Mapping the circular textile business ecosystem in Europe

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Executive summary

This report maps the emerging circular textile business ecosystem in Europe to inform the co-design of TexMat's automated collection and sorting business model. It combines a systematic literature review with TexMat consortium input to provide an updated picture of stakeholders and circular business models, as well as the regulatory, market and socio-environmental logics shaping post-consumer textiles in Europe. The ecosystem is structured around nine interdependent stakeholder groups: consumers and users, brand owners, producer responsibility organisations, collection and sorting operators, reuse and second-hand operators, recycling operators, technology providers, public authorities and policymakers, and civil society and non-governmental organisations. Their interactions are illustrated through national ecosystem case boxes from Finland, the Netherlands, and Spain, highlighting their corresponding material, financial and information flows, as well as critical dependencies.

The sector currently faces a paradox: whilst textiles are amongst the most environmentally intensive consumption areas in the EU, with rising per capita consumption, separate collection and fibre-to-fibre recycling rates remain low. At the same time, the compliance ecosystem is rapidly consolidating around the EU Strategy for Sustainable and Circular Textiles, the Ecodesign for Sustainable Products Regulation, including the Digital Product Passport, and the Waste Framework Directives. These institutional logics push the system towards ecodesign, traceability and producer responsibility, but are hindered by fragmented end-of-waste criteria, delays and uncertainties in national Extended Producer Responsibility scheme implementation and obstacles to trade in secondary raw materials.

Within this context, this report recognises and adapts to the textile industry's four key circular business model categories in line with the circular business model framework of the European Environment Information and Observation Network: longevity and durability; access-based models; collection and resale; and recycling and material reuse. Across models, the current business case for circular textiles is described as weak: with labour-intensive manual sorting, competitive costs for virgin materials, under-scaled recycling capacity and fragmented reverse logistics networks undermining profitability. This report therefore stresses the need for hybrid revenue architectures that combine Extended Producer Responsibility funding, service fees, long-term offtake agreements for recycled materials, public support and efficiency gains from automation and digitalisation, rather than relying solely on commodity sales.

Enabling factors include digitalisation – such as AI-enabled and Near-Infrared-based automated sorting, Digital Product Passports, the Internet of Things, and blockchain – which serve as the data backbone for traceability and coordination across business-to-business networks; efficient multi-actor reverse logistics that provide sufficient, predictable feedstock flows; targeted financial instruments and fiscal incentives for circular practices; and green skills development across the value chain. Social and environmental mission logics from non-governmental organisations, social economy organisations and critical research serve as counterweights to pure market logics, warning that some reuse, recycling and export practices can displace rather than reduce impacts, whilst also calling for more European-based reuse practices, better control of exports and the formalisation of the informal sector.

This report concludes that business model co-design must frame TexMat as a networked service helping brands, producer responsibility organisations, and authorities comply with emerging regulations; embed consumers as active co-producers through digital engagement tools and incentives; leverage automated presorting to address the cost bottleneck of manual sorting; and design multi-stakeholder governance, revenue-sharing, and risk-sharing arrangements that align incentives across the ecosystem.

Disclaimer

This deliverable is based on the project Grant Agreement, Consortium Agreement, and relevant guidelines by the European Commission. It is a draft version and should not be considered an approved deliverable until it has undergone the formal review process in accordance with the project's reporting schedule due in October 2027.

Digital tools, including AI-supported language and spelling checks, were used to improve clarity and readability of the text. AI-based tools were also used to support the identification of relevant references. All content and cited sources were reviewed, selected and validated by the authors, who take full responsibility for the final deliverable.

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Contents

Abbreviations

AI	Artificial Intelligence
B2B	Business-to-Business
C2C	Consumer-to-Consumer
CBM	Circular Business Model
DPP	Digital Product Passport
EEA	European Environment Agency
EEB	European Environmental Bureau
EIONET	European Environment Information and Observation Network
EPR	Extended Producer Responsibility
ESPR	Ecodesign for Sustainable Products Regulation
GPP	Green Public Procurement
IoT	Internet of Things
NGO	Non-governmental Organisation
NIR	Near-Infrared
P2P	Peer-to-peer
PRO	Producer Responsibility Organisation
QR	Quick Response (code)
RFID	Radio Frequency Identification
UNEP	United Nations Environment Programme
WFD	Waste Framework Directive
WISE	Work Integration Social Enterprise
WP	Work Package

1 Introduction

This study, *Mapping the circular textile business ecosystems in Europe*, is one of the first tasks within the TexMat project, focused on generating an automated collection and sorting solution for consumer textiles. Specifically, it is the first task in the work on business model and system requirements (Work Package 2 or WP2) which aims to co-design a sustainable business model for the TexMat solution.

Accordingly, the main objective of this document is to deliver a faithful and up-to-date picture of the European circular textile business ecosystem that can serve and inform the circular business model (CBM) co-design to be carried out in the following tasks. To this end, this report adopts a systemic lens to map the ecosystem, thereby identifying: the key actors, the current and emerging approaches of business models amongst textile waste collection, sorting, recycling and consumer reuse patterns and the logics, incentives and barriers driving or hindering consumer involvement in the ecosystem and the adoption of technological and non-technological solutions at hand.

As described, this report will serve as the starting point for the work on business model and system requirements (WP2), which aims to describe key value-creation mechanisms involving all ecosystem actors in the TexMat solution – including brands, consumers, second-hand retailers, waste operators – and identify, test and validate key strategies to engage consumers in circular practices. To achieve this, the work adopts a funnel approach, starting with a broad systemic picture of business challenges in the textile circular ecosystem (Task 2.1), which then feeds into a co-design phase (Task 2.2), a pre-validation phase (Task 2.3), and, lastly, a fine-tuning phase (Task 2.4).

The outcomes of this task therefore serve as a shared baseline to facilitate the business model innovation co-design phase (reported in Deliverable 2.2). The overall outcomes of this work (WP2) also inform the subsequent technical development of the solution (WPs 3–5) and the environmental assessment of the solution (WP7), as illustrated in Figure 1.

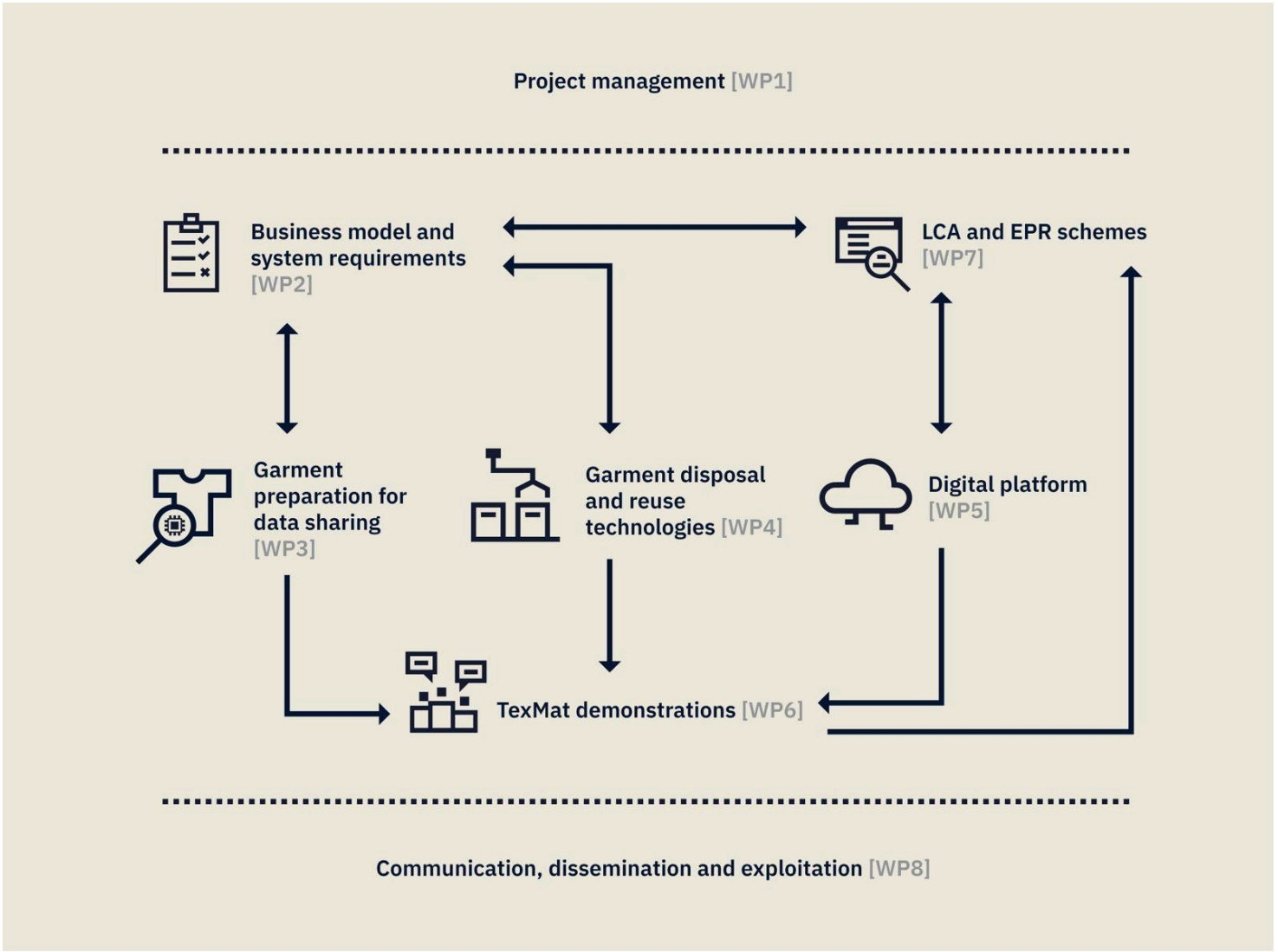

Figure 1: Interactions between TexMat work packages

The present report is the result of a systematic literature review on the circular textile business ecosystem in Europe, examining its main stakeholders – including consumers, brand owners, reuse and recycling operators, and public entities – and contributing to the creation and functioning of current and emerging CBMs. It was developed by the University of Coruña (UDC) and integrated insights from the University of Vaasa (UVA) on consumer, technological, civil society and regulatory aspects and case studies with participation from other relevant partners. Both academic and grey literature dealing with circularity and Extended Producer Responsibility (EPR) schemes was scrutinised and subsequently analysed. This

document search extended from 2020 to 2025, prioritising the European context, and was then supplemented with seminal academic articles and key documents from previous years. These sources were complemented by means of consultations with TexMat consortium participants, specially to include updated technological insights not covered in the latest literature, as well as determined policy and experiential aspects. The present mapping comprises specific, real cases, illustrating three national ecosystems and seven CBMs, as well as related, circular experiences from different actors, including TexMat partners undertaking circular activities. As a result, the present study is based on a selection of 172 documents (see References), of which 77 are academic papers and 94 grey literature (policy and legislative texts, official strategies and action plans, technical and research reports, NGO and industry reports, project documentation, factsheets/briefings and organisational web resources). As an example of efforts to provide an accurate representation of the current situation, 58 of the academic papers and 83 of the grey literature sources are from the 2020-2026 time period, with almost a third from 2025 to 2026 (50 in total from both types of literature streams).

The outcomes of the current task are depicted in the following report structure:

- **Mapping:** Sections 2 and 3 describe the ecosystem structure, providing an overview of the circular textile landscape, a map of stakeholders and interdependencies, and case examples of national circular textile business ecosystems and real-world CBMs operating in Europe.
- **Analysis:** Section 4 examines the institutional, market, and social rationales affecting the development of the circular textile business ecosystem in Europe, and details the enabling and hindering factors for textile business circularity.
- **Synthesis:** Section 5 presents the report's key conclusions, highlighting the critical insights and practical implications for CBM co-design in the subsequent phase (Task 2.2).

2 Mapping the circular textile ecosystem

2.1 Overview of the European circular textile system

The textile sector has various types of environmental impacts. At the European level, it ranks amongst the industries with the highest environmental footprint. In fact, it is the fourth most impactful area of consumption in terms of environmental and climate impact (EEA, 2022), only behind food, housing and mobility. This impact can be explained by its high contribution to water and land use, raw material consumption and greenhouse gas emissions throughout the products' entire lifecycles. According to the most recent data, textile consumption per person in the EU increased from 17 kg to 19 kg between 2019 and 2022 (EEA). Accordingly, end-of-life textiles, also referred to as post-consumer textiles, constitute an increasingly significant fraction of what is known as household waste or municipal solid waste. The latest data for EU27 indicates that approximately 6.95 million tonnes of textile waste are generated annually (of which 82% are post-consumer), representing approximately 16 kg per person, of which only 4.4 kg are collected separately for reuse and recycling in textile drop-off points; the rest is mixed with household waste (EEA, 2024). These figures are likely to improve with the expanding implementation of the separate collection of textiles as established by EU regulations, with an expected growth of post-consumer material flows destined for reuse and recycling. In this sense, since the textiles for reuse are mostly selected during the sorting for reuse stage, there is no accurate data. To get a glimpse of reuse practices in the EU, the closest estimation indicates a reuse of 2.3 kg per person annually, including different material flows apart from the EEA textiles waste management material flow (EEA, 2025b). After this pre-sorting stage, EU data from 2020 estimates that textile post-consumer waste entering the waste management stage was classified as follows: 72.9% destined for recycling and backfilling, 15.7% to incineration and energy recovery, 10% to landfill and 0.7% to incineration without energy recovery (EEA, 2024). However, these percentages refer to the treatment of textile waste entering the EU waste management system and do not fully capture what happens to textiles in the informal economy or those discarded as mixed municipal waste or exported as used textiles. In fact, there is an ever-growing flow of exported post-consumer textiles, reaching 1.4 million tonnes in 2023, mainly to Africa and Asia and with different outcomes, including: trade, sorting, reuse, recycling, landfilling, burning or dumping in nature (EEA, 2025a). Notably, it is estimated that 74% of low-value post-consumer textiles analysed in

the European context have the potential to be used as raw materials for fibre-to-fibre recycling: 21% for mechanical recycling and 53% for chemical recycling (Circle Economy, 2022b). However, from a lifecycle impact assessment approach, reuse in Europe has a lower environmental impact compared to recycling if it successfully replaces the production of new garments to a large degree (Trzepacz et al., 2023).

Meanwhile, according to data from Textile Exchange, global fibre production continues to set records: in 2024, it reached approximately 132 million tonnes, compared to about 125 million in 2023. Within this volume, recycled polyester increased slightly in absolute terms (from approximately 8.9 to about 9.3 million tonnes), though its relative weight amongst total polyester decreased as virgin polyester production grew even faster. In fact, although recycled fibres accounted for nearly 7.6% of all fibre production in 2024, most of that amount came from recycling plastic bottles into polyester. In this respect, less than 1% of the global fibre market originates from pre- or post-consumer recycled textiles, demonstrating that fibre-to-fibre recycling remains marginal (Textile Exchange, 2025).

In addition to the well-established fast-fashion phenomena, Europe is witnessing the rapid penetration of low-cost, low-quality and environmentally uncompliant products that quickly become obsolete, for example, those considered ultra-fast fashion garments which are sold remotely through Asian direct-to-consumer digital platforms. According to the European Commission's report on the control of products entering the market (European Commission, Directorate General for Taxation and Customs Union, 2025), these low-value e-commerce items nearly quadrupled between 2022 and 2024, representing 4.6 billion units in 2024. Therefore, this model can represent a traceability risk for the textile sector, stemming from what the Commission report describes as the difficulty customs authorities face in terms of controlling low-value shipments. In fact, the EU textiles and clothing market is highly import dependent, with a large share of garments and household textiles coming from countries such as China, Bangladesh and Turkey, with domestic production playing a comparatively smaller role (EEA, 2025a). Socially, the EU textile sector is thus being shaped by fast-fashion consumption patterns (European Commission, 2022) but also by a growing second-hand and repair culture (Schreven & Auxtova, 2025) and by social enterprises and charities that play a key role in collection and reuse (Auxtova et al., 2025; Bouzada-Novoa & Rey-Garcia, 2025).

Against this backdrop, reducing the textile industry's environmental impact requires strengthening the shift towards circular models, with ecodesign playing a central

role, supported by technological innovation, behavioural changes and the appropriate regulatory frameworks (EEA, 2024).

