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The perception of circular economy in the framework of fashion industry

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Abstract

Humanity's three main components are energy, food and clothing. Each of us, individually and collectively, contributes to climate change and CO_2 emissions, natural resource consumption, and social attitudes and behaviour. Global fashion trends are expected to increase in value from 1.5 trillion dollars in 2020 to around 2.25 trillion dollars by 2025, indicating that the fashion demand is on the rise. Due to climate change, soil and water scarcity, and a variety of other diseases, new natural resources must be developed from plastic fibres, natural colours must replace synthetic ones, water consumption must be reduced and the 'buy-and-throw-away philosophy' must be replaced with 'buy-less-and-these-are-needed' and incorporate the 12 'R' strategies to aid the transition to a circular economy. In the context of waste management as well as on the development of new strategy approach, the fashion industry requires a new business circular model and furthermore a new mindset.

Keywords

Business circular model, fashion development, plastic pollution, waste strategies

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Introduction

The fashion industry has a strict relationship to waste, as waste production is central to the operation of it. Fashion in today's world is based on everlasting stylistic change while operating withing the boundaries of an aesthetic market which replaces the old with a new. To establish and maintain this perpetuated '*fresh and fashionable*' movement which includes attitudes, self-expression, confidence, branding and glamour, the fashion industry must discard the '*irrelevant*' and categorize it as rubbish at disposal (Binotto and Payne, 2017). Consequently, in today's world, '*buy-and-throw-away philosophy*' in regards to clothing is strictly linked to '*fast fashion*', together maintaining the core cause of the overconsumption of textiles, raw materials, water and energy (Yan et al., 2021). More clothes are being produced, consumed and discarded than ever before. Between 2000 and 2014, clothing production more than doubled, with more than 150 billion garments produced annually while in Europe (EU), 2 million tons (MT) of textiles are discarded annually. Consequently, the equivalent of one garbage truck of textiles is landfilled or burned every second (United Nations Progamme, 2018). There are external and internal factors that determine consumers behaviour. External factors include accessibility, availability and affordability – what products are available and whether they can be afforded. Internal factors are related with the needs of each individual. Also, commercial communications is key for influence. Recent neurological studies show that humans are less rational and disciplined in their purchases and emphasize what others buy (European Environment Agency, 2014). Consumer behaviour and overbuying tend to have serious environmental consequences, so severe that the textile industry upholds the fourth position in regards to pressure categories on the environment (after housing, transport and food activities). $400 billion worth of clothing are wasted annually worldwide with a global consumption of textiles to 7–13 kg per capita while only 15% of the 100 MT consumed are being recycled (Provin et al., 2021; Shirvanimoghaddam et al., 2020). Before a garment or product reaches the consumer, 35% of all materials in the supply chain end up as waste. This usually occurs due to cutting textile waste, unusable stock due to false monitoring of supply and demand and last-minute design changes,

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transportation errors and other (CO, 2018). According to EcoWatch (2021), on November of 2021, almost 60,000 tons of clothing and textile ended up at Alto Hospicio in northern Chile as a result of the production and discarding of clothing from the United States and EU, while in general, 39,000 tons of wasted textiles get shipped to the driest desserts of the world each year. In Kenya, over 140,000 tons of fashion waste are imported from the EU, United States and Canada, resulting in approximately 20 million kg of clothing to be landfilled annually (World Resources Institute, 2021). Fast fashion stakeholders (i.e., leading EU fast fashion brands (2019) Zara, H&M, Marks & Spencer, Primark, Next, Sports Direct, ASOS, Debenhams, New Look, Matalan, etc.) considered as cheap, speedy and fashionable products constitute the best fast fashion brands of todays' world due to the huge amount of sales each year (Yan et al., 2021). If fast fashion remains at its sales for much longer, it is estimated that by 2030 human kind will generate 148 million more tons of waste, while more than 22 MT of textiles will be added to marine environments between the years 2015 and 2050 (Greenpeace, 2016; Ellen MacArthur Foundation, 2021a). According to the United Nations, the fashion industry holds almost 20% of the total global waste produced (EcoFriendly, 2021) and eventually 39,000 tons of unsold and unwanted clothes get trucked to the driest desert in the world each year (EcoWatch, 2021). Moreover, Mazotto et al. (2021) pointed out that on a universal level the fashion industry formed around 150 billion pieces/year with 50% v/v to be disposed anywhere.

While more than 2% (almost $3000 billion) of the planets' GDP is obtained by the fashion industry, the social and economic significance of the clothing industry cannot be overlooked thus, strategic and targeted action to minimize the risk of an economic crisis are needed to make the industry 'greener' (EcoWatch, 2021; Shirvanimoghaddam et al., 2020). This dependency of the world's economy to the industry is expected to grow. The industry's trends are expected to expand from $1.5 trillion in worth (2020) to almost $2.5 trillion (2025) (EcoFriendly, 2021), with the US holding the first position regarding the production of textile waste, accounting for 17 million metric tons (MMT) annually.

This opinion paper focuses on tomorrow's fashion requirements based on production, sales and disposal data, in order to reduce their environmental impact in the context of circular strategy models that address waste management disposal practices, market needs and trends (particularly in fast fashion). The necessity of a new mindset development from both the industry and consumers is emphasized while the ability to pay (ATP) for a labelled or non-labelled product made from waste is introduced as a major point of investigation for a smooth transition to circularity.

