CIRCULAR PRODUCT DESIGN ASSESSMENT APPLIED TO CLOTHING PRODUCTS

SABINA OLARU, IONELA BADEA

National Research and Development Institute for Textiles and Leather, 16, Lucretiu Patrascanu street, Bucharest, Romania, email: sabina.olaru@incdtp.ro, ionela.badea@incdtp.ro

One of the major Strategic Innovation Theme and corresponding Research Priority for the next years is Circular Economy and Resource Efficiency, according to Euratex. Recently, the European Commission launched the new “Industrial Strategy for a globally competitive, green and digital Europe”, that will help deliver on three key priorities: maintaining European industry's global competitiveness and a level playing field, at home and globally, making Europe climate-neutral by 2050 and shaping Europe's digital future. In this context, innovation and market potential of the European textile and clothing industry involve the frequent use of the terms “Circular Economy”. Forward, the sector will operate according to a globalised and efficient circular economic model which maximises the use of local resources, exploits advanced manufacturing techniques and engages in cross-sectorial collaborations and strategic clusters. Although the benefits of the circular economy are fairly well understood, in reality there are few industrial examples of companies that have implemented a circular economy paradigm. Circular product design provides long-term sustainability performance for products, by applying the principle of “designing out waste”. This paper presents the application of circular product design assessment for clothing, by using two practical tools to assess products' circularity: HotSpot Mapping and Circularity Calculator (developed by Delft University of Technology, Netherlands). Generally, clothing products need major redesign to fit the circular economy, so it is essential to assess the potential of the various circular strategies such as Reuse, Repair, Remanufacture and Recycle.

Keywords: circular economy, clothing, design, circular strategies

INTRODUCTION

According to the document “Towards a 4th Industrial Revolution of Textiles and Clothing - A Strategic Innovation and Research Agenda for the European Textile and Clothing Industry” developed by EURATEX and European Technology Platform, the first seeds of this 4th Industrial Revolution are currently being sown in the European textile and clothing industry (Euratex, 2016). One of the major Strategic Innovation Theme and corresponding Research Priority for the next years is Circular Economy and Resource Efficiency, including the research priorities:

- Novel flexible process technologies to save water, energy and chemicals;
- High-tech textile recycling for circular economy concepts;
- Sustainable substitutes for hazardous or restricted textile processing chemicals or bio-chemistry based textile processing;
- Bio-refinery concepts using European biomass or waste for textile fibers;
- Greater use of EU-origin natural fibers.

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In this context, innovation and market potential of the European textile and clothing industry involve the frequent use of the terms “Circular Economy”. Forward, the sector will operate according to a globalised and efficient circular economic model which

maximises the use of local resources, exploits advanced manufacturing techniques and engages in cross-sectorial collaborations and strategic clusters (EC, 2016).

Although the benefits of the circular economy are fairly well understood, in reality there are few industrial examples of companies that have implemented a circular economy paradigm (Parida *et al.*, 2019). Furthermore, the demand-based redesign activities can help an organization to earn a profit (Paras *et al.*, 2019).

PRINCIPLES OF CIRCULAR PRODUCT DESIGN

Circular product design provides long-term sustainability performance for products, by applying the principle of “designing out waste”: fitting the product in a circular economy where the value of the product, its components and materials are maintained and not wasted (TUDelft, 2020). Circular product design provides solutions for understanding the product development processes for fashion to rethink, reuse or upcycle the waste in the production stage (Cuc and Tripa, 2018).

This paper presents the application of circular product design assessment for clothing, by using two practical tools to assess products' circularity: HotSpot Mapping and Circularity Calculator (developed by Delft University of Technology, Netherlands).

The selected product is a quilted jacket for women composes by main material doubled with a thermal layer/padding and the lining, made from synthetic textile material (polyester). The fasteners are plastic zippers for the front component and also for the pockets. The upper pockets are covers with flaps that fasten with metal staples. Also, little metal staples are used in order to strengthen the termination waist line pockets, on shoulders line, on the back and on the hips line (Figure 1).

Figure 1. Selected clothing product for circular product design assessment

Gentle Dismantle

The disassembly took around an hour for the woman jacket using 10 cm and 25 cm shears/scissors and included the take off the lining, the labels, the trimmings and the collar, then the front zipper, the collar, the sleeves, the back and the front (Figure 2). The hardest part was to detach the stitches in the hip line and the metal staples.

Figure 2. Disassembly map of the selected clothing product

HOTSPOT MAPPING (HSM)

This tool was used to analyze the product architecture through the dismantling of the product, and mapping the key properties of all components, such as material, weight, ease of disassembly, likelihood to break, and more (Flipsen *et al.*, 2020). The tool spotted the critical points in the product architecture related to key circularity metrics (Figure 3):

- **Lining** was prioritised because of the time to cut the assemblies with the main material, especially in the hip line and sleeves line where the stitches were reinforced with a tape made for the same main material.
- **Trimmings and inner collar** were prioritised also for the time of disassembly. One edge of these components is attached to the zipper by multiple stitches.
- **Back** was prioritised on environment and economic impact. It gathers a larger mass of material made from synthetic fibres (polyester).

These 3 hotspots actually are inter-related and focus the functionality of the product. They were prioritized because of the time to detach but the resistance of the stitches is very important for the durability of the jacket during wearing. The quilted back doubled with the thermal layer assures the protection against external factors like cold, rain or wind.

Figure 3. Hotspot mapping of the selected clothing product

CIRCULARITY CALCULATOR

The tool was used to quantify key circularity metrics and develop circular scenarios based on the data from the early stages of product development. These metrics include resource circularity and potential value capture for different circular scenarios (IDEAL&CO Explore, 2020).

Generally, clothing products need major redesign to fit the circular economy, so it is essential to assess the potential of the various circular strategies such as Reuse, Repair, Remanufacture and Recycle.

Linear Scenario

The linear scenario is actually not circular but recycled materials are used for the metal staples and that means there is a loss of 33.4 k€ in total (Figure 4).

Figure 4. Linear scenario of the selected clothing product

Circular Scenarios

The disassembly of the jacket is a destructive one so it cannot be easily reassembled. And this is the general case of clothing products. In the redesign the trimming strategy can be applied by rethinking the use of stitches for lining assembly with reversible fasteners like Velcro band, zippers or unconventional (activated by heat) so the disassembly can be done very easy.

In the first circular scenario, the collected used products were assumed to 40% after applying offers of free shipment and a buy-back programme. In this case, the circularity increases to 36% and the value capture to 8%.

Refurbish

In the refurbish scenario, it was assumed that 80% of the collected used products can be refurbished and reused. In this case, resource circularity increases to 37% and the value capture to 8% (Figure 5).

Figure 5. Refurbish scenario of the selected clothing product

Recycling

The recycling scenario increases the circularity to 66% and the cycled content to 94%. In the same time, the value capture decreases to 2%. The assumption in this scenario is that all the polyester materials are 100% recycled (figure 6).

Figure 6. Recycling scenario of the selected clothing product

CONCLUSIONS

By using these two tools, substantiated criteria and facts were obtained to decide which are the most promising circular design strategies for the particular context. The tools pointed to the most significant contributors to the effective implementation of circular strategies.

The most promising circular scenario is the recycling, by using recycled materials and also recycled products after use in 40%. The business model is a circular and sustainable one, and the changes in the product architecture/design the trimming

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The opportunities are indeed not using virgin raw materials wherever possible. The bottleneck will be the collection of the products since the buy-back strategies are not so user friendly nowadays.

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