The circular economy has its origin in diverse academic streams, such as environmental and ecological economics or industrial ecology (Ghisellini et al., 2016) and was born as an alternative to the classic linear economic model. In this sense, the European Commission's first Action Plan for a Circular Economy defined it as an economy "where the value of products, materials and resources is maintained [...] for as long as possible, and the generation of waste is minimised" (European Commission, 2015, p. 2). Accordingly, the regulatory landscape for the textile sector in the EU has undergone significant transformation in the last few years towards a compliance ecosystem driven by the European Green Deal (European Commission, 2019), tackling different stages of the textile lifecycle. The first was the design stage with the Ecodesign for Sustainable Products Regulation (ESPR), formally adopted in 2024, and which includes the Digital Product Passport (DPP). The second addressed the end-of-life issue through the Waste Framework Directives (WFD), spanning from the compulsory, separate collection announced in 2018 and implemented by 2025 to the EPR scheme included in the latest revision, alongside other key measures such as the ban on destroying unsold consumer textiles and footwear.

This wide regulatory approach focused on implementing the circular economy in the textile sector involves rethinking industrial patterns and production processes by mimicking the environment and acknowledging its collaborative and systemic characteristics (Fehrer & Wieland, 2021; Konietzko et al., 2020). Therefore, transitioning towards this model implies the need for different actors to participate, organised to provide "more value and for a longer period" (Urbinati et al., 2017, p. 487) in a circular textile ecosystem. In this respect, the implications of implementing EPR schemes to foster circularity are key. Since producers are accountable for their products at the end of their lifecycles under EPR schemes (European Union, 2018), they can contribute not only to advance more sustainable design approaches throughout the entire lifecycles of textile products (Leal Filho et al., 2019) but also to the establishment of the essential ecosystem needed to achieve a closed loop (Bocken et al., 2016; Ghisellini et al., 2016; Jia et al., 2020).

The European textile ecosystem is, therefore, a complex system, interlocked with actors at the global, regional, national and municipal levels, including society as a whole, beyond the product consumers and civil society organisations. However, it primarily involves diverse actors related to textiles: European consumers and users, brand owners and retailers operating in the EU, PROs, collection, sorting and recycling operators, global technology providers and multi-level public authorities

and policymakers in the EU. The specific material flow for this initial mapping is constituted by consumer textiles throughout their entire lifecycles, excluding industrial-oriented textiles such as those destined for other sectors, for example, the automotive or hospitality industries, due to the TexMat focus on post-consumer textiles.

2.2 Circular textile ecosystem stakeholders and their relationships

The key stakeholder groups operating in the circular textile ecosystem are detailed next, with analyses of their main activities and roles within the system, the critical value flows – such as material and finance – that characterise their relations with other actors and the critical dependencies and constraints they experience in the articulation of circular ecosystemic practices.

2.2.1 Consumers and users

Consumers and users play a dual role in circular textile ecosystems. They act both as demand-side decision-makers, shaping market volumes and business models, and as everyday operators of circular practices, such as extended use, repair, reuse and return. At the system level, their aggregated purchase, use and disposal decisions determine the scale of textile flows, garment turnover rates and the quantity and quality of materials available for reuse and recycling. Textile consumption is amongst the most environmentally intensive consumption domains in Europe, thus making changes in consumer behaviour indispensable to achieve circularity and absolute impact reductions (EEA, 2019, 2024). At the same time, consumers do not act independently of other ecosystem actors. Their practices are embedded in infrastructures, social norms, product designs and market conditions shaped by brands, retailers, service providers and policymakers. Consumer engagement with circular textiles therefore reflects both individual motivations and structural enabling or constraining conditions.

Key activities and value flows

- **Demand and market signalling:** Consumers influence circular textile ecosystems through purchase decisions that shape demand for different

product categories and business models, including fast fashion, durable garments, second-hand products, rental services and repair-inclusive offerings.

- **Attitude-behaviour gap:** Whilst many consumers express concern for the fashion industry's environmental and social impacts, these concerns do not often translate into related purchase decisions. McNeill and Moore (2015) identify self-, social- and sacrifice-oriented consumers who negotiate tensions between sustainability values, affordability, trendiness and self-expression. Even highly committed consumers must continuously balance style, price, ethics and durability concerns (Lundblad & Davies, 2016).
- **Awareness and behavioural change:** In the circular fashion context, awareness of circular economy principles is positively associated with favourable attitudes, but awareness alone is insufficient to drive behavioural change. Structural conditions such as availability, convenience and trust in claims strongly mediate engagement (Jimenez-Fernandez, 2023).
- **Moral perceptions:** Consumers' moral perceptions also matter, with engagement increasing when responsibility for circularity is perceived as shared between consumers and companies, whilst perceived corporate hypocrisy reduces the willingness to participate (Ki et al., 2021).

Use and care practices

- **Use and care:** As a major value flow within circular textile ecosystems, decisions regarding how often garments are worn, how they are washed and dried and how they are stored and maintained directly affect garment lifecycles and environmental impacts. Sufficiency-oriented strategies, such as extending-use phases and reducing unnecessary laundering, are seen as critical levers for impact reduction alongside end-of-life solutions (UNEP, 2023).
- **Repair and maintenance:** To further shape product longevity, repair decisions involve recognising a repair need, assessing repairability, evaluating costs and benefits and navigating emotional and social dimensions such as attachment or embarrassment (Korsunova, 2023). Although many consumers express positive attitudes towards repairing

garments, a lack of specific skills, tools, time or access to services frequently leads to disposal instead, demonstrating that repair is a socially and culturally-embedded practice rather than a purely economic choice. Several EU projects, such as Circular Households and Solstice, currently explore consumer strategies to increase repair and reuse (CARE, 2026; Textile ETP, 2026).

End-of-life participation

- **End-of-life pathways:** Consumers influence end-of-life pathways through their decisions about resale, donation, participation in take-back schemes and disposal. European data show increasing participation in used-textile collection and retailer take-back schemes between 2019 and 2021 (EEA 2019, 2024; WRAP, 2021, 2022). However, these increases are partially offset by continued growth in the total volume of clothing placed on the market and by quality issues that limit reuse potential.
- **Downcycling and waste burdens:** Given the rise of fast and ultra-fast fashion, consumers increasingly donate low-quality garments that are unsuitable for resale, resulting in increased downcycling and exports to lower-income countries which can contribute to greater local waste burdens (EEA, 2023). Consumer end-of-life behaviour therefore interacts closely with upstream design and market dynamics to shape actual circular outcomes.

Critical dependencies and constraints

- **Price and convenience:** While price differentials between conventional and circular or more sustainable options remain significant, fast fashion dominates due to low prices and rapid trend cycles. Availability and convenience are also critical, as repair services, rental models and high-quality second-hand markets are often geographically concentrated, poorly integrated in mainstream retail outlets, or perceived as time-consuming.
- **Information asymmetries:** Despite growing awareness of circular economy concepts, consumers frequently struggle to assess the credibility of specific claims and express distrust related to greenwashing (Jimenez-Fernandez, 2023).

- **Social norms and identities:** As an additional dependency, fashion consumption is deeply embedded in self-presentation and belonging practices, and fashion's symbolic and emotional functions often override environmental concerns at the point of purchase (McNeill & Moore, 2015).
- **Collaborative consumption models:** These are more likely to be adopted when framed as fashionable and prestigious and resisted when associated with deprivation or second-hand stigma (Lang & Joyner Armstrong, 2018).

Policy and system implications

- **Systemic support:** Policy and industry initiatives increasingly acknowledge that consumer behaviour change requires systemic support. UNEP highlights the need for credible information, sufficiency-oriented lifestyles and enabling infrastructures that make circular choices accessible and attractive (UNEP, 2023).
- **Policy mixes:** The EEA similarly calls for policy mixes combining regulation, economic instruments and behavioural interventions, whilst warning against rebound effects if consumption volumes continue to grow (EEA, 2019, 2024).
- **Voluntary initiatives:** Agreements like WRAP's Textiles 2030 demonstrate how brands and retailers can influence consumer practices through campaigns, labelling, care guidance and service design, but also illustrate the limits of voluntary approaches in the absence of regulatory alignment (WRAP, 2021, 2022).
- **Structural conditions:** Recent scholarship cautions against framing consumers as solely responsible for achieving circularity. Consumers' willingness to engage depends on their perception that corporations and policymakers also assume genuine responsibility (Ki et al., 2021). Consumers operate within structural conditions largely shaped by other ecosystem actors and are therefore best understood as co-producers of circularity rather than as isolated decision-makers (Korsunova, 2023; Telaketju, 2024).

2.2.2 Brand owners

Brand owners and retailers are the central value creators within the global fashion value chain. These actors are defined by their capacity to control product design, marketing and distribution channels. Currently, these industry actors frequently outsource different manufacturing processes to upstream suppliers in fragmented global supply chains (Bonifazi et al., 2025; Ribeiro, 2024).

In the European context and with the EPR implementation, their role is being reoriented towards "obligated producers", redefining their role from sales drivers to chain coordinators of circular flows in order to assume financial responsibility for the entire lifecycle of their products in keeping with diverse legislation, such as the recent WFD (Kolotouchkina et al., 2025; Petreca et al., 2025).

Key activities and value flows

- **Circular design and sourcing:** Brand owners can determine up to 80% of a product's environmental impact at the design stage (Global Fashion Agenda, 2025c; European Commission, 2020). Therefore, a key activity should include designing for durability, disassembly and mono-materiality to facilitate high quality fibre-to-fibre recycling through agreements and ecosystemic collaboration with innovator actors (BOF, 2024; Global Fashion Agenda, 2024c).
- **Reverse logistics and take-back:** In order to close the material loop, numerous retailers started to implement take-back collecting systems for post-consumer textiles in stores and online years ago (Global Fashion Agenda, 2024b) in collaboration with experienced actors such as non-profit organisations.
- **Waste mitigation:** Retailers' adoption of new, AI-based demand forecasting technologies to align production with more accurate expected consumption is considered key in reducing unsold stock and reducing overproduction (BOF, 2024).
- **Decoupling revenue:** A critical strategic reorientation involves increasing revenue share derived from circular models, such as product resale, rental or repair (Global Fashion Agenda, 2025b), given that, for example, the second-hand market is increasing its growth projections and offering brands

the opportunity to adopt new ways of capturing value (Global Fashion Agenda, 2024b).

- **EPR fees and eco-modulation:** The EPR implementation implies that brands must assume responsibility for managing the products they place on the market once consumers discard them. This is usually operationalised by making financial contributions to PROs based on the volumes placed on the market (European Commission, 2020, 2025). The eco-modulation of these fees according to circular product criteria is key to catalyse the link between circular design decisions and financial liability (Global Fashion Agenda, 2025a).

Service provision and technology

- **Digital traceability:** Compliance with the ESPR requires the future implementation of the DDP amongst producers to ensure, amongst other obligations, transparency regarding essential material composition to downstream actors as sorters (D'Adamo et al., 2025).
- **Platform orchestration:** Brands are increasingly integrating C2C digital platforms to facilitate the resale (re-commerce) of their own products as well as rental models (BOF, 2024).

Critical dependencies and constraints

- **The displacement rate and rebound effect:** Brand owners and retailers face systemic dependencies and paradoxes that constrain the circular transition (Colucci & Vecchi, 2024). Specifically, tension exists between the displacement rate that takes place when the efficiency gains in circular models prevent the purchase of new items (WRAP, 2025)and the rebound effect, understood as the higher consumption and production that circular models can involuntary drive (Yerushalmi & Saha, 2025).
- **Fragmentation and traceability gaps:** Brands' dependency on global supply chains with complex supplier traceability beyond Tier 1, in addition to the lack of interoperable data standards, creates opacity that hinders the process of achieving price competence for high-quality recycled items (Do & Stevenson, 2025).

- **Regulatory uncertainty:** Whilst the EU regulation landscape is in a crystallisation phase, the fragmentation of EPR schemes and inconsistent requirements raise operational costs and complicate producers' efforts to address textile waste (Global Fashion Agenda, 2025a).

2.2.3 Producer Responsibility Organisations

Producers (manufacturers and distributors) play an integral role in the implementation of EPR schemes (OECD, 2024). PROs are collective entities established by producers or through legislation, assuming responsibility for meeting the recovery and recycling obligations of the individual producers (European Commission – DG Environment and BIO Intelligence Service by Deloitte, 2014). A PRO, therefore, is a "legal entity that financially, or financially and operationally, organises the fulfilment of extended producer responsibility obligations on behalf of producers" (European Commission, 2025). Key aspects relative to establishing new PROs or structurally changing existing ones according to the EU consist of delimiting which producers must be members of a PRO, setting the rules of incorporation of PROs as for-profit or non-profit organisations, and establishing the corresponding financial and material obligations (Girling, 2024; Global Fashion Agenda, 2025d).

Key activities and value flows

- **Recycled materials:** Although the first responsibility for ecodesign corresponds to producers, PROs are key actors in shaping the necessary recycled material markets that are still lacking due to low recyclability. They can modulate both the recyclability of used textiles through the promotion of ecodesign that facilitates recycling at end-of-life, and the intensity of usage of recycled materials in the manufacturing of their own products.
- **Waste mitigation:** PROs are also key actors in modulating the high volume of post-consumer waste that has turned used textiles into a pressing environmental issue and that constitutes an EPR input. They can achieve this through the reduction of ultra-fast and fast-fashion offerings, product range width, and frequency of offers or by facilitating repair or resale.
- **EPR fees and eco-modulation:** Under the mandatory EPR, producers will be required to cover the costs of managing textile waste and will be given

incentives to reduce waste and increase the circularity of textile products. The eco-modulation of EPR fees applies, whereby producers of harder-to-recycle products are charged higher fees than producers of easier-to-recycle products (Girling, 2024).

- **Financial ecosystem orchestration:** Additionally, PROs are key actors in shaping overall financial flows within emerging EPR systems. This includes customers, specifically the portion of EPR fees that will translate into higher prices, and collection, sorting, recycling and resale operators. Incumbent social enterprises and non-profits that have traditionally collected, resold or sorted textile waste – including those combining environmental goals with social inclusion goals through work integration social enterprises (WISEs) – may be crowded out by large, for-profit competitors that depend on EPR country-specific regulations governing PROs (Bouzada-Novoa & Rey-Garcia, 2025).

Service provision

- **Service ecosystem orchestration:** PROs occupy the central place in service provision under the EPR policy approach, understood as a group of economic and regulatory instruments that raise revenues and set incentives for producers to take into account environmental considerations when designing their products and to become responsible – physically or economically, in full or in part – for the collection and recovery of material during the post-consumer stage of the product lifecycle (OECD, 2024). For example, they can develop eco-modulation models (Girling, 2024).

Critical dependencies and constraints

- **Novelty:** As mandatory EPR only started in January 2025, academic research on the detailed development and operations of textile PROs at a national level across the EU is limited, particularly when compared with other waste streams (e.g., for plastic waste, see Tumu et al., 2023; for waste of electrical and electronic equipment, WEEE, see Mayers and Butler, 2013). Comparative efficiency and effectiveness are thus difficult to grasp.
- **Regulations:** New EPR implementation regulations being enacted at the country level are the main factors currently shaping emergent textile PROs.

- **Governance:** The decision to incorporate as for-profit or not-for-profit seems key, according to scientific and grey literature for PROs operating in other waste streams. Regulatory arguments in favour of non-profit PROs include the reliability of collection, treatment and recycling services as well as the avoidance of conflicts of interest. Beyond volumes of waste collected and treated, differences between non-profit and for-profit PROs include efficiency, competitiveness, financial resources, the flexibility to respond to market shifts, the capacity to innovate, public trust, transparency and accountability, amongst other dimensions (Mayers & Butler, 2013; Tumu et al., 2023).
- **Inputs-outputs imbalance:** PRO operations are constrained by both high volumes of post-consumer waste and low recyclability rates in the context of new regulations that forbid exporting used clothes to developing countries.

2.2.4 Collection and sorting operators

Collection and sorting operators are the "resource orchestrators" and, thus, critical actors in terms of enabling the textile circular ecosystem. They gather the post-consumer textiles and sometimes even post-industrial waste to then categorise them in order to determine their highest value application (Fashion for Good, 2022). This role has traditionally been undertaken by non-profit organisations and, more specifically in the European tradition, by the social economy (European Commission, 2021). Therefore, the revenue derived from these services is a way to fund social welfare projects, social inclusion efforts (Bouzada-Novoa & Rey-Garcia, 2025) and humanitarian aid (Zhuravleva, 2024).

However, with the expansion of the sector catalysed by the varying EPR regulations, new private, for-profit waste management companies, municipal services and technology providers are expanding the ecosystem (Fashion for Good, 2022). In addition to taking part in the circular transition, their role is being reoriented from "waste managers" to suppliers of verified and standardised feedstock for the recycling industry (Global Fashion Agenda, 2024a), critical in closing the loop.

Key activities and value flows

Collecting and sorting operations are traditionally characterised by being labour-intensive, with complex reverse logics. With the implementation of EPR systems, current financial models are undergoing critical transformation.