Material and methods

The records were obtained using PRISMA statement Preferred Reporting Items for Systematic Reviews and Meta-Analysis (www.prisma-statement.org) (Figure 1) by using *specified inclusion criteria* like (i) year of publication (2019–current) through SCOPUS platform, (ii) reports and studies providing statistical data (from 2010 to current), (iii) review and research papers, (iv) papers published in English only and *exclusion criteria*: (i) Non-English papers, (ii) duplicates, (iii) insufficient data, (iv) irrelevant data to fashion and (v) statistical data from untrustworthy databases. The keywords used were 'Fashion' OR 'Textile' OR 'Clothing' AND/OR 'clothes' AND/OR 'shoes', AND 'Waste Management', AND 'circular economy', AND 'social attitude' AND/OR 'social behaviour'. In case of inconsistency, the authors debated whether or not a paper with no clear boundaries concerning inclusion and exclusion criteria was to be used, in order to minimize bias. From the 1201 record identified, 101 were selected according to the inclusion and exclusion criteria, 53 articles and 48 records.

Furthermore, primary data were collected through Eurostat, Statista and other sources, statistical sources per country and were evaluated though specific criteria such as accuracy and year of publication.

To assess the production of the waste per country where not a relevant number was provided, the waste generation rate (WGR) was calculated according (Loizia et al., 2021; Pappas et al., 2022; Voukkali et al., 2021) to the equation (1).

$$\mathrm{WGR} = \text{waste production in area (kg)} \times \text{citizens in same area (in one day)} \quad (1)$$

In addition, the Fashion Waste Production (FWP) per citizen in 1 year, where no relevant number was provided, was calculated using the equation (2)

$$\mathrm{FWP} = \frac{\text{Total fashion waste produced in selected country (kg)}}{\text{permanent population of selected country}} \quad (2)$$

Results and discussion

In a survey conducted in September 2018, Swedish consumers were asked when they get rid of clothes and 64% stated that they do when they are worn out while 50% of them threw away clothes due to no longer fitting size. The research also showed that 40% of consumers threw away clothing when cleaning their wardrobe, 35% when worn out beyond repair or reused elsewhere, 29% when getting tired of them, 10% when no longer in fashion, 6% when purchasing new clothing and 2% when the consumer changes their own style (Statista, 2022a).

When shopping for fashion, EU consumers are not completely inattentive to the environmental impacts the clothing items they purchase may have. According to a EU-wide survey form Fashion Revolution (5000 respondents), compared to other EU countries surveyed by Statista, shoppers in Spain (23%) avoid purchasing more clothing due to concerns about their impact on the environment. Then followed: Germany (20%), United Kingdom and France (18%) while Italy (11%) was the last country with the least concerned consumers (Statista, 2021a).

Italy as a whole had the largest share of sales of plastic apparel and clothing accessories in 2016, amounting to 18,123 tons. Italy

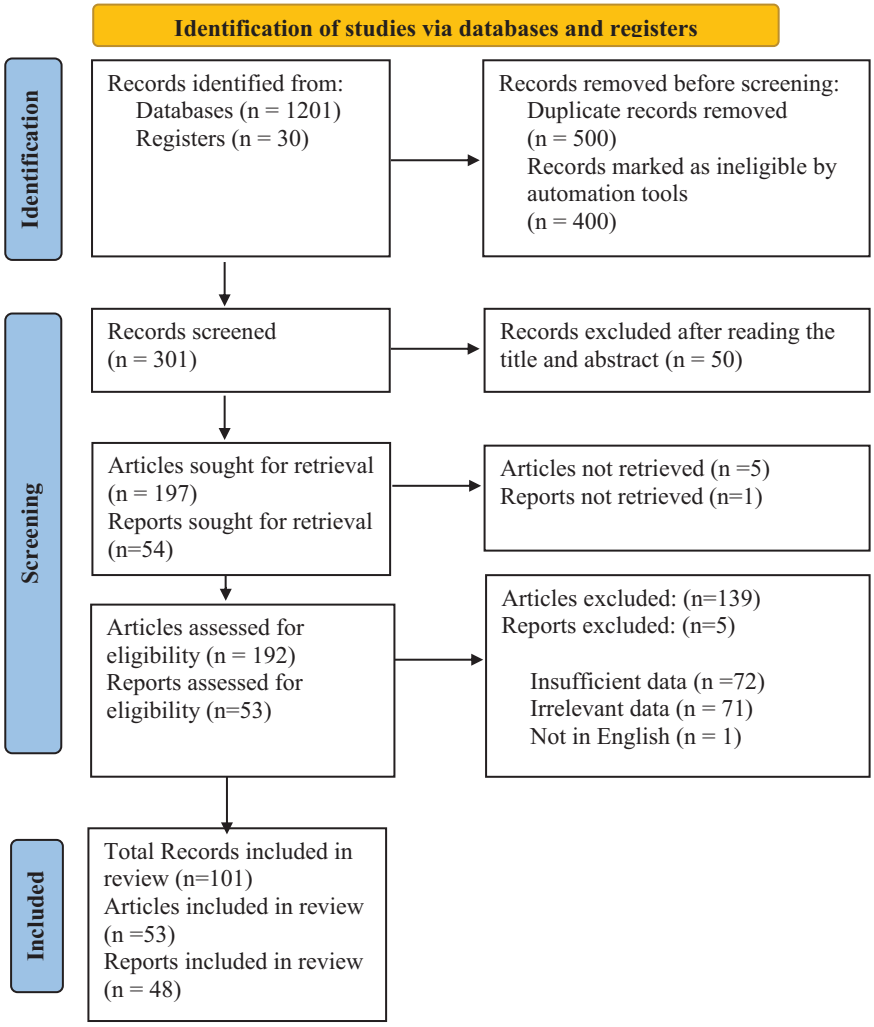

Figure 1. PRISMA statement for the identification of the eligible studies and reports of the presented review.

was followed by Hungary (1849 tons) and France (1496 tons). The following countries are Poland (814 tons), Spain (284 tons), Greece (182 tons), Estonia (177 tons), Chechia (124 tons), Lithuania (103 tons) and Denmark (10 tons) (Statista, 2021b).

