental impact is reduced.

IV. TYPES OF CIRCULAR ECONOMY

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The circular economy can be classified according to the way in which resource and waste management is approached. There are three types of economies that can be used successfully in the textile industry, namely, downcycling, upcycling, and cradle-to-cradle. These three economies have a similar process but with different results. Likewise, each one has different characteristics in its implementation, which will be presented below.

A. Downcycling

It is an approach that is based on collecting discarded products and recycling or reusing them to create another product. Unlike upcycling, in this approach, the original product is of higher quality than the recycled materials. This reduction in quality can be expressed functionally and economically [8]. An example of this is downcycling recyclable clothing by a mechanical process to obtain fibers which are blended with virgin fibers and finally form part of recycled yarn [9]. The clothes produced with this yarn are sold as second-hand clothes. Fig. 3 shows a production life cycle of a downcycled product.

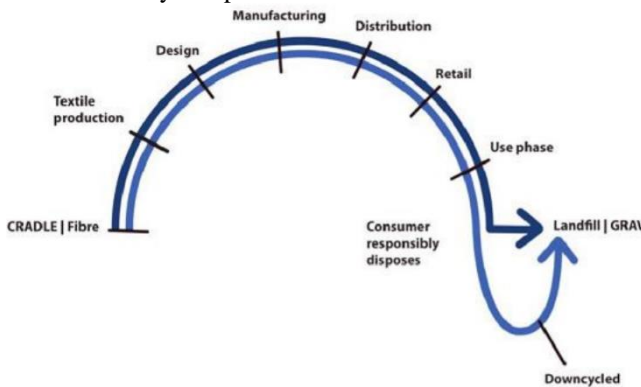


Fig. 3. Comparison of the stages of a linear production to the stages of a production with the downcycling approach [10].

B. Upcycling

It is an approach that is based on the repairing and updating of discarded products. Thus, products and materials which are obsolete or are about to be disposed, by different means, are instead repurposed, upgraded and remanufactured with the objective to make more valuable products, as [6] describes. An example of this is upcycling the textile waste by means of different chemical process to obtain copolymers which are part of new and most value product used to remove lead (Pb) in remediation of wastewaters [7]. Fig. 4 shows a production life cycle of an upcycled product.

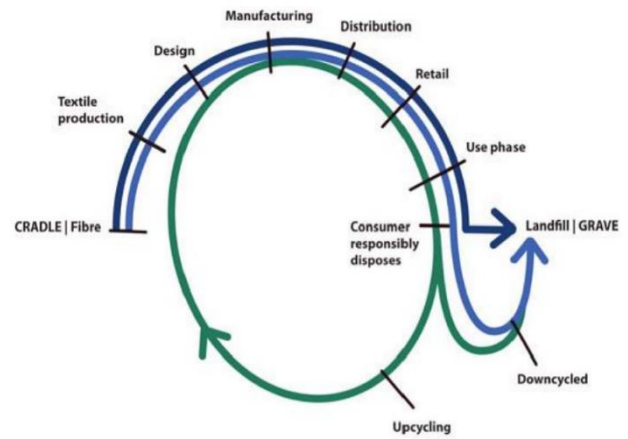


Fig. 4. The stages of linear production, production with a downcycling approach and production with an upcycling approach. [10].

C. Cradle to Cradle

Cradle to cradle is an approach that is based on the transformation of waste into resources for new cycles. This approach is different from the others because its objective is to produce raw materials instead of products. To achieve this, it is necessary to apply redesigns of products and industrial processes so that used materials can be regenerated. An example of this is the fabrication of nylon 6 Econyl, which is designed from raw materials regenerated from post and pre consumer waste [10]. Fig. 5 shows a production life cycle if a product is regenerated by cradle to cradle.

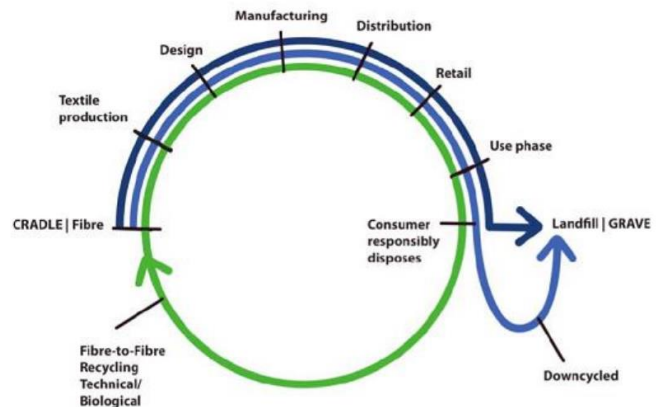


Fig. 5. Stages of linear production, production with a downcycling approach and production with a cradle-to-cradle approach [10].

All types of circular economy introduced in this section present similar processes and different results, which is why they are applied with different objectives. However, the three types can be analyzed in relation to the current situation of the textile industry and thus discuss their viability.

V. ANALYSIS OF VIABILITY

All types of circular economy introduced are very good options to reduce textile pollution. Each of them contributes with an increase in sustainability in this industry. However, they also present characteristics that do not favour the industry in other aspects. To go deeper, aspects of each approach will be described using real examples from the textile industry.

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The downcycling approach allows new products to be obtained through simple methods. For example, according to [11], at TransAmerica facilities, about 50% of what arrives is damaged or stained and it is recycled into cleaning cloths, carpet padding and sound insulation for other industries. This method can be carried out in a short time and it keeps textiles out of the landfill for an extended period. However, these materials eventually will end up in this place. Also, the implementation of these materials is too limited, and they do not generate large income for the industry.

The upcycling approach allows a new product of greater value to be produced from a discarded product. For example, Upcycled by Miu Miu is a special collection of vintage dresses designed by Miu Miu - transformed. Once restored, the garments are remodelled and finished with Miu Miu's signature embroidery and embellishments [12]. Although this increases the value of the garment, the methods used are generally artisanal and time-consuming. Also, some people are not willing to buy these products because they often confuse them with second-hand products.

The cradle-to-cradle approach encourages the development of new technologies such as the creation of fibre-based fabrics such as Econyl and Returnity. For example, Econyl is a fibre made from abandoned fishing nets on the high seas. This type of fibre is recyclable and reusable, allowing it to adapt to multiple uses [13]. On the other hand, Returnity is a recyclable polyester fabric that replaces not only traditional polyester, but also cotton and wool-based fabrics. This fabric reduces the CO2 impact, waste management and water use [13]. However, these materials are more expensive than traditional materials because their production involves complex and expensive methods [13].

In summary, each of these approaches presents challenges on the economic side of the industry. However, each of the approaches influences different areas of this aspect of the industry. On the one hand, downcycling provides a quick solution to give new life to discarded textile products, but this new useful life does not extend too much. Furthermore, these new products do not generate large income for the industry. On the other hand, upcycling, despite generating higher value products, faces challenges in terms of production and sales times due to the erroneous perception of being second-hand products. Finally, the cradle-to-cradle approach encourages the development of innovative and sustainable materials, but its adoption is limited due to its higher procurement cost.

VI. CONCLUSION

According to what SDG 12 emphasizes, which is to ensure sustainable consumption and production patterns, and all the information analyzed in this paper, it is evident that the actual production model has lack sustainability. Although the presented approaches in this article contributes greatly to reduce textile pollution, they are not completely sustainable because they continue generate environmental impacts. Therefore, it is essential to invest in the new technique developments and technologies to achieve further mitigate pollution. This goal should not only be pursued by the current population, but also by the future generations who will play

a crucial role in the evolution to more environmentally friendly practices.

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