- **Collection channels:** There is a wide variety of collection points or interfaces, for instance, street-side bring banks, in-store take-back schemes partnered with brands and municipal recycling depots (Fashion for Good, 2022). In addition, non-profits have traditionally been receptors of direct donations, such as charity shops, all of which usually implies greater quality compared to the "anonymous" containers (Zhuravleva, 2024).
- **Sorting and categorisation:** This involves a cascading sorting process (Fashion for Good, 2022):
    - Pre-sorting, an optional step, to remove contaminants and non-textile waste.
    - Manual sorting of rewearable and non-rewearable fractions.
    - The rewearable category is graded by quality and market suitability. For instance, the so-called "cream" fraction is composed of premium quality items, followed by the grade-A fraction of high-quality items that are not premium, and the grade-B fraction, with items in good condition but which may lack a "like-new" appearance.
    - The non-rewearable group is increasingly being sorted by fibre composition with the help of new technologies, serving as feedstock for fibre-to-fibre recycling technologies.
- **Output distribution**: Material flows have three main distribution channels: domestic resale, global export markets and recycling or downcycling (Fashion for Good, 2022; Zhuravleva, 2024).
- **Cross-subsidisation model:** Economic viability relies on the fact that the revenue generated from the top 30-50% of highest quality rewearable textiles – like the "cream" fraction – subsidises the cost of collecting and managing the low-value and non-rewearable fractions (Fashion for Good, 2022), a balance that can be at risk as the separate collected volumes increase (Manshoven et al., 2019).
- **EPR fees and eco-modulation:** Financial flows will increasingly depend on EPR fees to bridge the gap between collecting and sorting costs and the recycling material value, ideally compensating operators for managing the non-profitable fractions (Nørup et al., 2019).

Service provision and technology

- **Automated sorting technologies**: In order to meet the requirements of mechanical and chemical recyclers, sorting operators are increasingly integrating Near Infrared (NIR) technology like Fibersort since it allows them to identify fibre composition at high speeds beyond human capabilities (Fashion for Good, 2022; Global Fashion Agenda, 2024b; Rey-García et al., 2023).
- **Digital matchmaking and traceability:** Digital platforms that act as digital marketplaces for textile waste provide a way to facilitate matching the supply and demand of materials through traceability (Global Fashion Agenda, 2024a).

Critical dependencies and constraints

- **Reliance on export markets:** The global post-consumer textile market is becoming saturated due to the growing consumption of first-hand textiles and, especially, ultra-fast fashion (Zhuravleva, 2024), displacing the demand for secondhand items (Ritch et al., 2025). Therefore, as revenue streams become more limited, waste managers will increasingly rely on the capacity of EPR payments to help sustain the system (Rreuse, 2025).
- **Low-value post-consumer increase**: The lower quality and the non-rewearable volumes are increasingly forcing collecting operators to manage more textile waste with less revenue (Pal & Sandberg, 2024).
- **Technological and infrastructure gaps:** Whilst manual sorting remains superior in terms of identifying higher-quality rewearable textiles, the growing lower quality volumes also require high capital investment in infrastructures and automated sorting technologies to facilitate the identification of proper recyclable fractions (Pal & Sandberg, 2024). In addition, individual item traceability in bulk flows remains a major challenge, even if the DPP exists at the product level; once garments enter mixed collection and sorting streams, linking physical items to digital identities is a critical challenge (TexMat partner feedback).
- **Labor skills and costs:** High-quality sorting requires skilled labour with “tactile knowledge” to identify vintage and high-value items. However,

especially in higher labour-cost countries, the manual sorting of lower-value items is less viable, reducing domestic control on waste streams (Nørup et al., 2019).

- **Regulatory uncertainty:** The inconsistent definitions of "End-of-Waste criteria" hinder the trade of sorted fractions (Manshoven et al., 2019). In addition, the sector's future economic viability is dependent on EPR scheme implementation (Fashion for Good, 2022; Rreuse, 2025).

2.2.5 Reuse and second-hand operators

Reuse and second-hand operators are the key actors responsible for extending the life of textiles after the consumers themselves, given that their crucial role is to redistribute products that maintain their original form and function (Miller et al., 2025). This category encompasses a diverse group of actors that includes non-profit organisations (that are also collectors), second-hand clothing and vintage retailers, digital peer-to-peer (P2P) platforms and rental service providers (Pal & Sandberg, 2024). Historically, non-profits have dominated this sector in Europe, using it to fund their social projects. However, this landscape has undergone a profound transformation in the last few years with the entry of for-profit actors, such as fashion brands with their own digital platforms, and several applications, such as Vinted (Dissanayake & Pal, 2025). This role is key in prioritising preventative actions for the highest waste hierarchy whilst collaborating in the decoupling of economic activities from virgin resource extraction (Schreven & Auxtova, 2025).

Key activities and value flows

The operations of reuse and second-hand actors are characterised by labour-intensive curation, complex reverse logistics and evolving financial models driven by digitalisation.

- **Acquisition and collection:** Collection operators make use of diverse input channels, including street containers, in-store take-back schemes and donations (Pal & Sandberg, 2024), but also commercial digital platforms that leverage financial incentives for consumers to "circulate" their closet (Eggert et al., 2025).
- **Sorting and curation:** Besides the manual sorting of items categorised as "Cream", second-hand retail operations require a certain degree of collection

curation based on market knowledge, taking into account the end consumers' different profiles in the distribution channel (Zhuravleva, 2024).

- **Redistribution channels:** Textile goods can be sold through physical stores, such as charity shops, vintage boutiques, in-store corners or in digital platforms such as marketplaces Vinted or Depop, which are increasingly facilitating direct P2P exchanges (Eggert et al., 2025).
- **Revenue models:** Non-profits typically operate in the cross-subsidisation model as collectors and sorting operators, whilst for-profit platforms generate revenue through commissions, transaction fees or subscription models in the case of rentals (Eggert et al., 2025).
- **Displacement value:** Reuse activities are key in preventing purchases of newly produced items (WRAP, 2025).

Service provision and technology

- **Digital intermediation:** Digital P2P platforms act as brokers, directly connecting buyers and sellers, and one of their key values consists of standardising critical aspects for customers, such as payment and shipping processes (Do & Stevenson, 2025).
- **Digital circularity logics:** Different digital platforms are adopting fast-fashion practices, such as the use of algorithms, to push new second-hand arrivals, creating a sense of urgency that contributes to speed up consumption cycles in reuse markets as well (Eggert et al., 2025; Kaivonen et al., 2025).

Critical dependencies and constraints

- **Consumer perception and trust:** With respect to the second-hand sector, there are traditional barriers related to hygiene and social stigma, despite the rebranding of used goods as "pre-loved" or "vintage" (Sepe et al., 2025).
- **Competition:** There is growing tension between the different types of actors entering the market and competing for the highest-quality used goods (Dissanayake & Pal, 2025). The danger is relegating traditional actors to

manage the low-value fraction with the implicit economic viability risk (Rreuse, 2025).

- **Rebound effects:** Whilst in circular economy terms reuse aims to displace new production, there is the risk of a "rebound effect" if consumers use the affordability of second-hand goods or the convenience of digital resale platforms to justify an increase in overall consumption under the logic of "buy to sell" rather than reducing the purchase of new goods (Eggert et al., 2025; Yerushalmi & Saha, 2025).
- **Reuse-oriented sorting** remains largely manual and experience-based. Decisions depend on market demand, garment condition, style and brand, and there is a persistent gap in scalable decision-support tools that combine condition, market value and traceability data to guide reuse pathways in a more systematic way (TexMat partner feedback).

2.2.6 Recycling operators

Recycling operators are the industrial actors responsible for reprocessing the textile waste that can no longer be reused. Their critical role consists of transforming non-reusable textiles into secondary raw materials for new manufacturing cycles. Therefore, these operators function as the loop-closing mechanism for the industry (Bonifazi et al., 2025). The traditional process with post-consumer textiles has been "downcycling", in which textile waste is mechanically shredded into lower-value industrial products, for example, in insulation materials or industrial wiping products. However, the new regulatory framework is reorienting this process (EEA, 2019). The industry is evolving little by little to provide fibre-to-fibre or textile-to-textile solutions to close the loop, the final objective being to decouple the industry from the extraction of finite virgin resources (Do & Stevenson, 2025). However, this requires innovation by introducing new technologies and investments and fomenting demand to scale the volumes (Do & Stevenson, 2025).

Key activities and value flows

Recycling actors' operations are characterised by specific technological archetypes, standardised material requirements and high capital intensity.

- **Input and feedstock:** In addition to other pre-consumer textiles, recyclers process the fraction consisting of non-rewearable textiles and even low-value rewearables without market demand (Fashion for Good, 2022).
- **Textile recycling archetypes:** The sector employs three main types of processes:
    - Mechanical recycling: This is the most mature technology and it has a lower environmental footprint compared to chemical recycling (polymer or monomer recycling) and the production of virgin fibres. This lower impact is primarily due to the preservation of the original fibres, which avoids the high energy and chemical intensity required for molecular disassembly (Arun et al., 2025; Bonifazi et al., 2025; Solis et al., 2024). It involves physical shredding, cutting and carding of textiles into fibres, and it generally implies blending virgin fibres – mainly cotton and wool – to compensate for the loss in fibre length and quality produced during this process (Sandin & Peters, 2018).
    - Chemical recycling: This is an emerging, energy intensive field that involves the use of chemical solvents (Pender et al., 2025). The process is based on depolymerisation or pulp dissolution to break down the fibres to the monomer or polymer level. This process, however, allows producing high-quality outputs (Bonifazi et al., 2025).
    - Thermo-mechanical recycling: This technique is primarily used for polyester and involves melting synthetic thermoplastic materials (often PET bottles instead of textiles) into pellets for their later extrusion (Global Fashion Agenda, 2025c).
- **Output:** Downcycling processes can lead to shoddy fibres, and, increasingly, fibre-to-fibre processes are expanding, resulting in high-quality fibres and yarns for new apparel (Fashion for Good, 2022).
- **Investment and scaling:** The sector faces a financing gap in terms of infrastructure and logistics for commercial-scale recycling facilities which can help to reverse the current reality in which recycled fibres are often more expensive than virgin ones (Global Fashion Agenda, 2024c). To mitigate financial risks, recyclers are signing long-term contracts with brands to secure future demands, for example, H&M with the polyester recycler, Syre.

Service provision

- **Pre-processing:** It is critical for industrial recyclers to have the appropriate feedstock sorted to meet their technology and infrastructure requirements. In this sense, solutions, such as the real standardisation of recyclable materials and digital platforms – like Reverse Resources – to develop markets with consistent input volumes, are essential (Do & Stevenson, 2025; Fashion for Good, 2022).

Critical dependencies and constraints

- **Feedstock purity and composition:** A critical mismatch exists between what advanced recyclers currently require to properly scale their operations and what the sorters can deliver, especially in terms of volume and traceability (Do & Stevenson, 2025). Today's supply chain is highly fragmented and opaque, with waste moving through multiple informal intermediaries and becoming contaminated, for example, through the presence of non-removable disruptors such as sequins or complex fibre blends containing elastane. This hinders the production of homogeneous and consistent volumes of material needed for continuous operations.
- **Technological readiness and capacity:** Global recycling capacity is currently minuscule compared to fibre production (Manshoven et al., 2019). In addition, despite mechanical recycling being a mature technology, it is still widely perceived as a form of downcycling because it typically reduces fibre quality. Chemical recycling may provide higher-quality outputs, but it remains confined to pilot and demonstration stages and is thus not broadly accessible for post-consumer textile flows. Furthermore, current technologies struggle to process complex fibre blends, such as cotton–elastane mixtures, on a large scale, continuing to pose a major technical bottleneck (Fashion for Good, 2022; Global Fashion Agenda, 2024b).
- **Economic and regulatory constraints:** Flow-splitting logic decisions between reuse, recycling, export and disposal are not only technical or driven solely by the items' physical properties, but also by market prices, long-term offtake contracts, EPR fee structures and local treatment capacity. This implies that, from the recycling operator perspective, traceability and data systems need to support decision rules that incorporate economic and regulatory constraints, not just material identification (TexMat partner

feedback). Recyclers compete in a market where virgin material prices do not internalise the true cost of their environmental impact. As a result, recycled materials are more expensive, directly affecting the lack of the incentives to invest in scaling (Global Fashion Agenda, 2025b).

2.2.7 Technology providers for collection, sorting and traceability

Technology providers in the textile sector constitute a rapidly evolving and heterogeneous group of actors that develop hardware, software and data infrastructures for collection, sorting and traceability. Their role is increasingly recognised as pivotal for enabling circularity, because the quality, reliability and granularity of post-consumer textile streams largely depend on the performance and integration of these technologies (Circle Economy, 2020; Heikkilä, Heikkilä, et al., 2024).

Types of technologies and their purposes

- **Sensor-based automated sorting:** As the dominant innovation trajectory, the sorting phase centres on high-precision material identification. The Fibersort and Siptex projects exemplify NIR and visual spectroscopy systems that classify textiles by fibre composition and colour in continuous, high-throughput processes (Circle Economy, 2020; Nellström, 2022). Technology providers such as Valvan Baling Systems and Smart Fiber sorting build integrated production lines, combining conveyor systems, feed-in mechanisms (including robotic arms), NIR or visible light scanners, compressed-air ejection and baling. The purpose is to convert low-value, mixed post-consumer textiles into defined output fractions that are tailored to the needs of mechanical and chemical recyclers.
- **Data traceability infrastructure:** As a critical second technology layer, this infrastructure is aligned with DPP developments. IT providers, tagging companies and platform operators provide DPP solutions that embed fibre composition, origin and sustainability data at the product level and make them accessible to sorters and recyclers via Quick Response (QR) codes, RFID tags or other carriers. In CISUTAC's Texaid pilot project, technology providers delivered AI-enhanced decision-support tools combining NIR data, RFID identifiers and condition scoring to direct items toward reuse, repair or recycling pathways in real time.

- **Pre-processing and characterisation technologies:** Positioned upstream of the recycling phase, technology providers also develop infrastructure, including shredders, opening equipment, and contaminant-removal systems. Reviews by Islam (2025), Enking et al. (2025) and Ghosh et al. (2025) all emphasise that successful mechanical and chemical recycling depends on precise classification and pre-treatment of feedstock, which in turn hinges on advanced analytical tools and process control systems supplied by specialised firms. AUTOLOOP (VTT Technical Research Centre of Finland, 2025) pushes this further by integrating additive tracing like optical tracers or markers, and DPP-compatible data hubs with automated sorting and chemical recycling, constructing a tightly coupled technological ecosystem in which tracer, sensor, software and recycling equipment providers must collaborate (VTT Technical Research Centre of Finland, 2025).
- **Platform and analytics infrastructure:** As a growing segment, technology providers offer digital applications that link sorters, recyclers and brands. Sorting for Circularity Europe sees digital platforms such as Reverse Resources as intermediaries mapping waste streams and matching them to recycling capacity, with technology companies providing the underlying data infrastructure (Circle Economy, 2022b). In these models, technology providers are not only hardware suppliers but also orchestrators of information flows and marketplace functionality.

Critical dependencies and constraints

- **Structural business case challenges:** Automated sorting lines and smart collection units require high, upfront capital expenditures, and their profitability depends on throughput, stable demand for sorted fractions and price differentials between recycled and virgin materials (Circle Economy, 2020; Nellström, 2022).
- **Feedstock variability and data gaps:** As primary technical limitations, post-consumer textiles remain highly heterogeneous in terms of fibre blends, colours, finishes and contamination. Sensor-based systems still face difficulties with complex blends, dark colours and multilayer items, limiting the purity and marketability of output fractions (Circle Economy, 2020, 2022b). Condition information and detailed, layer-wise composition data are often unavailable, constraining the ability of semi-automated systems to

make optimal routing decisions (CISUTAC, 2025). Technology providers therefore operate under conditions of incomplete and inconsistent data, which complicates algorithm development and system optimisation.

- **Interoperability and standards:** DPP-related studies emphasise that, without harmonised data models, vocabularies and identifiers, technology providers risk developing siloed solutions that cannot interoperate across brands, sorters and recyclers (EPRS, 2024; SITRA, 2023). Practitioners explicitly call for standardised condition levels, material taxonomies and data carriers; they also note that QR codes may be unsuitable for high-speed industrial sorting, whereas RFID tags show greater technical promise but require significant coordination amongst technology suppliers and apparel brands (CISUTAC, 2025).

- **Dependence on public funding and policy signals:** National innovation agencies and Horizon Europe provide crucial grant funding that de-risks R&D and demonstration projects (Nellström, 2022; VTT Technical Research Centre of Finland, 2025). Without such support, the long development cycles and uncertain early markets for sorting technologies would make private investment unlikely. However, this reliance on project-based funding creates discontinuities. Technology providers must repeatedly secure grants, and scaling beyond pilot plants into commercial operations remains difficult.