Figure 2 illustrates interesting facts about the quantities of textile waste per country including EU countries and also the United States, Kenya, Canada, Australia, Chile and New Zealand. It allows comparison between the countries versus the waste production quantities which end up in landfills in kg/person in a year. Leading is the United States with 50.9 kg/person of textile waste in 2014 (EPA, 2016), followed by New Zealand with 36.6 kg/person (2020) according to Eunomia (2020) and the Ministry of Environment (2021). According to Koszewska (2018), for the EU countries for the year 2014, Cyprus is the first country in Europe to produce textile waste with 29.3 kg/person. Australian Bureau of Statistics (2013) reports 23 kg/person in a year 2013, for Australian residents. In addition, according to Table 1 (Statista, 2022d) the annual quantity of landfilled textile waste per person in Belgium is 8.40 kg followed by Czechia with 5.8 kg and Portugal with 4.6 kg. It is important to point out that the results provided from STATISTA was based on the year 2016 (Statista, 2022e).

Following the amount of textile waste of Koszewska, (2018) concerning the population of each country, (the provided FWP per country) Belgium follows with 16.1 kg/person, Luxemburg 14.4 kg/person, Chez Republic 8.6 kg/person, Austria 8.5 kg/person, Portugal 7.3 kg/person, Italy 7.2 kg/person, Poland 6.8 kg/person, Netherlands 5.6 kg/person, UK 4.3 kg/person, Germany 4.2 kg/person, Slovenia 4 kg/person, Finland 3.1 kg/person, France and Lithuania also 2.6 kg/person, Spain 2.3 kg/person, Bulgaria and Slovakia 2.1 kg/person, Croatia 2 kg/person, Ireland 1.7 kg/person, Hungary 1.6 kg/person, Estonia 1.5 kg/person, Romania 1.3 kg/person, Malta 0.7 kg/person, Sweden and Norway 0.6 kg/person, Denmark 0.5 kg/person, Greece and Latvia 0.1 kg/person. In addition, Canada in 2018 sent to disposal in landfills 12.9 kg/person (David et al., 2018; Environment and Climate Change Canada, 2021). Furthermore, data for the construction of Figure 2 were obtained by various reliable sources (Australia Government: Department of Agriculture, Water and the Environment, 2021; Eurostat, 2015; United States Environmental Protection Agency (EPA), 2016; Worldometer, 2022)

According to Eurostat data on waste generation in EU countries, Belgium had the highest recycled and reusable textile waste

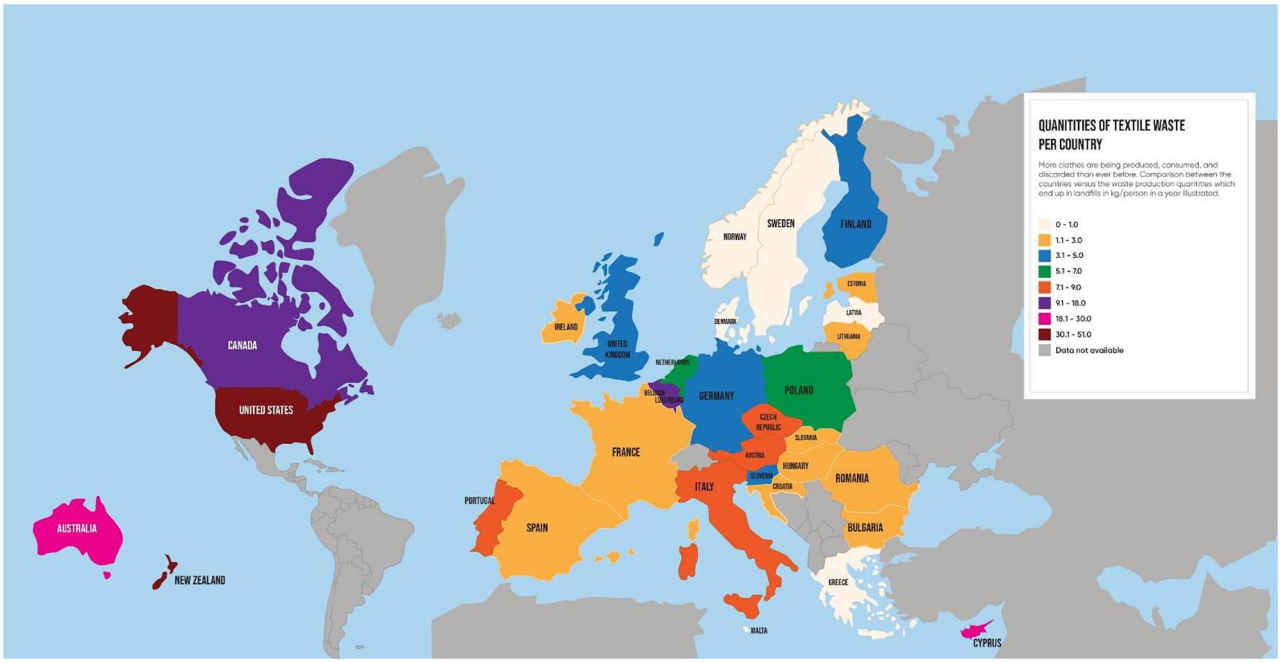

Figure 2. Mapping the textile waste volumes in each country.

Table 1. Annually total quantity of landfilled textile waste per person in selected EU states in 2016.

