

Textile waste in the concept of circularity

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Due to overproduction and consumption resulting from consumer behaviour, the clothing industry is defined as one of the most polluting industries in the world due to the fast fashion concept and has severe environmental consequences (water and energy consumption, CO₂ emissions, waste disposal practises etc.). Therefore, the inevitable integration of fashion into everyday life extends beyond social alterations through beliefs, perceptions, psychology, brands etc. and is translated to water consumption (100 L of water/fabric), air emissions, soil degradation, energy consumption and pollution (European Environment Agency (EEA) 2019; Gyde and McNeill 2021; Li et al. 2014). More than 92 million metric tons of textile waste are produced every year, accounting for 400 billion USD with the annual consumption of textiles being 13 kg/person and a recycling rate of 15%. 3000 billion USD are held by the fashion industry equalling to 2% of the Gross domestic product (GDP) of the planet (Shirvanimoghaddam et al. 2020).

As natural resources for the production of clothing are becoming scarce due to climate change, new raw materials must be introduced for the textile industry (Provin et al. 2021; Shirvanimoghaddam et al. 2020). For this reason, Circular Economy has gained significant attentions in today's fashion industry, especially after the inspiration fostered by the European Green Deal and the introduction of the UN Sustainable Development Goals (SDGs) (Das et al. 2021). The use of waste as raw materials in the fashion industry has been an area of interest for the replacement of natural sources in industrial processes (i.e., conventional dyeing techniques) with sustainable solutions (i.e., colorants from ores, plants, insect, microorganisms, food waste and redyeing) (Gupta, Shukla, and Agarwal 2019). Such practises have been found to have less environmental consequences (i.e. redyeing textiles uses 90% and 85% less water and energy respectively) (Gupta et al. 2019; Sugiura 2019; Yun et al. 2020). The use of food waste which constitutes 40% of solid waste and 1.3 billion tons annually around the globe, is a source of biomaterials and can be used for the construction of main polymers (i.e., nylon 66 and nylon 6) used in the fashion industry (Agapios et al. 2020; Provin et al. 2021). At the same time, wasted non-biodegradable polymers like poly-ethylene terephthalate (PET) upcycled to biodegradable polymers (R-PET) have been found to have 55% less carbon emissions and 55% less water consumption for the production of clothing (D'Adamo and Lupi 2021). Furthermore, mass production of classic raw materials in the fashion industry like cotton and line, can be replaced by waste products like pineapple plants for the decrease of their environmental consequences. Specifically, 27 million tons of cotton are produced each year, with 15 billion tons of water demand for production and approximately 2700 L per one cotton t-shirt (The World Counts 2022).

The development of a new business circular model is essential for the fashion industry in the framework of waste management. Such transition, requires drastic change of behaviour from both consumers and the industry (markets and production line). The new circular business model must entail new strategies towards circularity by using the R-strategies (i.e., reuse, recycle, refurbish, remanufacture, repair, reduce, re-think, repurpose, rent, recover etc.). This new mindset, will provide the stepping stone for the innovation towards a new strategy and vision through motivation, regulatory relief measures, education, promotion and smart application by the development of a trusted environment (i.e., through Key performance Indicators for monitoring circularity, LCA, end-of-waste criteria and quality protocols). Such thinking, will lead to the development of a new eco-design which will entail the monitoring of supply and demand, the recycling rates of the fashion industry, the use of waste as raw materials, smart branding of sustainability and innovation through new technologies (Provin et al. 2021; Zorpas, Navarro-Pedreño, et al. 2021; Zorpas, Doula, and Jeguirim 2021).

Lastly, a critical axis to the successful development such model concerning customer behaviour, is the willingness to pay (WTP). WTP demonstrates a growing interest regarding consumers' attitude towards sustainability. The dilemma of the customer is accompanied by the origin of the product (from waste or not) and the branding of it (labelled or non-labelled) and it is deeply related to the customer's ability to pay as it has been demonstrated that WTP

for green products increases with higher income rate and paying capacity (Xiong et al. 2018). Taking into account the psychological dimensions of fashion, the next steps towards circularity through a new eco-design of the entire textile production line, from raw materials to markets to the consumer, must be adopted.

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