- **Interface problems between sorting and recycling technologies**: Enking et al. (2025) and Ghosh et al. (2025) argue that chemical recycling routes are highly sensitive to impurities and require tight control over feedstock properties. Where sorting technologies cannot yet reliably deliver mono-material or narrowly specified blends, recyclers tend to design processes for more homogeneous industrial waste rather than post-consumer feedstock. This misalignment constrains demand for the outputs of advanced sorting facilities, undermining the business case for technology providers. In addition, solutions based on RFID, tracers or container-level tracking all have trade-offs, and there is still no dominant model for how individual tagging can realistically survive high-throughput sorting and baling operations (TexMat partner feedback).

Future developments and directions

- **Integration of AI and machine learning into sorting systems:** Islam (2025) calls for "scalable AI-assisted sorting" to move beyond simple NIR classification to be able to handle complex blends, pattern recognition and condition assessment. CISUTAC's semi-automated pilot demonstrates how AI-based decision support can help human operators direct flows more efficiently, suggesting a hybrid future combining automation and human oversight (CISUTAC, 2025).

- **Coupling sorting technologies with DPP and tracer systems:** *AUTOLOOP* plans to create a DPP-compatible textile data hub and additive tracing to track textiles throughout recycling, indicating a future in which technology providers deliver integrated hardware/software/data stacks rather than stand-alone machines (VTT Technical Research Centre of Finland, 2025). As the ESPR and DPP become mandatory, technology providers who can embed regulatory compliance – data fields, access rights, and security – into their solutions will likely gain a competitive advantage.

- **Expansion of decentralised and modular collection and sorting concepts:** This suggests new roles for technology providers as service operators for municipalities, EPR schemes and brands, potentially offering collection-as-a-service and data-as-a-service models rather than one-off equipment sales.

- **Interaction between mechanical and chemical recycling:** This will shape requirements for technology providers. Reviews by Enking et al. (2025) and Ghosh et al. (2025) indicate that mixed, lower-quality feedstock will continue to exist, requiring multi-route sorting strategies whereby technology providers design systems that can direct fractions to the most appropriate mechanical or chemical pathway. This may encourage the development of more flexible sorting algorithms and modular plant layouts.

- **A shift from single-firm providers to collaborative ecosystems:** Projects like Fibersort, Siptex, AUTOLOOP, TexMat and CISUTAC all involve consortia of machinery manufacturers, IT companies, research institutes, sorters, recyclers and brands. This suggests that future technology provision is likely to be organised as multi-actor innovation networks rather than as isolated suppliers. Technology providers will thus act increasingly as coordinators and

integrators of hardware, software and data flows in circular textile value chains.

2.2.8 Public authorities and policymakers

Public authorities and policymakers in the European context act as strategic architects to facilitate the textile circular ecosystem. Their main role is to establish the regulatory, fiscal and infrastructural boundaries within which all other actors operate. At the European level, the European Commission defines strategies such as the European Green Deal and the Circular Economy Action Plan (European Commission, 2020). Meanwhile, national, regional and municipal governments are responsible for transposing directives into local laws and managing waste infrastructures. Furthermore, public authorities act as major economic participants through public procurement, representing approximately 14% of the EU's GDP and giving public authorities significant leverage to drive demand for sustainable textiles and circular services (European Commission, 2020).

Key activities and value flows

Policymakers create the framework conditions for material and financial flows whilst actively managing information and service provision. At the same time, public authorities such as municipalities are key in the public procurement of separate collecting services.

- **Regulating circularity:** The legislative push for the separate collection of textile waste under the 2018 WFD and the EPR advancement in the 2025 update created the conditions to initiate the circular transition with an ecosystemic lens. Additionally, the ESPR introduced further specific requirements in the design stage for durability, recyclability and recycled content whilst effectively banning the destruction of unsold consumer textiles.
- **Harmonisation:** Authorities are working to standardise "End-of-Waste" criteria to define when waste ceases to be waste and becomes a secondary raw material according to the latest WFD. This is critical for facilitating the cross-border trade of sorted textiles and recycled feedstock within the internal EU market (European Commission, 2020).

- **Enforcement:** Market surveillance authorities are tasked with enforcing compliance, checking products for hazardous chemicals, verifying sustainability claims to prevent greenwashing and ensuring imported goods meet EU standards (European Commission, 2022).
- **EPR:** Policymakers are increasingly implementing mandatory frameworks to fund collection and treatment. As of 2026, operational schemes are established in four EU member states: France, the Netherlands, Hungary and Latvia. The "eco-modulation" of EPR fees, where producers pay lower fees for products designed for circularity, will create a direct financial incentive for ecodesign (European Commission, 2022).
- **Fiscal incentives and funding:** Governments can offer tax reductions – such as VAT reductions on repair services – and fund research and innovation efforts through programs like Horizon Europe and LIFE (European Commission, 2020). These funds are essential for de-risking investments in unproven recycling technologies and infrastructure (Global Fashion Agenda, 2024c).
- **Green public procurement (GPP):** By establishing mandatory GPP criteria, authorities act as "launching customers", creating a stable market for circular textiles – for example, for uniforms and linens – that might otherwise struggle to compete with low-cost linear alternatives (European Commission, 2024).

Service provision

- **Municipal separate waste collection:** Collection is a critical component of the circular economy that has shifted from a voluntary, charity-led activity to a mandatory public service driven by the WFD (Fashion for Good, 2022).
- **Knowledge sharing:** The European Commission is orchestrating platforms to share knowledge at multiple layers to catalyse a systems shift. These initiatives range from ECOSYSTEX for inter-project collaboration and research dissemination to the standardisation of digital tools like DPP for the creation of a digital infrastructure, but also boosting green human capital with the EU's Pact of Skills (D'Adamo et al., 2025; European Commission, 2022; Global Fashion Agenda, 2024c).

Critical dependencies and constraints

- **Fragmentation vs. harmonisation:** The lack of harmonised implementation across Member States and different definitions of "waste" create barriers for the shipment of textile resources to sorting and recycling facilities (Manshoven et al., 2019). This regulatory fragmentation makes it difficult to operate across European actors and hinders economies of scale (Global Fashion Agenda, 2025d).
- **Data availability and monitoring:** There is a significant lack of reliable data on textile flows, particularly regarding the final destination of exported used textiles. Working with estimations deters setting realistic circular targets or monitoring the effectiveness of the measurements (Pal & Sandberg, 2024).
- **Global interdependency:** Strict internal standards like bans on hazardous chemicals must be balanced with trade relations (European Commission, 2022). There is a risk that EU regulations could displace environmental burdens to the Global South (Do & Stevenson, 2025).

2.2.9 Civil society and NGOs

Civil society and non-governmental organisations occupy a distinctive position in circular textile ecosystems. Unlike state agencies or firms which are primarily driven by regulatory mandates or market incentives, civil society actors derive their legitimacy from social and environmental missions that champion human rights, environmental integrity and global justice. In the European and global textile debates, they have been key in reframing circularity as a socio-ecological transformation rather than as a narrow material-efficiency project. The Civil Society European Strategy for Sustainable Textile, Garments, Leather and Footwear, drafted by a broad coalition of NGOs, explicitly calls for a textile system that respects human rights, creates decent jobs and operates within planetary boundaries while also positioning civil society as both a normative reference and a practical partner in delivering that vision (Fair and Sustainable Textiles, 2020).

Activities and value flows

- **Independent accountability:** Civil society and NGOs serve a critical "watchdog" function, exerting normative pressure on brands to improve transparency and environmental performance (Fair and Sustainable Textiles, 2020). Research by Schäfer (2024) indicates that this pressure both responds to and stimulates supply chain disclosure, as these entities interpret disclosed data to expose abuses and compel firms to adopt more sustainable practices.
- **Collaborative co-design:** NGOs participate in hybrid arrangements that combine monitoring, campaigning and collaborative projects on safer chemicals, living wages or recycling infrastructures (GIZ, 2021; Liu, 2020).
- **Strategic advocacy:** Civil society can lead activities related to shifting consumption patterns, advocating for ambitious regulation and ensuring that circularity strategies address social “hotspots”, such as wages and occupational health (Fair and Sustainable Textiles, 2020; UNEP, 2023).
- **Information synthesis:** Fashion Revolution’s Fashion Transparency Index, for instance, converts large volumes of corporate disclosures into accessible scores and rankings that can be used by citizens, media and policymakers to compare brands, thereby exerting reputational pressure and shifting expectations of “normal” practice in the fashion sector (Fashion Revolution, 2022).
- **Community mobilisation:** NGOs, community groups and social enterprises organise repair cafés, clothes-swaps, local collection initiatives and education campaigns, whilst global events such as World Cleanup Day increasingly highlight textile waste as a thematic focus (YLE Foundation, 2025). These activities translate circularity into everyday practices – repairing, reusing, sharing – that embed circular norms at the household and community levels (UNEP, 2023).

Dependencies and constraints

- **Resource limitations:** Financial and human resource constraints often limit the capacity of civil society and NGOs to engage in technical regulatory

processes, monitor complex supply chains or participate in numerous multi-stakeholder initiatives.

- **Data accessibility:** Access to reliable information remains a recurring obstacle. NGOs often depend on incomplete or voluntary disclosure by firms, and, even when transparency improves, power asymmetries may persist, as firms decide what to disclose and when (Schäfer, 2024).
- **Institutional co-optation:** A significant risk exists when NGOs are invited into partnerships or consultation processes without sufficient power to influence decisions, or where their presence is used primarily to legitimise pre-defined agendas (Liu, 2020).
- **Mission subordination:** As the circular textile agenda becomes more institutionalised and technical – focused on product passports, EPR fee structures or chemical criteria – there is a risk that social and environmental missions will be subordinated to techno-economic optimisation (Fair and Sustainable Textiles, 2020; UNEP, 2023).

2.3 Stakeholder interdependencies

Across the European circular textile ecosystem, all stakeholder actors are structurally interdependent, as illustrated by the material flows in Figure 2. For instance, consumers' everyday practices shape the quality and volume of postconsumer textiles, whilst brand owners and retailers determine design, business models and demand patterns. At the same time, PROs, collectors, sorters, reuse operators and recyclers must translate these patterns into concrete material and financial flows, whereas technology providers enable the data, automation and traceability that make this translation possible. For their part, public authorities and civil society establish the regulatory, fiscal and normative conditions that ultimately shape whether these interactions remain linear or transform into a circular system. Therefore, single actors by themselves cannot achieve circularity. In this sense, circular design choices fail without adequate collection and sorting, and vice versa; advanced recycling cannot scale without predictable feedstock and demand; and EPR schemes and DPP infrastructures collapse when misaligned with actual consumer practices, social economy entities' roles and justice-oriented civil society demands.

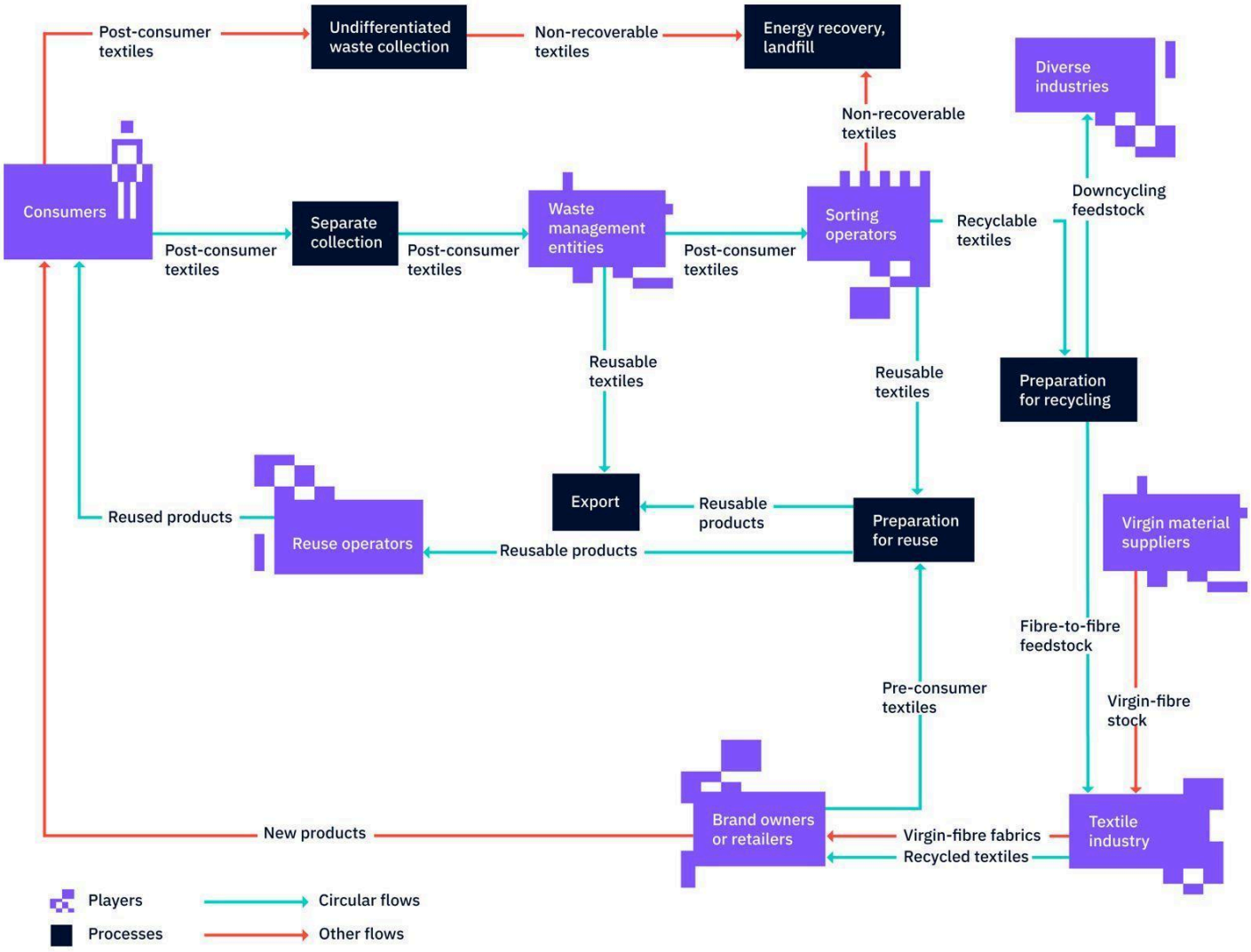

Figure 2: Linear and circular flows in Europe's textile business ecosystems (adapted and expanded from Bouzada-Novoa & Rey-García, 2025)

To illustrate stakeholders' interdependencies in three different scenarios in Europe, the following case boxes provide a synthesis of national circular textile business ecosystems in Finland, characterised by technological research and innovation; the Netherlands defined by its early EPR implementation; and Spain, notable for its high concentration of global fashion retailers and the prominent role of the social economy. Each case provides a comprehensive overview of the national regulatory

landscape, identifies principal stakeholders, and analyses the value flows, dependencies, and systemic constraints shaping the transition.

Case box 1: The circular textile ecosystem in Finland

Finland is widely recognised as one of the most active European countries in the development of circular textile systems, supported by an advanced waste-management sector, a strong research and innovation base and early regulatory action on textile waste collection (UNPD, 2021). However, despite this favourable context, the Finnish textile ecosystem remains characterised by a mixture of rapidly expanding infrastructures, experimental initiatives and structural constraints that shape the pace and direction of circular transitions.

Regulatory overview

Finland's circular textile ecosystem is built on a national framework that predates and exceeds European requirements. The country's Waste Act (646/2011) and Waste Decree (978/2021) represent a legal obligation for municipalities to organise the separate collection of post-consumer textiles starting in January 2023 – two years earlier than the EU-wide requirement established in the revised WFD (Dahlbo et al., 2021). These national rules require municipalities to provide adequate reception points, ensure high-quality sorting and channel collected end-of-life textiles towards reuse, preparation for reuse or recycling "as much as possible" (Lounais-Suomen Jätehuolto, 2020).

Finland has also prohibited landfilling municipal waste, which has historically routed most textile waste to energy recovery (Eastcham Finland., n.d.). The introduction of mandatory textile collection therefore represents a major structural shift away from incineration toward material circulation. Furthermore, national guidance documents produced by Lounais-Suomen Jätehuolto (LSJH) and the Telaketju programme have sought to harmonise definitions, sorting practices and roles across municipalities to build a coherent national system (Heikkilä et al., 2020).

EPR for textiles is not yet implemented in Finland, but anticipated future EPR obligations already influence investment and operational decisions. Analyses of Finnish pilot projects note that municipalities and waste companies are wary of making major long-term investments until responsibilities and cost allocations under a future EPR scheme are clarified (Zero Waste Europe, 2022). The expectation of regulatory change thus functions as an institutional driver shaping the ecosystem's development.