Country	Textile waste per person in kg
Belgium	8.40
Czechia	5.80
Portugal	4.60
Italy	4.40
Austria	4.00
Netherlands	3.40
Germany	2.70
Ireland	2.70
Denmark	1.80
France	1.80
UK	1.70
Poland	1.60
Finland	1.50
Hungary	1.40
Spain	1.20

production per capita in 2016, with an average of 1.5 kg of recycled and 1.2 kg of reusable textile waste. Belgium ranked among the leading five textile polluters in the EU. Czechia recycled 1 kg per capita and reused 0.8 kg per capita. Italy, which had the highest quantity of total yearly textile waste in the EU in 2016, recycled 0.8 kg per capita of textile waste and reused 0.6 kg per capita on average as well as Portugal. Austria recycled 0.7 kg per capita and reused 0.6 kg per capita, Netherlands recycled 0.6 kg per capita and reused 0.5 kg per capita, Germany and Ireland recycled 0.5 kg per capita and reused 0.4 kg per capita. In addition, UK, Denmark, France, Finland and Poland recycled 0.3 kg and reused 0.3 kg per capita. Closing, Hungary and Spain recycled and reused from 0.2 kg per capita (Statista, 2022b, 2022c).

The fashion industry has made significant steps towards sustainability and circularity (Niinimäki et al., 2020). Eliminating any stereotypes regarding circular thinking, like re-use of clothing through second-hand markets, the environmental and social effects of second-hand clothing along with added benefits of price reduction contribute key elements in the development of viable business models with essential benefits to consumers (Borg et al., 2020; D'Adamo et al., 2022; Kasavan et al., 2021).

Price reduction in regards to circularity development in the fashion industry must constitute a key element of the development of circular business models. As illustrated by Zorpas et al. (2021c), a strong correlation between income level and waste production exists which also translates to a correlation between income level and fashion waste production. The relation overtakes a more ethical dimension regarding fashion production like the occupational hazards arising from the close proximity of residential areas to a textile industry correlated with the standard of income as there is a higher level of danger for low and middle income countries (LMIC), space regarding LMICs as US exports around $700 million worth of clothing to LICs accounting for 5000 tons of used clothes and human rights in a work environment in LICs (Bick et al., 2018; Koch, 2019).

A typical waste management practice in Cyprus and Greece covers the disposal of apparel waste in dedicated waste bins throughout the cities (Figures 3 and 4). Such practices are common yet not effective as collection routes of such waste are neither known or applied. In particular, general municipal solid waste disposal practices in Greece are far from the EU average as in 2010, 374 kg of the 450 kg produced per person per year were disposed of in landfills (Eurostat, 2018). Regarding apparel waste, 100,000 tons of textiles are discarded each year in Athens and only 10% of them donated to charities. The reason for these

Figure 3. Textile disposal practises in Cyprus (social dimension).
Source: The photo taken by the authors.

Figure 4. Textile disposal practices in Greece.
Source: The photo take by the authors.

numbers is the solid establishment of fast fashion companies in Greece through a well-structured network compared to other more populated EU countries.

Figures 3 to 6 indicate dedicated textile disposal bins in Cyprus, Greece, Mulhouse and Corfu, respectively. The main difference regarding the four bins is that the clothing recycling bins in Greece, Corfu and Mulhouse indicate the garments that can be disposed of in the recycling bins (i.e. clothes, shoes, bags, linen) and what is not allowed in the bin (i.e. food, metal, glass, paper) while in Figure 8(a) of the clothing recycling bin in Cyprus, there is no such indication. On the other hand, Figure 8(b) indicates the textile recycling bins of PASYKAF organizations in Cyprus, where the types of textiles to be recycled are indicated clearly on the bin. PASYKAF is an organization of thousand members in Cyprus providing professional help and support for cancer patients. In addition, in Figure 7 shows the innovative action with Massimo Dutti's branding where they create fabrics from plastic bottles.

At the same time, according to Eurostat (2018), approximately 2000 tons of textile waste were disposed of in 2018 for a population of 1 million in Cyprus while in Greece 9000 tons were disposed of at the same time (for a population of 10 million) (Eurostat, 2018; The World Bank, n.d.). Even with a larger population, this accounts only for 9% of textile waste per household in Greece while for Cyprus 22%. This difference in numbers arise from the insufficient collection and handling routes in Cyprus as indicated in Figure 8(a). Such examples show the differences in the cultural dimension of sustainability and circularity in general, derived from the notion that sustainable development business plans and prevention actions fail to differentiate between different cultural systems, norms and behaviours, economic and ecological aspects of the specific area. The adequate change of behaviour regarding textile waste moves beyond the consideration of social ethics to the personalization of waste management strategies according to the subject area (Kozlowski et al., 2019).

Such example is provided by the case of Greece where according to Koukouvinos, (2012), disposal behaviours of apparel is strongly affected by societies where personal responsibility is encouraged by opposing forces like actions being '*inappropriate*' or '*immoral*'. The social attitude of Greek population is heavily influenced by social norms as well as the individual's concept of self-righteousness. Due to the heavy religious effect among the Greek – and Cypriot – population, there has been an increase in clothing exchange events through second-hand shops as well as textiles circulating through church donations.

Due to the '*buy-and-throw*' mentality, EU countries consume a large amount of fabric, with up to €350 billion in wasted textiles reported each year. At the same time, the Ellen MacArthur Foundation (2017) estimates that roughly $460 billion worth of clothing will be thrown away in the world, much of which will still be usable. While popular models like rental and resale have a lot of potential, they don't always achieve this decoupling and the associated environmental benefits. Fashion is still dominated by the linear operating model in terms of design, production and

Figure 5. Textile disposal practices in Mulhouse.
Source: The photo taken by the authors.