Main stakeholders and their roles

Finland's circular textile ecosystem comprises a network of municipal waste companies, reuse organisations, recycling firms, fibre innovators, textile and fashion companies and research institutions. These actors correspond closely to the circular textile business

ecosystem model developed by Fontell and Heikkilä (2017), which distinguishes citizens, collection and sorting operators, recyclers, textile companies and enabling institutions.

Municipal waste management companies are central, because Finland considers textiles to be municipal responsibility. Around 30 regional waste companies manage collection infrastructures, contract pre-sorting services and supply end-of-life textiles to centralised refinement plants such as the Rester Oy facility in Paimio (Lounais-Suomen Jätehuolto, 2020). In the Helsinki region, HSY manages a network of "Sortti" stations and shopping-centre collection points, ensuring broad public access (Zero Waste Europe, 2022).

Reuse actors, including UFF and the Helsinki Metropolitan Area Reuse Centre, constitute an established ecosystem operating in parallel with the municipal system. These organisations handle reusable textiles, generate revenue for the common good through second-hand retail sales and wholesale and prevent large volumes of textiles from entering the waste stream (Dahlbo et al., 2021).

Recycling and fibre innovation companies form the backbone of industrial circularity. Rester Oy operates the largest textile recycling facility in the Nordic countries, supplying fibre for nonwoven, insulation and composite applications (Turku University of Applied Sciences, 2024). On the chemical side, Finland is home to two internationally significant innovators: Infinited Fiber Company, developing regenerated cellulose fibre at its forthcoming flagship plant in Kemi, and Spinnova, producing wood- and waste-based fibre at commercial scale in Jyväskylä (Dahlbo et al., 2021; Spinnova, n.d.)

Research and innovation institutions – such as VTT, Turku University of Applied Sciences, LAB University of Applied Sciences and other universities – play a systemic coordination role by providing technological development, experimentation and ecosystem-building support. The Business Finland–funded programmes, Telaketju and Telavalue, have been especially influential in shaping the country's ecosystem, linking research institutes with more than a dozen firms to develop CBMs, new fibre technologies and national infrastructures (Heikkilä, Arvez, et al., 2024).

Finnish Textile & Fashion and leading textile and apparel firms increasingly act as downstream adopters of recycled and bio-based materials and as political advocates for regulations and industrial strategies that support circularity (Dziubaniuk, 2025).

Key activities and value flows

The most detailed mapping of Finnish textile flows, based on 2019 data, estimates that about 130,000 tonnes of textiles enter the market in Finland annually, with more than half from industrial or business sources and the remainder from households (Dahlbo et al., 2021). Prior to the introduction of separate collection, more than 40,000 tonnes of textiles entered mixed waste streams and were incinerated, representing a significant resource loss. Under the new system, material flows branch into several parallel pathways. Reusable textiles are channelled toward the reuse ecosystem—charity shops,

second-hand markets and export flows, thereby generating value through extended product lifetimes (Dahlbo et al., 2021). End-of-life textiles collected separately by municipalities undergo pre-sorting and are then transported to LSJH's Paimio facility, where they are mechanically turned into fibre and sold as a secondary raw materials to industrial buyers in nonwoven, insulation and composite manufacturing processes (LSJH, 2020).

Financial flows are shaped by a hybrid model combining municipal funding, waste fees and substantial public investment through Business Finland and EU research programmes. Many recycling and ecosystem-building initiatives – such as Telaketju, Telavalue, and LSJH's plant – have relied on public funding for capital and operational costs (Heikkilä, Arvez, et al., 2024). Downstream, recycled fibres must compete economically with virgin fibres, meaning that recyclers rely on long-term supply contracts and brand commitments, as illustrated by international agreements between Infinited Fiber Company and global apparel brands (Dziubaniuk, 2025).

Service and technology flows span the system. Research institutions provide technological development and testing services; waste companies contract sorting and pre-treatment services; innovators supply machinery, sensor technologies and fibre-processing solutions; and networks like Telavalue facilitate ecosystem learning and capacity building (Heikkilä, Arvez, et al., 2024).

Critical dependencies and system constraints

- Operational dependencies: The national model relies on harmonised municipal collection and high-quality pre-sorting to provide reliable feedstock for mechanical recycling (LSJH, 2020). However, pilot evaluations show that effectiveness varies: free, convenient collection points significantly increase recyclable fractions, while fee-based systems suffer from higher contamination (Zero Waste Europe, 2022).

- Economic viability: Market demand for recycled fibres remains nascent, with a price gap against virgin materials challenging the profitability of Finnish recyclers (Dahlbo et al., 2021). The ecosystem is currently characterised by small firms and a lack of established pricing structures for recycled outputs (Dziubaniuk et al., 2025).

- Technical bottlenecks: High labour costs make manual sorting expensive, while automated technologies require substantial capital investment (Heikkilä et al., 2024). Current mechanical and chemical recycling processes also struggle with contaminated or blended post-consumer textiles, reducing overall system efficiency.

- Institutional uncertainty: The absence of an operational EPR scheme creates a "wait-and-see" environment. As future frameworks may reallocate funding and responsibility, many stakeholders have adopted cautious investment strategies (Zero Waste Europe, 2022).

- Consumer behaviour: Despite moderate consumption levels, significant volumes of textiles are still lost to mixed waste. Uneven awareness of separate collection and repair

options creates persistent gaps in material availability for the circular loop (Dahlbo et al., 2021).

Case box 2: The circular textile ecosystem in the Netherlands

The Netherlands is widely seen as one of Europe's frontrunners in circular economy policy and implementation, with a national goal of achieving a fully circular economy by 2050 (Government of the Netherlands, 2023c). In this plan, textiles are identified as a priority value chain. The Dutch circular textile ecosystem is characterised by early EPR adoption, a dense network of professional collection and sorting organisations, strong innovation intermediaries and a central role in international second-hand textile trade. At the same time, the ecosystem faces structural constraints related to material quality, export dependency, chemical safety and the economic viability of fibre-to-fibre recycling.

Regulatory overview

The Dutch circular textile ecosystem is anchored in a legally binding EPR scheme for textiles, which entered into force in July 2023 (Government of the Netherlands, 2023a). The decree requires producers and importers of clothing and household textiles to organise and finance post-consumer textile management, including collection, preparation for reuse and recycling. The regulation establishes quantitative targets, including minimum shares when preparing textiles for reuse and fibre-to-fibre recycling by 2025 and 2030, thereby explicitly linking producer responsibility to higher-value circular outcomes rather than waste diversion alone (Government of the Netherlands, 2023a; Ministry of Infrastructure and Water Management, 2024). Producers must register and annually report the volumes they introduce into the market and treat and demonstrate compliance through an approved producer responsibility organisation.

Strategic direction is further articulated in the Policy Programme for Circular Textiles 2025–2030, which frames textiles as a system transition spanning product design, safe materials, reuse, recycling infrastructure and enforcement (Ministry of Infrastructure and Water Management, 2024). The programme explicitly anticipates tighter European requirements, including mandatory separate collection and evolving rules on waste shipments, and it positions the mid-2020s as the timeframe for EPR's implementation, monitoring and adjustment. Supervision and enforcement are assigned primarily to the Human Environment and Transport Inspectorate (ILT), which oversees compliance, reporting and fraud prevention within textile value chains (Rijkswaterstaat/ ILT, 2023). In contrast to Finland's municipality-led model, the Dutch framework shifts both financial responsibility and system steering toward producers, fundamentally reshaping incentives and contractual relationships across the ecosystem.

Main stakeholders and their roles

The Dutch circular textile ecosystem consists of interconnected public, private and third-sector actors operating across collection, sorting, reuse, recycling, governance and innovation.

Producers and importers are the legally responsible actors under the country's EPR. Compliance is largely coordinated through Stichting UPV Textiel, the producer responsibility organisation that aggregates obligations, contracts and operational partners and that distributes financial compensation along the chain (Stichting UPV Textiel, 2024). Public authorities – including the Ministry of Infrastructure and Water Management and the ILT – set policy direction, approve schemes and supervise implementation.

The Netherlands has a professionalised collection and sorting sector with large national operators, such as Sympany and ReShare (Salvation Army). These organisations manage container-based collection systems, operate industrial sorting facilities and channel textiles toward domestic resale, export markets or recycling. Reuse organisations such as Sympany or Reshare also play a social role by combining textile management with employment and social-inclusion objectives. Sector representation is provided by Vereniging Herwinning Textiel (VHT).

Mechanical recycling is carried out by firms such as Frankenhuis and Wolkat, which process post-consumer textiles into secondary fibres and yarns for applications including nonwovens, interiors and industrial textiles. Chemical recycling remains more limited but is represented in research and pilot contexts, for instance, with the SaXcell™ cellulose-recovery pathway developed in the Netherlands (Oelerich et al., 2017).

Research institutes, consultancies and innovation platforms play a systemic coordination role. Studies by RIVM, Metabolic and academic researchers contribute material-flow analyses, safety assessments and innovation-system perspectives that shape policy and investment decisions (Hekkert et al., 2022; Metabolic, 2024; RIVM, 2022). Circular-economy intermediaries such as Circle Economy provide data and international benchmarking, particularly for textile trade flows.

Key activities and value flows

Post-consumer textile flows in the Netherlands follow a branching system after collection. Higher-quality fractions are prioritised for reuse, whilst lower-quality or non-reusable textiles are routed toward recycling or downcycling. Large collectors and sorters explicitly apply "reuse-first" logics, as reuse generates higher economic and environmental value than recycling. A defining feature of the Dutch system is its strong integration in international reuse markets. The Netherlands is one of Europe's largest exporters of used textiles, with substantial volumes leaving the country for resale abroad (Circle Economy, 2023). These export flows constitute a major value stream but also

expose the ecosystem to global market volatility and regulatory changes in destination countries.

Recycling value flows are centred on mechanical processing. Sorted textiles are converted into fibres and yarns that are sold to downstream industrial users. These secondary materials must compete with virgin fibres on price and performance, making demand highly sensitive to market conditions and long-term purchasing commitments (Vermeyen, 2024).

Under EPR, producers finance collection, sorting and treatment through fees managed by the producer responsibility organisation. These funds are redistributed to municipalities, collectors, sorters, reuse organisations and recyclers through contractual arrangements, effectively replacing municipality-funded waste management with a producer-financed circular system (Government of the Netherlands, 2023b).

Material flows are further shaped by chemical safety constraints. RIVM has highlighted the presence of concerning substances in certain post-consumer textiles, which can restrict recycling routes or end markets and necessitate additional sorting or testing steps (RIVM, 2022). These safety considerations act as “gatekeepers” for circular flows, particularly for fibre-to-fibre recycling into new consumer products.

Critical dependencies and system constraints

- Technical limitations: System performance depends heavily on sorting quality and fibre identification. Achieving EPR targets for fibre-to-fibre recycling requires the reliable separation of blends and contaminants, which remains technically and economically challenging at scale (Vermeyen, 2024).
- Export vulnerability: Whilst international reuse markets currently absorb large volumes of Dutch used textiles, tightening import regulations or declining demand could rapidly destabilise collection and sorting economics (Circle Economy, 2023).
- Economic uncertainty: Recycling operations face narrow margins due to competition with low-cost virgin fibres and limited willingness amongst downstream users to pay price premiums for recycled content (Hekkert et al., 2022). Ambitious EPR targets thus risk outpacing the market development.
- Regulatory compliance: Chemical safety remains a primary constraint for circular options. Legacy substances in textiles limit the feasibility of closed-loop recycling and increase operational costs for testing and segregation (RIVM, 2022).
- Institutional coordination: The effectiveness of the EPR scheme hinges on stable agreements between producers, municipalities, collectors, reuse organisations, and recyclers. As implementation is recent, roles, compensation mechanisms, and monitoring practices remain in flux, impacting long-term investment decisions (Stichting UPV Textiel, 2024).

Case box 3: The circular textile ecosystem in Spain

The Spanish textile sector is characterised by its powerful retailers with a global presence and substantial macroeconomic weight, responsible for approximately 2.9% of national GDP for the third consecutive year, 3.7% of total employment and 8.2% of goods exported in 2024 (Modaes, 2025). Thus, the sector currently sits at the crossroads of two forces: a sizeable economic share and an accelerating push to shift towards circular practices based on cross-sector alliances and collaboration amongst brand owners, social economy entities and the industry (Bouzada-Novoa & Rey-Garcia, 2025).

Regulatory overview

The collection aspects of the ecosystem are currently governed by Law 7/2022 on Waste and Contaminated Soils for a Circular Economy which acts as the transposition of the European WFD. This national law established three fundamental pillars to start catalysing the circular ecosystem: the mandatory separate collection of textiles by local entities by 2025; a total ban on destroying unsold production surpluses; and a 50% reservation of public management contracts for social economy entities. Furthermore, the system is transitioning toward EPR, regulated by an upcoming Royal Decree that will force producers to finance the entire post-consumption cycle, from collection to recycling. This is supported by the national circular strategy, "España Circular 2030", which prioritises textiles as a key sector to reduce material consumption and increase reuse with specific targets: a 15% reduction in waste generation and increasing waste reuse to 10% by 2030 (ECODES, 2024).

Main stakeholders and their roles

Spanish consumers show an attitude-behaviour gap: Whilst 76.6% of Spaniards are familiar with fast fashion and associate it with negative environmental impacts, 45.2% of them admit buying it regularly (CECU, 2023). This makes households the main generators of postconsumer textile waste but also a latent driver for circularity, as online C2C digital platforms together with social economy second-hand stores have gained visibility and normalised reuse, especially amongst younger and urban segments (Bouzada-Novoa et al., 2025).

Brand owners and retailers are highly concentrated around large multinationals headquartered in Spain, such as Inditex, Mango or Tendam, which lead the first national PRO for textiles, Reviste, followed by the one specialised in footwear, Gerescal. Whilst the Royal Decree for EPR has not been implemented yet, these stakeholders are carrying out pilot tests on collecting and sorting solutions in collaboration with the Spanish Municipal Federation (Re-Viste, 2025).

Collection and sorting operators are dominated by social economy entities which are mainly organised around two main networks, Moda re- and AERESS. The latest data available estimates thatModa re- collected 41% of total textile waste in Spain in 2021,

with AERESS representing 16%, the Humana foundation 16% and the Madre Coraje NGO 6% (Moda re-, 2021).

Specialised industrial players like Textil Santanderina and Hallotex are pivoting toward fibre-to-fibre recycling. For instance, Post Fiber is an innovative project that was launched as a collaborative effort between industry, brand owners and social economy players to advance in solving critical technological and organisational issues related to fibre-to-fibre recycling (Bouzada-Novoa et al., 2025).

Key activities and value flows

In 2024, 118,951.80 tonnes of domestic textile waste were selectively collected, mainly through street containers, shop take-back points and charity channels. This material flow comprises three broad types of fractions: reusable garments (often subdivided by quality and destination), recyclable textiles (for mechanical or chemical recycling through emerging pilot projects such as loopamid) and rejects destined to energy recovery or landfills in Spain (Bouzada-Novoa et al., 2025).

Financial flows are undergoing a structural shift with EPR's incipient implementation. In the last few years, many municipalities have adopted new contracts for textile separate collection in keeping with Law 7/2022. Therefore, the combination of mandatory separate collection, EPR and rising treatment costs is pushing a transition towards paid public service contracts and EPR-funded schemes, where producers, through different PROs and public authorities, will collaborate in financing collection, sorting, reuse and recycling in line with the future EPR national legislation.

Public funds like the Circular Economy Strategic Project for Economic Recovery and Transformation (PERTE) have awarded €30.5 M to 37 textile projects to stimulate circular industrial innovation and scaling. Indeed, the penetration of sorting technologies in Spain is growing thanks to collaboration between brand owners and social economy players. In this sense, *Fibersort*, the main technology enabling automated identification of fibre composition, is key in the country's primary classification facilities (Rey-García et al., 2023).

Critical dependencies and constraints

The delay in the final approval of the EPR Royal Decree is creating a regulatory limbo for producers and especially for textile waste managers who lack clear rules on the upcoming eco-modulation fees and the exact EPR financial system. In addition, the lack of clearly defined "End-of-Waste" criteria creates legal uncertainty for strategic investments (Bouzada-Novoa et al., 2025).

3 Current and emerging circular business models

This section examines how interdependent stakeholder roles are configured into CBMs – the concrete mechanisms for proposing, creating, and capturing value around goals such as durability, reuse, and recycling. In doing so, the analytical perspective shifts from "who is involved" to "how value creation is organised."