Figure 6. Textile disposal practices in Corfu.
Source: The photo taken by the authors.

consumption. Material innovation and recycling are critical components of the solution, but they are insufficient to sustain the fashion industry. Circular business models – one of the most important elements of a circular economy for fashion – must become mainstream in the industry to make this vision a reality (Appolloni et al., 2022; Colasante and D'Adamo, 2021; Ellen MacArthur Foundation, 2021a). In this context, it is mainly about how a new mindset will be developed for consumers and the fashion industry itself. According to Zorpas (2020), it is motivating as circular business models embrace the '*R*' strategies for their development like: *Refused* (the production of waste); *Reduce* (the volume of waste); *Re-accept* (new products made from waste); *Re-think* (purchase and dispose habits); *Re-use* (good quality clothes to extend their life-time); *Rent* (rent clothing instead of buying in the case of weeding for example); *Repair* (repair clothing that can be reused, rented or donated); *Recycle* (clothing that can be recycled); *Refurbish* (modernizing old clothing); *Remanufacture* (used parts of discarded clothing in a new product of the same function); *Repurpose* (discarded products usage in a new one with the same function); *Recover* (recover materials from textile and other waste for the production of raw materials to be used in the industry).

Without limitation, the approach in developing a new circular model with a new mindset for consumer behaviour must include: (a) key performance indicators to measure circularity, (b) smart application and a gamified approach for learning, (c) quality protocols and end-of-waste criteria as presented in Article 6 of the waste framework directive (Antoniou and Zorpas, 2019; Joint Research Centre and Institute for Prospective Technological Studies, 2009; Kazamias and Zorpas, 2021; Zorpas, 2016), (d) Life Cycle Assessment for the development of a product with infinite life cycles, (e) 10 'R'strategies approach in textile and clothe treatment, (f) a new eco-friendly design, (g) promoting renting activities and (h) sustain advertizing and awareness campaigns (Loizia et al., 2019; Voukkali and Zorpas, 2022; Zorpas et al., 2021b).

Further understanding of the implications and circular economy of the fashion industry can lead to the development of new '*R*' strategies with even more in-depth consideration of cultural and personal needs of consumers. *Re-wear* could be a new approach where clothing is not only *Reused* but is stored to be worn again at later times. As the industry has shown, fashion goes round in circles as trend come and go (Khan et al., 2022). Therefore, what is fashionable now is later on considered out of fashion and then back in fashion again. At the same time, clothes cannot only be rented but they can also be *Resold*, even after their purchase from secondary markets if in good condition (Dissanayake, 2022). Even if such strategies seem closely related and to some even identical, their uniqueness in their actual implementation could create a spiral of processes which can entail new understanding and innovation from consumers and the industry for the development of a targeted circular economy business plan.

Textile production entails a plethora of processes, each of which is carried out by a different set of players. To make

Figure 7. New textile design of recycled plastic by Massimo Dutti.
Source: The photo taken by the authors.

Figure 8. Failing (a) and success (b) of textile disposal practises in Cyprus due to insufficient waste management policies.
Source: The photo taken by the authors.

anything worn today, various types of fibres are required (from natural fibres, silk, to artificial fibres). To be used, several characteristics must be met, including strength, durability, appearance, resistance and texture (Mazotto et al., 2021). Cellulosic materials such as bamboo, cotton, line and hemp, as well as protein-based raw materials such as silk and wool, are essential in the fashion industry. The annual production of such materials for the fashion industry is estimated to be 53 MTs, with cotton accounting for 13 MT of that total (Ellen MacArthur Foundation, 2017). According to Statista (2021c), China will be the leading country in cotton production in 2021, with 6423 MMT, followed by India with 6162 MMT, and Greece in 10th place with 305 MMT. It is estimated that global cotton production will reach 28 MT in 2030, with a market price of close to $2000 per ton in 2030 (OECD and Food and Agriculture Organization of the United Nations, 2021). Simultaneously, the annual global demand for silk will be close to 202,000 metric tons per year (Common Obhective, 2018).

According to Mazotto et al., (2021), cotton accounts for 35% of existing fibres in the market (27,000,000 t/year) (The World Counts, 2022a), despite the fact that its production requires massive amounts of water (15,482,270,534 t/year) because 10,000 L are required for the production of 1 kg of cotton and approximately 2700 L of water for one cotton t-shirt (The World Counts, 2022b), $3,300,000,000 worth of pesticides, insecticides (16% of global insecticides releases) and around 3500 chemical fertilizers, 750 of which are deemed hazardous for human health and 440 of them hazardous for the environment (European Parliament, 2020). Cotton cultivation consumes about a quarter of all pesticides used in the agricultural sector each year. Furthermore, 1.5–6.9 kg of chemicals are required for every kilogram of clothing. Simultaneously, fibres made from petrochemical products, glass and certain metals are being developed or existing fibres are being regenerated to meet the fashion industry's needs. Furthermore, 60% of the fibres on the market come from monomers such as fossil oil feedstocks (Mazotto et al., 2021). According to Provin et al., (2021), more than 100 L of water per kg of fabric manufactured is required. Pineapple plants are a valuable source of natural fibres because their annual global production is estimated to be around 28 MMT and contains 80% cellulose. Despite the fact that the harvest was frequently burned (Pereira et al., 2021), they are regarded as a low-cost material for the extraction of high-value products. It was mentioned that

extract fibres (degummed and bleached) from pineapple leaf waste were used in textiles in India via suitable mechanical processing systems, thanks to the decortication of leaves accomplished by water retting.