To align with an ecosystemic approach, this section is structured following the Eionet analytical framework for circular business model innovation as it allows moving beyond static definitions and aligns with the report's ecosystemic approach (Coscieme et al., 2022). This facilitates understanding circularity as a systemic property that emerges from the interaction of multiple actors, infrastructures and social norms, rather than a mere characteristic of a product or service (Konietzko et al., 2020). Accordingly, this framework distinguishes between circular goals, targets such as reuse, repair or recycling and business model innovation, that is, the means to implement and achieve those objectives (Gillabel et al., 2021). It also provides an analytical lens to examine how value is proposed, created and captured in a non-linear system, addressing the need for business models to synchronise with the systems' technical and social innovations. Additionally, this framework recognises that effective policy measures, behavioural change and educational initiatives play a key role in enabling circular business model innovation. Finally, it also acknowledges that circular goals, strategies, challenges and the actors involved depend on the different lifecycle phases: material sourcing, product design, production and distribution, use and the end-of-life phase (Gillabel et al., 2021).

Accordingly, we build on Eionet's mapping to outline different business models supporting the shift towards a circular textile system: a) longevity and durability, b) access-based, c) collection and resale and d) recycling and material reuse models.

3.1 Longevity and durability

Circular business models are centred on "slowing resource loops", extending the active period of product use and thus reducing the overall speed of material flow in the economy (Bocken et al., 2016; Geissdoerfer et al., 2018). In this way, value is created by providing high-quality, durable goods that encourage sufficiency and long-term ownership (Lüdeke-Freund et al., 2019) in contrast to the fast-fashion

paradigm present in the textile sector (Abbate et al., 2023). Therefore, it draws on physical durability and emotional appeal by different means, such as timeless design and personalisation (Bocken et al., 2016; Lüdeke-Freund et al., 2019). From a business logic perspective, this often follows a "classic long life" model in which lower sales can be compensated by a premium pricing strategy and strong, after-sales support service (Bocken et al., 2016; OECD, 2019).

Technological innovation can be a critical catalyst to achieve better circular business practices. For instance, the integration of IoT (internet of things) sensors or AI can allow producers to identify potential faults in advance by monitoring the products' status and facilitate predictive maintenance (Chauhan et al., 2022; Ranta et al., 2021). However, the OECD notes that these models still face significant cultural and organisational barriers since firms are generally focused on incentivising high-volume sales targets (OECD, 2019). In addition, to scale these models, social innovation is required to shift customer mindsets toward valuing product longevity over novelty (Coscieme et al., 2022).

Case box 4: Fjällräven

Fjällräven's approach is deeply rooted in its outdoor heritage and long-term perspective on product use, positioning longevity as the central response to the environmental impacts of outdoor apparel and equipment (Fjällräven, 2024).

Challenge

The core challenge Fjällräven addresses is the high environmental footprint associated with outdoor products that are often replaced long before their technical end of life. Outdoor garments and backpacks rely on material-intensive fabrics, coatings and hardware designed to withstand demanding conditions, making premature disposal particularly wasteful. Fjällräven seeks to counter both physical wear and psychological obsolescence in an industry shaped by seasonal collections and performance marketing, whilst remaining commercially viable in a competitive premium market.

Value proposition

Fjällräven's value proposition is built around offering highly durable, functional and timeless outdoor products designed to remain in use for many years, often decades. Customers are encouraged to view their purchases as long-term investments rather than short-lived consumables. This promise is reinforced through clear communication about care, maintenance and responsible use, positioning the brand as a long-term partner in outdoor life. Circularity is framed less as innovation or disruption and more as stewardship, responsibility and respect for nature.

Value creation and delivery

Value creation in Fjällräven's model is driven primarily by durability-led design and material choices that prioritise robustness, repairability and long product lifetimes. Products are constructed with reinforced stress points, repair-friendly components and classic aesthetics that resist both technical failure and fashion-driven obsolescence. This design approach is supported by repair services offered through selected stores and partners, as well as extensive guidance on product care, including maintenance practices that extend the items' functional lives. Value delivery occurs through Fjällräven's retail network and brand communication, where staff training and customer interaction consistently emphasise long-term use, care and repair as integral parts of the product experience.

Value capture

Fjällräven captures value primarily through the sale of new products, whilst circular practices play a supporting albeit strategically important role. Long-lasting products justify premium pricing and reinforce brand credibility, whilst repair services and care guidance strengthen customer loyalty and repeat engagement. Unlike models that generate significant revenue from resale or leasing, Fjällräven's circularity contributes to value capture indirectly by protecting brand equity, reducing reputational risk and stabilising long-term customer relationships. Circular practices thus reinforce financial resilience rather than acting as independent profit centres.

Sustainability impact

The sustainability impact of Fjällräven's circular business model is concentrated in extending product lifetimes and the resulting reduction in material and energy use per year of service. By keeping products in active use for longer periods, the company reduces demand for virgin materials and lowers associated emissions across the value chain. Beyond environmental effects, the model supports social and cultural change by promoting care, repair and sufficiency as normal and desirable practices amongst outdoor consumers. Fjällräven's case demonstrates how a durability- and care-centred circular business model can deliver meaningful sustainability outcomes without relying on complex reverse logistics or ownership-based innovation.

3.2 Access-based models

These models represent a fundamental shift in the circular economy, transitioning from product ownership to the provision of Product-Service Systems (PSS) in order

to intensify resource loops by increasing the utilisation rate of different assets (OECD, 2019). This pathway allows multiple users to fulfil their needs with fewer physical items. For instance, in the textile sector this includes clothing libraries, high-end rental services – like Rent the Runway – or special occasion rentals (Gillabel et al., 2021). In this sense, the OECD highlights that the emergence of digital platforms has been a key driver behind this shift, as they drastically reduce transaction costs and implement reputational systems that build trust between strangers. However, these models are not sustainable by definition. Instead,they should be carefully designed to avoid rebound effects (Geissdoerfer et al., 2020) when improved efficiencies or lower costs can drive overall consumption. Indeed, these models require specialised competencies in reverse logistics and maintenance together with long-term customer relationship strategies (Gillabel et al., 2021; OECD, 2019). Lastly, social innovation related to marketing and community-building is needed in order to contribute to the normalisation of the “user” rather than "owner" identity (Ferasso et al., 2020).

Case box 5: MUD Jeans

The business model of MUD Jeans in the Netherlands is a pioneering example of a product-as-a-service model within the circular fashion economy. The company is best known for its innovative “Jeans as a Service” leasing concept, which challenges the traditional ownership-based model of apparel consumption by keeping denim products and materials in continuous circulation (MUD Jeans, 2024).

Challenge

The core challenge MUD Jeans faces is the highly resource-intensive and wasteful nature of conventional denim production and consumption. Traditional jeans require large amounts of water, cotton, chemicals and energy, though the final products are often underused and prematurely discarded. At the consumer level, fast fashion encourages overconsumption, low emotional attachment to garments and limited responsibility for end-of-life disposal, resulting in massive textile waste and lost material value.

Value proposition

MUD Jeans’ value proposition is to offer consumers a sustainable alternative to owning jeans by leasing high-quality, timeless denim instead of buying it outright. Through its “Lease A Jeans” model, customers pay a monthly fee to use a pair of jeans, with free repairs included. At the end of the lease period, customers can either keep the jeans, swap them for a new pair or return them, ensuring the product re-enters the circular system. For consumers, this reduces upfront costs, eliminates guilt about disposal and

simplifies sustainable choices. For the environment, it ensures longer product lifespans and systematic material recovery.

Value creation and delivery

MUD Jeans' value creation is centred on designing jeans specifically to ensure their durability, repairability and recyclability. The process begins with circular design, using organic and recycled cotton, non-toxic dyes and mono-material components that simplify recycling. The leasing system is the core operational innovation. Customers select a style online or in-store and enter a lease contract, typically lasting 12 months. During use, MUD Jeans provides free repairs, extending the jeans' functional life and strengthening customer relationships. Once returned, jeans undergo sorting and processing: Wearable jeans are cleaned, repaired and resold as vintage or second-life products, whilst worn-out jeans are mechanically recycled into new denim fibres. Value delivery occurs through MUD Jeans' direct-to-consumer online platform and selected retail partners, ensuring transparency and close customer engagement throughout the products' lifecycle.

Value capture

MUD Jeans captures value through a combination of recurring leasing revenues and secondary sales. Instead of relying solely on one-time transactions, the leasing model generates predictable monthly income whilst maximising the value extracted from each pair of jeans across multiple lifecycles. Additional revenue streams include the sale of second-life jeans, recycled denim products and customers choosing to purchase their leased jeans at the end of their contracts. By retaining ownership of the materials as long as possible, MUD Jeans reduces raw material costs and decouples revenue generation from virgin resource extraction.

Sustainability impact

MUD Jeans' business model generates significant sustainability impacts by closing material loops and reducing environmental footprints. Leasing increases product utilisation rates and extends garment lifespans, directly lowering demand for new cotton production. The use of recycled fibres and take-back systems reduces water consumption, CO_2 emissions and textile waste. By demonstrating that consumers are willing to obtain clothes without owning them, MUD Jeans also drives a broader behavioural shift toward circular consumption models. The company's transparency and measurable impact contribute to systemic change within the fashion industry, proving that circular economy principles can be both environmentally effective and economically viable.

Case box 6: Lindström Group

The business model of Lindström Group, headquartered in Finland, is a long-established and scalable example of a Textile-as-a-Service (TaaS) model within the circular economy. Operating across Europe and Asia, Lindström specialises in workwear, protective clothing and industrial textiles provided through long-term rental and service contracts, thus decoupling textile value creation from ownership and single-use consumption (Lindström, 2024).

Challenge

The core challenge Lindström faces is the inefficiency and environmental burden of traditional textile ownership in professional and industrial contexts. Companies that purchase workwear outright often face high upfront costs, inconsistent quality, poor maintenance practices and difficulties managing hygiene, compliance and end-of-life disposal. This linear approach leads to premature textile replacement, safety risks, excessive textile waste and unnecessary resource consumption.

Value proposition

Lindström's value proposition is a fully managed textile service that allows customers to access high-quality, compliant and hygienically maintained textiles without owning them. Instead of purchasing workwear, customers subscribe to a service that includes textile provision, regular washing, maintenance, repair, replacement and end-of-life management. For clients, this reduces capital expenditure, administrative burden and operational risk, whilst ensuring consistent quality, safety standards and availability. For employees, it guarantees clean, well-fitting and functional workwear. For society and the environment, it ensures textiles are used intensively and responsibly throughout their full lifecycle.

Value creation and delivery

Lindström's value creation is built on service-oriented textile lifecycle management. The process begins with customer-specific textile design and selection, ensuring garments meet industry regulations, branding needs and functional requirements. Once deployed, textiles enter a closed-loop service system. Lindström owns the garments and manages their circulation through RFID tagging, enabling precise tracking of usage, washing cycles, repairs and inventory levels. It performs industrial laundering and maintenance in optimised facilities designed to minimise water, energy and chemical use whilst maintaining high hygiene standards. Repairs are prioritised to extend garment lifespan, and items are only replaced when they no longer meet functional or safety criteria. Value delivery occurs through regular, scheduled service rounds where clean textiles are delivered and used items collected, ensuring uninterrupted availability for customers and seamless integration into daily operations.

Value capture

Lindström captures value through recurring service-based revenue, typically charged as a monthly fee per garment or per employee. This predictable income model replaces one-time sales with long-term customer relationships and stable cash flows. By retaining ownership of the textiles, Lindström maximises value extraction through prolonged use, multiple repair cycles and optimised replacement timing. Additional value is captured through operational efficiencies enabled by data-driven tracking systems and economies of scale in laundering and logistics.

Sustainability impact

Lindström's TaaS model delivers substantial sustainability impacts by prioritising longevity, reuse and resource efficiency. Garments are designed and managed to last significantly longer than customer-owned equivalents, reducing the need for virgin textile production. Centralised laundering processes are more water- and energy-efficient than decentralised washing, and systematic repairs prevent unnecessary disposal. At end-of-life, textiles are directed toward reuse, recycling or material recovery, ensuring minimal waste. Beyond environmental benefits, the model supports social sustainability by improving worker safety, hygiene, and comfort whilst helping client organisations meet sustainability and compliance goals. Lindström thus demonstrates how service-based CBMs can scale effectively in B2B contexts.

3.3 Collection and resale

The collection and resale business pathway aims to exploit the residual value of products by extending their useful lives beyond the first user (Bocken et al., 2016; OECD, 2019). This model contributes to what Lewandowski et al. describe as the necessity of a robust "take-back system" (2016) to capture goods that would otherwise have been discarded and prepare them for a second life by readying them for reuse and second-hand retail (Bocken et al., 2016; Geissdoerfer et al., 2020; Lüdeke-Freund et al., 2019). Second-life applications range from initiatives with brands to independent resale platforms and traditional second-hand stores habitually run by charities and social economy entities (Bouzada-Novoa & Rey-Garcia, 2025).

These models heavily depend on having efficient collection systems and reverse logistics, as well as the ability to verify the quality of the returned items (OECD, 2019). In addition, a major cultural element in this sector is consumer perception

regarding hygiene and the social stigma that is sometimes associated with used clothing (Silva et al., 2021). In terms of technological innovation, automated NIR sorting, AI textile identification, DPP implementation and smart containers (IoT tracking) with sensors can critically facilitate efficient, scalable, circular textile reuse (Circle Economy, 2022b; D'Adamo et al., 2025).

Case box 7: Emmy (Emmy Clothing Company OY)

The business model of EMMY (Emmy Clothing Company Oy) in Finland is a leading example of a circular economy solution in the fashion industry, primarily focused on providing a convenient, high-quality, pre-owned clothing resale service. The model is structured around solving the major pain points for both sellers and buyers in the second-hand market (Emmy, 2024).

Challenge

The core challenge Emmy confronts is the environmental impact of the linear "take-make-dispose" fashion model, which wastes immense amounts of resources. At the consumer level, the specific problem is the lack of time and effort required for individuals to sell their high-quality, unused branded clothing through traditional methods such as flea markets and P2P platforms.

Value proposition

EMMY's value proposition is a "turnkey model" that makes reselling effortless for the consumer. For sellers, this means they simply drop off or mail their clothes, and EMMY handles the entire process: inspection, photography, pricing, selling and delivery. For buyers, EMMY offers a curated, reliable selection of high-quality, pre-owned branded garments, bridging the gap between second-hand shopping and a traditional retail experience by guaranteeing quality and offering a return policy.

Value creation and delivery

EMMY's value creation is centred on a high-control, centralised consignment model, which positions it as a retailer of used goods. The process begins with collection and inflow, achieved through strategic partnerships, such as placing collection boxes in all Sokos department stores nationwide and offering a home pickup service (Emmy-kotinouto). Once collected, the processing and curation team professionally inspects each item, ensuring it is a high-quality, accepted brand, before taking quality photographs and setting a price. This process standardises quality and builds trust with buyers. Value delivery occurs primarily through EMMY's extensive online store, though it is also expanding through physical retail collaborative initiatives, such as operating dedicated second-hand departments within partner department stores, making sustainable fashion accessible within everyday shopping environments.

Value capture

EMMY captures value through a commission-based revenue model, which is financially low-risk as payment is only made upon a successful sale. The primary revenue stream is a sales commission, where EMMY deducts a pre-defined commission and a small handling fee from the final selling price, with the remaining proceeds being paid to the original sellers. The latter's share is typically around 50% of the item's price and is often paid out monthly. To encourage product reuse and loyalty, sellers can opt to receive their earnings via bank transfer, as a bonus-enhanced EMMY gift card (+20% bonus) or partner gift cards.

Sustainability impact

As a circular economy enterprise, EMMY's model directly contributes to sustainability. By keeping high-quality textiles in circulation for longer, EMMY helps to save vast amounts of natural resources (water, energy, chemicals) that would otherwise be required for new production. Over 80% of the clothes it receives find a new owner, and unsold items are directed to charity or textile recycling, ensuring minimal waste and maximising the products' lifespan. Furthermore, the company's focus on selling only quality and branded items promotes a shift in consumer behaviour, encouraging people to buy garments that are durable and retain their resale value, thus favouring quality over the consumption of fast fashion.

Case box 8: HUMANA

The business model of Humana Fundación Pueblo para Pueblo (Humana) in Spain is a well-established example of a social economy entity driven by the circular economy. Its structure is unique in that all its commercial operations—the collection and sale of used clothing—serve as the funding mechanism for international development cooperation and local social projects (Humana, 2025).

Challenge

The primary challenge Humana faces is two-fold: the massive environmental problem of textile waste in the Global North and the need to improve well-being in the Global South.

Value proposition

Humana's value proposition provides Spanish consumers a transparent and accessible way to manage their unwanted textiles responsibly, knowing that their donations have two benefits: protecting the environment through textile reuse and generating funds for global social causes. To beneficiaries in the Global South, the value proposition is access to affordable, quality clothing and comprehensive development programs focused on education, health and sustainable agriculture.