Reusing and reprocessing textiles to recycle them into new garments has piqued the interest of the fashion industry (i.e. clothes made entirely of polyester), reducing waste to landfills (D'Adamo and Lupi, 2021; Zorpas et al., 2021a). As such, the use of waste non-biodegradable poly-ethylene terephthalate (PET) upcycled for the production of clothing (R-PET) has been found to use 50% less energy compared to virgin PET, with carbon emissions reduced by 55% and water consumption reduced by 20% (D'Adamo and Lupi, 2021; Zorpas et al., 2021c). Depolymerization of PET by hydrolysis, methanolysis and glycolysis is used to re-use regenerated raw materials as monomers for new polymerization processes, and the chemical recycling method provides value-added products from PET bottle wastes (i.e. higher-quality materials) (Han, 2019). 'Ministry of Supply' in Boston USA designed clothes made for comfort and movement out of recycled and bio-based fabrics, including recycled poly-ethylene terephthalate (RPET). Specifically, in 2019, 26% of its raw materials were recycled materials while the company managed to increase this percentage to 43% by 2020. The company diverted 1,127,908 post-consumer water bottles from landfills, equivalent to 21 tons of CO_2 emissions (Ministry of Supply, n.d.). In general, the use of biodegradable polymers for garment production has increased in demand in the fashion industry in order to reduce the impact of conventional polymers and landfill waste (Provin et al., 2021). As a result, for many different conventional textile production processes like dying have been replaced by nonconventional methods.

Different dying techniques such as 'Dry-Dye' technology, melange yarns or even redyeing clothes can reduce the demand for chemical dyes while using 90% less water and 85% less energy than traditional dying methods (Gupta et al., 2019; Sugiura, 2019; Yun et al., 2020). Despite the fact that there are over 10^5 commercial dyes on the market, it is nearly impossible to predict global invention and consumption. According to Madamwar et al. (2019), 9×10^6 tons of material were used in the year 2020. Dyes pose a threat to employees' safety, produce hazardous waste, and, more importantly, dyes can become toxic during natural decomposition in the environment (Mazotto et al., 2021). Synthetic colours are being phased out in favour of natural colours, such as bio-pigments or bio-colourants, which are less harmful to the environment and human health. According to Businesswire (2019), natural dyes (from plants, insects and microorganisms) will account for 11% of the global market by 2024, with a turnover of around $5 billion. Food waste (FW) can also be a solution for the dyeing process of textiles, according to Provin et al., (2021). Verma et al., (2021), investigated the effects of biopolymer and dyeing behaviour with a natural dye (onions skins) on the functional properties of cotton fabric (antibacterial and UV protection). Furthermore, Provin et al. (2021), stated that after the dying process (at 100°C, 120 minutes dyeing time, pH = 3 for direct dyeing or pH 7–9 for mordant dyeing), the dyed wool fabrics demonstrated good colourfastness to washing with soap and rubbing, as well as acceptable colourfastness to light. Each piece of clothing released on the market must pass specific tests (quality criteria) such as electrostatic propensity for withstanding frictional charge, mechanical and physical property testing, and colour fastness staining tests, according to ISO 18080-3:2015 (2015), ISO 139:2005 (2005) and ISO 105-F03:2001 (2001).

In the context of circularity, '*Looop*' was developed by the H&M Foundation (2020) in Sweden and the Hong Kong Textile and Clothing Research Institute (H&M: Magazine, 2020). Within 5 hours, *Looop* transforms discarded clothes regularly provided by customers into new clothing items. Similarly, according to Ellen MacArthur Foundation, 'Clothes Doctor' offers simple and convenient clothing repair services, as well as educating customers on how to care for their clothes and why it is important to do so. Clothes Doctor provides a variety of products and services to assist customers in storing, repairing and cleaning their clothing at home, as well as professional alteration and repair services. Clothes Doctor was founded in response to traditional clothing repair services that it found unappealing and disempowering. Through their services, customers are educated and empowered by newfound knowledge regarding clothing care and sustainability while benefited with convenient user experience fit in a busy lifestyle (Ellen MacArthur Foundation, 2021b).

At the same time, '*ERDOS Cashmere Care Center*', located in Beijing and other major cities was introduced as late as 1980 and provides cleaning, maintenance and repair services to ERDOS Group members. Any customer can join and earn credits that can be '*cashed*' in exchange for these services. By reducing water and detergent consumption, centralized and specialized care services can help the environment. Many cashmere garments that had been worn for more than 20 or even 30 years were sent to be looked after (Ellen MacArthur Foundation, 2021c).

'*By Rotation*', a peer-to-peer fashion rental platform launched in 2019, encourages users to rent what they need and lend what they don't wear often for a fraction of the cost of retail. This mobile app simulates and mimics social media habits for instance liking, commenting and user interactions. It now has over 150,000 users and allows renters to set the price of each item per day as well as the rental period. By increasing the number of users per item, By Rotation effectively increases clothing use. It may also obviate the need for new clothing production if users prefer to rent something for a one-time event rather than buy something they won't wear again. The resource consumption and environmental impacts are reduced if five people share one occasion dress rather than each purchasing their own. Users can rotate their idle products with one another using the peer-to-peer social app. In its efforts to create a style-conscious and environmentally conscious diverse community, the company does not buy inventory and does not charge subscription fees (Ellen MacArthur Foundation, 2021d).

In the same logic, one of the luxury brands to embrace circular thinking was Ralph Lauren founded in 1967. Ralph Lauren fashion house based in New York City has launched a rental

subscription service called '*The Lauren Look*' in March 2021, with the value of the apparel rental market in the United States expected to reach $4.4 billion by 2028. It is one of the first luxury brands to introduce a subscription rental service, with membership starting at $125 monthly. Through the Lauren Look, the company is benefited by the added ability to respond to growing customer concerns about the fashion industry's overproduction. To achieve this, Ralph Lauren intends to increase the use of garments that would otherwise be purchased and worn only a few times by renting them (Ellen MacArthur Foundation, 2021e).

Furthermore, according to Bansal (2020) an emotional connection or emotional 'durability' to a product of the fashion industry, could lead to a lower waste production. Engaging the users during the creation and maintenance as well as giving 'uniqueness' to each product of a company, gives a potential of emotional connection to a product. Example of such practice was the 'Repair It Yourself' shoes designed by Eugenia Morpurgo. These shoes are made with mechanical fastenings rather than permanent stitching are delivered to the customer with a repair kit. This allowed the users to customize and personalize the shoes as well as repairing them, cratering the need for individuality for each user (Bansal, 2020; Changing Markets Foundation, 2017).

According to a study conducted by the Ellen MacArthur Foundation in 2021, a $73 billion market is currently represented by the four pillars of a circular fashion business model: Remaking, Repair, Resale and Rental, while despite the Covid-19 pandemic, several rental and resale platforms have been valued at over $1 billion since 2019. Customers are increasingly adopting new ways of accessing fashion, motivated by factors such as affordability, convenience and environmental awareness, and these business models are expected to grow. Circular business models (such as Ralph Lauren, Clothes Doctors, By Rotation, ERDOS and others) have the potential to grow from 3.5 to 23% of the global fashion market share by 2030, representing a $700 billion opportunity. If the 23% target is met by 2030 using the four pillars of the circular fashion business models: Remaking, Repair, Resale and Rental, a reduction of 16% of CO_2 equivalent could be achieved and a limitation of the global heating to 1.5°C could be reached (Fletcher, 2012; Ellen MacArthur Foundation, 2021a).

To reduce the fashion industry's environmental footprint and aid the transition to a circular economy (while also taking into account the European Green Deal (EGD) and the Sustainable Development Goals (SDGs)), a social and technical innovation supported by policy implementation and behavioural change must be developed, and a new proposal (Figure 9) must be promoted, which must include a new mindset and must cover without limitation the following (Ellen MacArthur Foundation, n.d.; Fashion for Good, 2018; Global Fashion Agenda and The Boston Global Fashion Agenda & The Boston Consulting Group, 2017; Greenpeace, 2016, 2017; The Global Leadership Award in Sustainable Apparel (GLASA), 2015; Wrap, 2017): (i) trusted environment development (i.e. to allow cycling and avoid negative impacts during the production, use and after-use phases, the material input must be safe and healthy. In the seas or the environment, no pollutants such as plastic or microfibres are released); (ii) a new eco design development to increase life-time of clothing through branding and the commitment of the industry by the development of new policies; (iii) no longer usable products. This will have a direct impact on the improvement of recycling to allow the industry to capture the value of the materials in clothes; (iv) increase clothes' characteristics like durability to increase usage among different individuals; (v) technological advances based on artificial intelligence for optimizing output quality of clothing; (vi) the monitoring of supply and demand through transparency and communication; (vii) scale-up of clothing collection along with recycling technologies and application of it where not yet available. Generating mandates for recycled clothing growth markets for non-wearable items, allowing collectors to better capitalize on these items; (viii) new raw material from waste inputs (i.e. FW, plastic, biomass, etc.), where no natural or recycled material are available; (ix) collaboration ideals to keep on track with opportunities and challenges through systems thinking approach; (x) a strategy planning vision for a transition from a well-known practise to a new approach, engaging the entire value chain as well as stakeholders; (xi) dynamic advertizing and promotion through marketing skills; (xii) the exchange of knowledge; (xiii) the development of educational programs; (xiv) motivation to the consumers as well as regulatory relief measures for the fashion industry are also part of the new mindset to the transition to circularity. As indicated in Figure 9, all these different aspects need to work in synergy and continuity in order for a new circular business model to be viable (D'Adamo and Lupi, 2021; Manshoven et al., 2019; Pantelitsa et al., 2018; Zorpas, 2020).

As previously stated, 1/3 of global food production is wasted each year, totaling 1.3 billion tons of FW. This amount is equivalent to 3.5 billion metric tons of CO_2 (Agapios et al., 2020; Loizia et al., 2019, 2021). The research community is inspired to produce biodegradable polymers from FW because it is a valuable source of producing biomaterials and contributes to sustainable development (Provin et al., 2021; Ranganathan et al., 2020). According to Wood (2019), companies like Orange Fiber S.R.L. in Catania Italy use 700 MT of waste generated by the orange juice industry in Sicily and create sustainable fibres. They use extraction of cellulose from wasted products and then processed to make knitted and woven textiles (Wood, 2019). FW can be used to make monomeric precursors of nylon 66 and nylon 6 for use in the fashion industry (by extracting levulinic acid, 5-hydroxymathylfurfural – the well-known HMF – and glycose from FW) (Lee et al., 2020; Provin et al., 2021). In the fashion industry, a new business model necessitates new advertizing. Vegans, who make up 0.1% of the world's population and will number around 79 million in 2021 (Martinelli and De Canio, 2021; The Vegan Society, n.d.), do not eat any animal-derived foods (including honey) and do not use natural leather textiles. As a result, bio-based leathers are required for the production of bio-based polymers, hand backs, shoes, microbial cellulose and fungal mycelium products (Hildebrandt et al., 2021).