Value creation and delivery

Humana's value creation model is centred on high-volume, professional textile waste management. The collection process is done through an extensive network of over 5,000 brightly coloured collection bins placed in public locations across Spain in collaboration with municipal leaders. This makes textile donation highly accessible. The collected items are transported to specialised sorting centres in major Spanish cities like Madrid and Barcelona, where they are professionally graded according to the waste hierarchy (reuse prioritised over recycling). Value delivery then follows a multi-channel, global approach: High-quality garments are sold in Humana's 58 second-hand retail stores across Spain (generating funds and creating local green jobs); other reusable clothing is exported to Humana's sister organisations in Africa to be sold at affordable prices to local shops and traders, thereby stimulating local economies; and finally, textiles deemed unfit for reuse are sold for material recycling/downcycling.

Value capture

Humana's value capture mechanism is entirely geared toward generating funds to finance its humanitarian mission. As a non-profit organisation, its goal is not to maximise shareholder profit but, rather, to maximise the value generated from textile flows for social investment. Its main source of income is the sale of used clothing and textiles both through its Spanish retail stores and through the wholesale export of sorted clothes to global second-hand markets. Since the organisation acquires the clothing at zero cost (through donations), the revenue generated from these sales—minus operational costs (collection, sorting, logistics, retail salaries)—represents its financial surplus. The latter is then reinvested into its core mission: funding international development cooperation projects in sectors such as education, health and sustainable agriculture, as well as local social support projects in Spain.

Sustainability impact

Humana's business model inherently has profound sustainability impacts, aligning with the UN's Sustainable Development Goals (SDGs). It achieves its environmental impact by diverting tens of millions of kilos of textiles from Spanish landfills annually, significantly conserving the water and CO2 emissions associated to new production. High-volume professional sorting ensures a high reuse rate (often over 60%) and a high recycling rate, maximising the materials' life. Societal impact is also central to the model, as the income generated funds hundreds of development cooperation projects abroad, impacting millions of people. Additionally, Humana creates thousands of green jobs both in Spain (in collection, sorting centres and retail outlets) and in the countries receiving the exported clothing, where the second-hand trade provides affordable clothing and supports local entrepreneurship.

3.4 Recycling and material reuse

This final pathway focuses on the circular goal of closing resource loops. It refers to business models that transform post-consumer textile waste into new raw materials for future production cycles (Bocken et al., 2016; Coscieme et al., 2022). In textiles, this includes high-value upcycling but also cascading, where materials are used iteratively in different applications before finally reaching the energy recovery process (Lüdeke-Freund et al., 2019). The related technical challenges are immense, especially because of the complexity of separating blended fibres. In this sense, technical innovation in the form of Industry 4.0 is vital. For instance, AI-enhanced identification, automated sorting systems and chemical extraction in biorefineries are critical to make high-quality recycling economically viable. However, an OECD report warns that the low price of virgin raw materials often makes recycled inputs uncompetitive unless measures such as recycled content mandates are implemented (2019). Strategic alliances, such as industrial symbiosis networks, are also necessary to ensure that recyclable textiles from one actor effectively become the feedstock for another (Bocken et al., 2016).

Case box 9: Reuse Centre (Kierrätyskeskus)

The business model of Reuse Centre (Kierrätyskeskus) in Helsinki is a well-known example of a municipal circular economy organisation focused on reuse, preparation for reuse and secondary material flow management. Operating at the intersection of waste management, social inclusion and retail, Reuse Centre plays a key role in slowing and closing resource loops within the Helsinki metropolitan area by diverting usable goods from waste streams and reintegrating them into the local economy (Kierratyskeskus, 2025).

Challenge

The core challenge Reuse Centre faces is the high volume of reusable materials entering municipal waste streams due to convenience-driven disposal, the lack of repair or resale channels and limited awareness of product reuse potential. Furniture, textiles, household goods, electronics and construction materials are often discarded despite retaining functional and economic value. This leads to unnecessary landfill use, incineration and the loss of embedded materials, energy and labour, whilst municipalities simultaneously face rising waste management costs and social employment challenges.

Value proposition

Reuse Centre's value proposition is to provide an accessible, trustworthy system that allows citizens, companies and public organisations to dispose of unwanted goods responsibly whilst ensuring that reusable items are prioritised over recycling or disposal.

For residents, Reuse Centre offers affordable second-hand goods in well-organised retail environments, combining sustainability with everyday consumption needs. For municipalities, it functions as a partner that reduces waste volumes, improves reuse rates and supports local circular economy targets. At the same time, the organisation delivers social value by creating employment and training opportunities for vulnerable people at risk of exclusion from the labour market.

Value creation and delivery

Reuse Centre's value creation is based on professional second-hand material flow management. The process begins with collection and inflow, where goods are received through direct donations from households, dedicated reuse containers, company clear-outs and municipal recycling stations. Items are transported to centralised facilities where they undergo sorting and assessment, with priority given to identifying products suitable for direct reuse. Reusable items are cleaned, tested, repaired when necessary and priced for resale or free of charge giveaways, whilst non-reusable materials are separated into secondary material streams for recycling in collaboration with specialised partners. Value delivery takes place through a network of Reuse Centre second-hand stores across Helsinki and the metropolitan region and a nationwide online store, as well as through educational services, workshops and collaboration with schools and municipalities that promote reuse skills and circular thinking. Employment opportunities and on-the-job training opportunities are core value creation mechanisms for Reuse Center.

Value capture

Reuse Centre captures value through a hybrid economic model that combines retail revenue, service contracts and public funding. Income is generated through the sale of second-hand goods, paid reuse and sorting services for companies and municipalities, training-related activities and environmental consulting services for businesses. Because most goods are acquired at low or zero cost, value is created by extending product lifespans and recovering materials before they enter the waste system. Any financial surplus is reinvested into its operations, social employment programs and the development of new reuse services, rather than distributed as profit.

Sustainability impact

Reuse Centre has a substantial sustainability impact by prioritising reuse at the top of the waste hierarchy and ensuring that materials remain in circulation at their highest possible value. Large volumes of goods are diverted annually from incineration and landfill, reducing greenhouse gas emissions and conserving raw materials. The model also generates social sustainability benefits by providing supported employment, vocational training and inclusion opportunities whilst also strengthening local circular economies. By embedding reuse into municipal waste management systems, Reuse Centre

demonstrates how cities can operationalise circular economy principles at scale and turn waste prevention into a public service.

The following table synthesises the key value propositions (how value is offered), value creation and delivery strategies (how value is provided) and value capture tactics (how the organisations generate money and other types of value) that can characterise the different business model pathways. It also describes the main challenges they may face and the circular goals to which they may contribute.

Model subtype	Challenges	Key value propositions	Key value creation and delivery strategies	Key value capture strategies	Circular goals
Longevity and durability	Cannibalisation of new sales. High production and repair costs. The volatility of fashion.	Specific customer segments, premium branding. Durable, high quality, timeless, emotional attachment or adaptable garments.	Durable, high-quality fibres, yarns, fabrics, and coatings that ease maintenance. Designs made to last and to be repaired. Standardisation and compatibility. Industry 4.0 integration (IoT, AI). Physical or online retail channels, after-sales maintenance and repair services, and take-back schemes for used products.	Traditional sales with premium pricing. Customer loyalty. Additional revenue from maintenance and repair services, sale of auxiliary products or take-back and resale of second-hand products. Social employment and recognition of craftsmanship.	Slowing resource loops and reducing overall consumption. Minimising virgin resource extraction, reducing environmental footprint associated with manufacturing and distribution.
Access-based models: renting, leasing and shared use	High upfront capital. Logistical complexity and costs. Consumer preference for ownership. Environmental rebound effects.	Affordable access to products and services. Good user experience and performance. No need for upfront investment. Convenience and additional complementary services. Access to premium goods.	Durable, repairable products. Offering maintenance and repair as complementary services. Operating take-back schemes. Using sharing platforms and providing digital intermediation. Strategic incentives for durability.	Rental or leasing fees (or pay-per-use). Market differentiation. Close relationships with customers. Revenues from take-back and second-hand sales. Secondary revenue streams for brand owners. Risk mitigation in terms of raw material price volatility.	Intensifying resource flows. Extending use and repair practices.

Model subtype	Challenges	Key value propositions	Key value creation and delivery strategies	Key value capture strategies	Circular goals
Collection and resale	High operational costs. Cultural and social stigma. Cannibalisation risk from sale of new, premium products. High transaction costs for consumers: time and effort. Uncertain supply.	Takeback or buyback options for textile items. Affordable second-hand products. Specific branding such as preloved, vintage or eco. Environmental storytelling. Sometimes unique or rare items. Return incentives. Providing recyclable feedstock.	Collecting textiles, sorting and checking their quality to resell through physical or online shops. Different take-back schemes (in-store drop-off, street collection and dedicated containers). Partnerships with specialised sorters. Automated sorting technologies. Digital traceability.	Earning revenue from second-hand sales (budget or premium). Accessing low cost or free input materials. Creating social jobs or volunteer opportunities. Reduced material risks: raw material price volatility. Service-based revenue. Customer loyalty and engagement: take-back creates contact points.	Extending product value. Slowing resource loops contributing to keeping products in their highest-value state for as long as possible. Contribution to effective material flow management at the centre of political agenda (e.g., WFD).
Recycling and material reuse	Dominance of downcycling practices. Technical sorting complexity. Virgin material price dominance. Labour intensity of upcycling. Intellectual property barriers: chemical composition of fibres.	Providing recycled fibres or fabrics marketed with ecobranding. Verified sustainability data.	Collecting, sorting, disassembling and recycling textiles' components. Industrial symbiosis and partnerships with textile collectors, industry and brand owners. Upcycling materials into new products. Provide materials designed for technical or biological cycles. Industry 4.0: AI-based image recognition and robotics.	Accessing low cost or free input materials. Selling recycled fibres. Marketing upcycled products based on originality or sustainability claims. Creating green jobs and social employment. Supply risk mitigation: virgin raw material price volatility.	Closing resource loops. Reducing environmental impacts compared with using virgin materials.

4 Circular business textile ecosystem logics and enabling and hindering factors

4.1 Institutional logics: Regulatory and compliance frameworks for circular textiles in the EU

The transition toward circularity in the European textile sector is shaped by a rapidly expanding regulatory architecture that redefines how products are designed, marketed, managed at end-of-life and monitored throughout global value chains. These institutional frameworks aim to mitigate the environmental and social impacts associated with textile lifecycles by creating binding rules on durability, chemical safety, recyclability, waste prevention and transparency. Four instruments stand at the centre of this regulatory landscape: the EU Strategy for Sustainable and Circular Textiles, the ESPR, the WFD and its forthcoming mandatory EPR for textiles, and the DPP.

The EU Strategy for Sustainable and Circular Textiles, adopted in 2022, formulates the strategic vision guiding the transformation of Europe's textile system. The Commission identifies textiles as one of the most environmentally harmful product groups in the Union and positions circularity as the central organising principle for future textile value chains (European Commission, 2022). The Strategy outlines a comprehensive reform agenda that includes mandatory ecodesign criteria for durability, reparability and fibre-to-fibre recyclability; a progressive reduction of unsold goods destruction; the establishment of DPP for all textile products; and the development of harmonised EPR schemes across Member States by 2025. In parallel, it commits to phasing out substances of concern and addressing microplastic release through preventive and corrective measures. The Strategy does not function as a binding act in itself but instead sets the direction for subsequent legal instruments, notably the ESPR and WFD. According to the EEB (2024) much of the Strategy's ambition has begun to materialise in secondary legislation, though further clarity is required to ensure that its environmental ambitions translate into enforceable obligations.

ESPR

The ESPR, formally adopted in 2024, constitutes the centrepiece of Europe's transition from traditional product regulation toward a systemic approach that embeds sustainability across the entire product lifecycle (European Commission, 2024). Unlike the earlier Ecodesign Directive, which focused primarily on energy-related products, the ESPR applies broadly to most physical goods placed on the EU single market, including apparel, footwear and home textiles. It establishes a framework enabling the Commission to adopt delegated acts that will define product-specific performance requirements. For textiles, these will encompass durability and reliability standards, criteria for ease-of-repair and disassembly, minimum thresholds for recycled content, restrictions on substances of concern that hinder recyclability and obligations to ensure product-level traceability through the DPP.

A significant innovation introduced through ESPR is the ban on destroying unsold consumer textiles. Initially applying to large enterprises and extending over time to medium-sized firms, this prohibition aims to curb overproduction and reduce the environmental impacts associated with wasteful stock management. The EEB warns, however, that without adequate reuse and recycling infrastructures within the EU, the ban may unintentionally lead to increased exports of unsold textiles to third countries, where governance frameworks for waste handling may be weaker (European Environment Bureau, 2024). The ESPR also marks a shift in chemical governance by targeting substances that block circularity – such as persistent coatings or finishes – even when these substances are not yet restricted under REACH. Nonetheless, concerns remain regarding the latitude given to manufacturers to justify the presence of chemicals of concern and the limited scope of coverage when compared to the wider ambitions outlined in the Chemicals Strategy for Sustainability.

The implementation of the ESPR is closely aligned with complementary initiatives, including the revision of EU ecolabel criteria, forthcoming rules on GPP, ongoing discussions on the revision of the Textile Labelling Regulation and the development of the Green Claims Directive. Together, these measures form an integrated compliance ecosystem that reinforces the sustainability obligations imposed on textile producers and distributors.

WFD and mandatory EPR for textiles

The WFD provides the legal backbone for circular waste governance in the European Union. The 2025 targeted revision of the Directive introduces the first EU-wide mandatory EPR scheme for textiles, with implementation expected by April 2028, following final negotiations. Under the revised regime, producers—not only European manufacturers but also importers and online sellers—will bear financial and organisational responsibility for the collection, sorting, preparation for reuse and recycling of post-consumer textiles (European Commission, 2023b; European Parliament & Council, 2008). The revised WFD further obliges producers to provide transparent information regarding volumes placed on the market and the corresponding end-of-life destinations, creating a database for monitoring system-wide environmental performance.

A defining feature of the new EPR scheme is the eco-modulation principle, whereby producer fees are adjusted according to the environmental performance of textile products. Products designed for durability, repairability and high-quality recyclability will be subject to lower fees, whereas blends, products containing substances hindering recycling or items with scant durability will incur higher charges. The intent is to establish a clear economic incentive favouring circular design. The EEB (2024) observes that eco-modulation must be applied cautiously to avoid creating distorted incentives, such as inadvertently privileging synthetic fibres based solely on mechanical durability whilst overlooking broader environmental impacts.

The governance model foreseen by the revised WFD relies on PROs, which will coordinate funding, contracting, compliance monitoring and reporting. The EEB highlights the importance of protecting the role of social economy entities and reuse organisations within EPR structures, noting that these actors currently handle significant volumes of reusable textiles in many Member States. Ensuring their involvement is essential to maintain high-value reuse as the preferred end-of-life option.

The DPP is one of the most far-reaching innovations introduced through the ESPR. It establishes a unified digital information system, accessible through a QR code or similar identifier, that contains verified product data accompanying textiles throughout their lifecycles. The DPP is expected to include detailed information on fibre composition, recycled content, chemical substances of concern, durability indicators, repairability features, environmental performance metrics and instructions to support sorting and recycling. Its objective is to foster transparency and enable informed decision-making by consumers, regulators, waste-handling actors and recyclers.

The DPP's development faces several implementation challenges. Harmonising data structures across Member States, defining which actors have access to which information, ensuring interoperability with global value chains and safeguarding commercially sensitive data all represent substantial obstacles. The EEB (2024) notes that the DPP could impose significant compliance burdens on small and medium-sized enterprises and on producers in third countries exporting to the EU, underscoring the need for international cooperation and capacity building. Nevertheless, the DPP is expected to become a cornerstone of circularity by enabling precise sorting, improving material quality for recycling, supporting corporate due-diligence obligations and strengthening traceability in complex supply chains.

EPR has become one of the most influential institutional mechanisms for restructuring end-of-life responsibilities in the European textile sector. By shifting the economic and organisational burden of collection, sorting, reuse and recycling from municipalities and consumers to producers – including brands, importers and online retailers – EPR schemes aim to internalise environmental costs and create incentives for circular design. Within the European Union, the push toward EPR has accelerated considerably following the targeted revision of the WFD, which mandates separate textile collection by 2025 and establishes the legal basis for a harmonised EU-wide EPR scheme (European Commission, 2023a). The Directive makes EPR the default governance model for post-consumer textiles, paving the way for Member States to implement nationally adapted systems in advance of EU-level harmonisation.