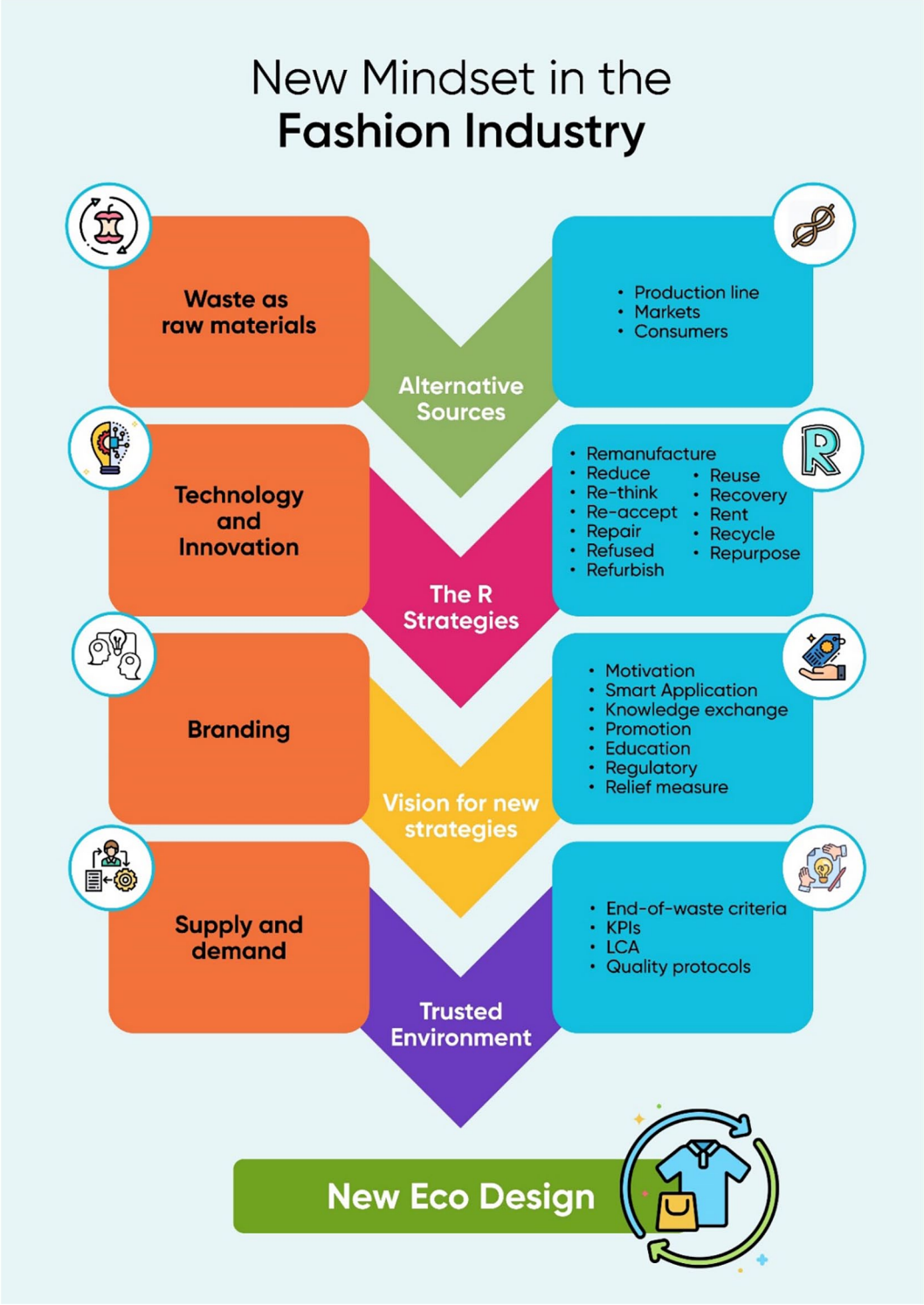

Figure 9. A dynamic approach of the new bussing circular model concerning consumers behaviour.

The lack of consumer awareness and social norms constitute critical components for diverting the industry away from fast fashion and towards circularity (Zhang et al., 2021). Consumer awareness and behaviour in regards to waste reduction and environmental implications require the adoption of eco-conscious fashion purchase habits (Zhang et al., 2021). A great challenge concerning consumer attitude and behaviour is the willingness to pay (WTP) versus ATP. Green products are gaining popularity among consumers (Zhang et al., 2021). However, there is a significant difference in what consumers (in this case, customers) are WTP or have the ATP for clothing/shoes and/or any textiles (labelled and non-labelled) made from waste. Without exception, the higher the income level, the greater the willingness of citizens to pay for any green products, as these are concerned with environmental education, social attitude (which is the result of a pattern or predisposition to specific adjustments on market trends or

advertizing effects), cultural background (Europeans tend to care more about environmental and slavery implications, Africans care more about slavery issues connected to fast fashion while Americans do not tend to give credits to sustainable businesses), Religious background (Muslims are not at large concerned with sustainability while Buddhists prioritize social equity) and consumer behaviour regarding the purchase of products from waste raw materials or natural resources (Zhang et al., 2021).

Conclusion

Novelty and innovation are the single most critical instrument for surviving severe competition in an almost saturated market in today's global economy. As the circular economy and life cycle thinking gain traction in the business world, novelty and innovation for circularity and/or sustainability is becoming increasingly important for organizations to maintain their competitive edge. The massive waste produced, as many building materials that the fashion industry requires (i.e. dyes, colours, fibres, etc.) can be extracted and used, replacing natural resources at the same time, is a source of inspiration that can foster innovation while supporting the transition to a sustainable, circular economy, as well as the adoption of SDGs and the EGD Strategy. On the other hand, because the fashion industry plays a significant role in people's everyday lives and is a significant sector of the global economy, this move to a more circular economy model may have a positive or negative impact on attitudes and behaviour. Many actors throughout the world, including social media advertizing campaigns, sociologist, engineers, economists, business management and others, will be working on a new mindset to modify how buyers will accept tomorrow's fashion designs.

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