France provides the most mature example of textile EPR implementation, having introduced a mandatory scheme in 2007. Managed by the PRO, Refashion, the French system has generated predictable financing flows for sorting and recycling and has incorporated eco-modulation criteria that reward durability, repairability and recycled content (Refashion, 2024). Recent reforms adopted in 2022–2023 strengthened requirements on ecodesign and increased fee differentiation, reflecting broader EU objectives to align product design with circularity principles.

The Netherlands became the second EU country to fully operationalise a national EPR scheme for textiles. The Dutch scheme, known as UPV Textiel, entered into force in July 2023 and places legal responsibility on producers to ensure high-quality reuse and recycling, complemented by ambitious targets for fibre-to-fibre recycling and transparency obligations regarding downstream treatment (Government of the Netherlands, 2023b). Several other Member States – including Denmark, Belgium, Finland and Spain – are developing or

testing national schemes in anticipation of forthcoming EU-level harmonised requirements.

In July 2024, Latvia became the fourth EU Member State to adopt EPR for manufacturers, importers and distributors of textiles and footwear, applying to both new and imported second-hand products. This approach builds on the large share of reuse in Latvia, with approximately one third of textile consumption being second-hand (Akule et al., 2023), as well as on experience gained from the early introduction of separate textile collection in January 2023—two years ahead of the EU requirement. National performance targets require textiles to be prepared for reuse, recycling or recovery, rising from 20% in 2024 to 25% from 2026 onwards. Three EPR operators cooperate with partners engaged in reuse and repair, whilst social enterprises and other reuse operators are allowed to maintain their own collection points (Cabinet of Ministers Regulation No. 359, 2024). The government has committed to harmonising criteria with EU regulations by 2028.

Despite the proliferation of initiatives, evidence from existing schemes indicates that EPR performance is highly dependent on institutional design and enforcement capacity. Research on early adopters shows that, whilst EPR reliably increases collection volumes, it does not automatically translate into high-value recycling or meaningful waste prevention (Watkins et al., 2017). The effectiveness of EPR depends on fee levels that adequately reflect environmental impacts, robust eco-modulation criteria that reward circular materials and discourage blends that hinder recycling and transparent reporting systems that prevent leakage into low-value export channels. Weak monitoring, insufficient differentiation of fees or limited governance capacity can dilute the intended effects, allowing producers to comply at minimal cost without adjusting their design, sourcing or production practices.

Furthermore, EPR schemes alone cannot compensate for systemic barriers such as insufficient recycling infrastructure, lack of fibre-to-fibre capacity or persistent economic advantages of virgin materials. For this reason, EPR is increasingly conceptualised not merely as a financing instrument but as part of a broader institutional logic that must be embedded within ecodesign regulations, due-diligence requirements, investment in collection and sorting technologies and robust controls on international waste shipments (European Parliament & Council, 2024). EPR thus functions as a cornerstone mechanism for accelerating textile circularity, but its transformative potential relies on its integration within a coherent regulatory, market and technological ecosystem.

4.2 Market logics

Market logics constitute a powerful yet ambivalent driver in the transition toward circular textiles. In contrast to institutional logics, which are grounded in formal regulation and policy frameworks, market logics emerge from competitive pressures, cost structures, consumer demand and the entrepreneurial search for new business opportunities. The fashion industry, in particular, is highly exposed to public scrutiny and reputational risk, making it a fertile terrain for circular initiatives such as the use of recycled materials, resale platforms, rental models, repair services and brand-led take-back schemes. Empirical work shows that these initiatives are increasingly embedded in brands' sustainability narratives and value propositions, even though the overall sector remains structurally aligned with fast-fashion logics of rapid turnover and low prices (Niinimäki & Hassi, 2011; Todeschini et al., 2017).

Technology and business model innovation

Technological and business-model innovation are central to these market-driven dynamics. Start-ups and specialised technology providers are developing advanced sorting systems, chemical recycling solutions and digital traceability tools, often in partnership with large brands and retailers (Ellen MacArthur Foundation, 2021; Global Fashion Agenda, 2023). At the same time, new CBMs—such as resale, rental, and product-as-a-service—have begun to proliferate. More entrepreneurs are experimenting with innovative sustainable business models that integrate circularity as a core value creation logic rather than a marginal add-on (Todeschini et al., 2017). Resale can function as a catalyst for business model adaptation, though it also requires organisational restructuring, new capabilities and changes to brand identity and customer relationship management (Hvass, 2015). However, the capacity of the market logic to deliver systemic circularity remains constrained by the underlying economics of textile production and consumption (EEA, 2019; Sandin & Peters, 2018). Many CBMs are labour- and logistics-intensive, they operate with thin margins and depend on uncertain consumer uptake, which limits their scalability without complementary regulatory and financial support (Circle Economy, 2022a; Global Fashion Agenda, 2023).

Consumer behaviour

A distinct segment of consumers actively seek out sustainable clothing, value durability and are motivated by ethical and environmental considerations

(Lundblad & Davies, 2016; UNEP, 2023). However, these trends coexist with persistent fast-fashion consumption, characterised by low prices, rapid style turnover and short garment lifespans. Many consumers may experience a conflict between their sustainability attitudes and their actual purchasing practices, a phenomenon often referred to as the attitude-behaviour gap (McNeill & Moore, 2015). Consumers express environmental concern whilst simultaneously engaging in high-volume, trend-driven consumption (Joy et al., 2012). The continued dominance of ultra-fast-fashion platforms in the European market underscores the strength of these contradictory drivers.

Managing the circularity paradox

These dynamics give rise to a form of "circularity paradox" in the marketplace. On the one hand, market actors increasingly recognise environmental and reputational risks associated with linear textile systems, they experiment with circular models and invest in new technologies. On the other hand, structural cost advantages for virgin materials, fragmented and under-resourced end-of-life infrastructure and the persistence of fast-fashion consumption patterns prevent circular practices from becoming the dominant market logic (EEA, 2019; UNEP, 2023). Market-led circularity often remains selective and incremental and can be constrained by rebound effects, lock-ins and power asymmetries (Corvellec et al., 2022). Voluntary initiatives and niche business models typically coexist with rather than replace mainstream linear practices.

4.3 Social and environmental logics

Social and environmental missions constitute a third, increasingly prominent logic shaping circular textile ecosystems. Rather than being driven primarily by regulatory compliance or profit maximisation, these mission logics are oriented toward respecting planetary boundaries, safeguarding human rights and achieving more just socio-ecological outcomes across global textile value chains. They are adopted by NGOs, trade unions, community initiatives and mission-driven enterprises.

Environmental dynamics

From an environmental perspective, the mission logic is grounded in a growing consensus regarding the severity of the textile sector's impacts. The EEA's series

of reports argues that only profound changes in design, business models and consumption patterns can align the sector with circular economy and climate goals (EEA, 2019, 2024, 2022). In this framing, circular textile ecosystems are not merely efficiency improvements but instruments to reduce absolute environmental pressures and move closer to science-based targets.

Social justice issues

At the same time, circularity is increasingly framed as a social justice issue. Bick, Halsey and Ekenga (2018) describe fast fashion as a form of "global environmental injustice", noting that communities and workers in production regions bear disproportionate exposure to water pollution, hazardous chemicals and unsafe workplaces, whilst consumers in high-income countries benefit from cheap clothing. In this view, circular textile ecosystems are legitimate only if they contribute to both environmental integrity and social well-being across the entire chain. In this sense, social economy entities, such as WISEs, have been pioneers in creating jobs related to the circular economy whilst strengthening social inclusion in Europe. Indeed, they are considered key actors to achieve the EU's circular economy goals and a just transition (European Commission, 2020). Their contribution highlights that circularity is not only about closing material loops but also about reshaping labour markets and improving access to decent work.

Recent scholarship on circular textiles explicitly integrates this socio-environmental mission perspective: Härri, Levänen and Linnanen (2022) conceptualise a "just sectoral transition" in textiles, arguing that circular economy strategies must address the distribution of benefits and burdens between workers, firms and regions, rather than focusing solely on material flows. Suarez-Visbal et al.(2024) adopt a socio-environmental justice lens on EU textiles policy and warn that circular textile regulations risk externalising costs to production countries if the export of used textiles and waste is not carefully governed, thus calling for "globally accountable" just transition mechanisms embedded into policy design, rather than appended as after-the-fact corrections. Another important dimension of social sustainability concerns the consequences of backshoring and offshoring. Whilst reshoring textile production to Europe is often presented as a way to ensure higher labour standards and reduce environmental impacts, it may also disrupt the economic dependence of many low- and middle-income countries on garment manufacturing (Casadei & Iammarino, 2023).

Civil-society organisations have begun translating these ideas into practical guidance for companies and policymakers. The Finnish organisation, Pro Ethical Trade, proposes that a circular economy for fashion must be compatible with both human rights and planetary boundaries (Pro Ethical Trade Finland, 2025). UNEP's roadmap likewise frames its nine "building blocks" for a circular textile value chain around simultaneous environmental and social objectives (UNEP, 2023).

Slowing the loop vs closing it

These mission-driven perspectives also challenge simplistic narratives that equate circularity with any recycling or reuse activity. The EEA underscores that certain forms of circularity – such as low-quality downcycling, exports of used clothing to markets lacking waste infrastructure or reuse models that do not reduce overall consumption – may simply relocate or prolong environmental burdens rather than reduce them (EEA, 2019, 2024, 2022). Mission-oriented actors therefore increasingly advocate "slowing" the flow of textiles by extending their use and sufficiency and reducing overall production, rather than relying solely on "closing" loops through recycling (Härri et al., 2022; Niinimäki et al., 2020).

Social and environmental mission logics add a critical layer to the understanding of circular textile ecosystems. They reorient circularity from a narrow technological or economic optimisation problem to a broader socio-ecological transformation in which textile systems are redesigned to operate within planetary boundaries and to advance rather than compromise human rights and social justice.

Case box 10: Textile circularity in Latvia

With over 30 years of experience in sustainable consumption and resource use, non-governmental organisation Green Liberty has played an important role in advancing textile circularity in Latvia. The following are its major textile-focused awareness-raising activities.

The first textile campaign in 2018, entitled *"What is in our closets?"*, encouraged people in Latvia to reflect on the environmental and the textile industry's social impacts by encouraging consumers to adopt the simple habit of checking garment labels. Data were collected from over 200 participants via social media, who reported on five clothing items of their choice, including the country of production, textile fibres, and information about how they acquired the garments and how long they had been used. This data was consolidated into visualisations and discussed at public events held

across every region in the country. The discussions highlighted issues such as the predominance of products being produced in distant countries, the prevalence of synthetic fibres and consumer use patterns.

The *"Inherited is valuable"* campaign in 2019 focused on celebrating reuse, specifically, clothing and textile accessories passed down from one generation to the next. A competition was organised to collect the best inherited clothing stories via Instagram and Facebook. The winning entry featured a wool scarf worn by a granddaughter in honour of her grandmother who had taken the scarf with her to Siberia when deported under the Soviet regime. All ten finalist stories were shared on social media and recognised at a final event held in one of the largest shopping malls in Riga, which also included a fashion show featuring two local upcycling designers.

In 2021, the social media campaign, *"Unmask your T-shirt",* focused on the textile industry's environmental impacts and on solutions to increase sustainability in line with circular economy principles. Using the example of a single t-shirt, the campaign presented key research findings about the textile industry through animations, data visualisations, expert videos and the participation of social media influencers, illustrating five stages of the garment's lifecycle: fibres, design, production, consumption and post-consumption. In-depth knowledge was also provided to approximately 500 students in 17 high schools in Latvia through online lectures during the COVID-19 pandemic. Social media competitions encouraged participants to analyse their own t-shirts, promoting active engagement with the topic.

These activities demonstrate a combination of online and offline engagement strategies to reach diverse audiences. Social media campaigns were complemented with in-person events, competitions and storytelling to foster active participation. Collaborating with influencers and integrating educational activities in schools proved effective in reaching not only younger audiences but also their parents and siblings.

Key lessons

- Encouraging participants to interact directly with their own garments – analysing labels or sharing inherited clothing stories – increased personal connection and engagement.
- Combining visual content (animations, data visualisations, videos) with participatory elements (competitions, workshops, lectures) helped make abstract sustainability concepts tangible.
- Using both mainstream media and niche events allowed Green Liberty to extend its reach beyond the "usual-suspects" audience, ensuring broader public awareness of sustainable textile practices.

- Applying a balanced approach in messaging, avoiding a black-and-white perspective, not promoting a single "right" answer, and refraining from blaming consumers or producers helped to achieve its objectives.
- Empowering consumers by helping them to not feel guilty about their consumption patterns enabled them to instead see small steps in their everyday lives as meaningful ways to adopt more sustainable behaviours that benefit both their resources and the planet.

Using opportunities to reach audiences beyond the "usual-suspects" bubble, Green Liberty continues to engage the public by organising events in shopping malls, contributing to sustainability-focused side-events during Riga Fashion Week and sparking conversations at the annual democracy festival LAMPA. Regular media presence in print, online and broadcast outlets further amplifies these efforts, helping to raise awareness of sustainable textile practices.

4.4 Enabling and hindering factors for the European circular business textile ecosystem

The transition towards a real circular business textile ecosystem in Europe is both driven and hindered by a complex interplay of institutional, financial, technological and collaborative factors summarised below.

Key enabling factors

- **Regulatory orchestration:** Governments act as the primary orchestrators of circularity through legislative frameworks and mandatory standards (WFD, EPR, GPP, ESPR, etc.). Accordingly, organisations now understand circularity as a response to an expanding "compliance ecosystem" shaped by EU and national policy, rather than merely optional, voluntary Corporate Social Responsibility measures (European Commission, 2022; Faludi, 2025; Franco & Giannoccaro, 2025).

- **Systemic design:** Brands are progressively adopting a "systemic designer" role in the circular textile supply chain (Franco & Giannoccaro, 2025; Nacchiero et al., 2024). This includes addressing ecodesign challenges based on key enablers such as design for reuse and recyclability (European Commission, 2022; Fashion for Good, 2022) or improving emotional durability to prevent premature disposal (Gillabel et al., 2021; Global Fashion Agenda, 2025c).
- **Consumer agency:** Education and behavioural change are considered cross-cutting enablers (EEA, 2019). Therefore, effective circularity requires awareness, behavioural interventions or nudging users to shift their consumption habits towards circularity (Ritch et al., 2025), including marketing messages that explicitly promote circular models (Global Fashion Agenda, 2025b).
- **Transparency and trust:** Traceability is essential to building trust amongst diverse actors (Civera et al., 2025) and can be supported by verified data architectures and digital platforms (Do & Stevenson, 2025). This process also involves the formalisation of the informal sector which is primarily involved in textile waste collection and trade (Global Fashion Agenda, 2024c).
- **Digital architecture:** Digitalisation provides the essential data architecture needed to monitor and optimise material flows across complex B2B networks (D'Adamo et al., 2025). Beyond automated and AI-based sorting solutions, technologies such as DPP, blockchain, and IoT require a collaborative effort amongst stakeholders to be effective (Civera et al., 2025). From a system perspective, the ability to exchange consistent product and batch-level data across organisations may matter more than the technological choice used in isolation (TexMat partner feedback).
- **Reverse logistics:** Efficient, multi-actor networks are pivotal for enhancing competitiveness by closing material loops that require advanced decision-making methodologies (Naranjo et al., 2025) and a scalable infrastructure to ensure large feedstock volumes (Global Fashion Agenda, 2024b).

- **Financial mobilisation:** Scaling circularity requires bridging the gap between impact investment and the substantial capital needs for infrastructure transformation. In this sense, targeted subsidies and tax incentives to favour circular strategic practices – such as repair services or second-hand commercialisation – are key (EEA, 2022). In addition, access to financing tools for circular implementation – including low-interest loans, co-financing mechanisms, and venture capital for material-innovation startups – de-risks the adoption of unproven circular technologies (Global Fashion Agenda, 2025b).
- **Collaborative innovation:** Multi-stakeholder consortia and innovation hubs, such as ECOSYSTEX or ReHubs, foster pre-competitive collaboration, knowledge sharing and the joint development of industry-wide standards (Global Fashion Agenda, 2025a).
- **Green human capital:** Upskilling the workforce for the "twin transition" is a prerequisite for operationalising innovation. For instance, upskilling the workforce in circular innovative practices is a prerequisite for operationalising technical innovations (Chaity et al., 2025). In this sense, training efforts should be extended across different levels, from top managers to collecting or sorting workers that should be dealing with the IoT and EPR digital platforms (Martin, 2025; Rey-García et al., 2023).

Key hindering factors

- **Institutional barriers:** Critical institutional hurdles hinder the shift towards a circular textile business ecosystem. Firstly, the lack of standardisation of end-of-waste criteria is a major bottleneck. Without a unified EU-wide definition of when textile waste becomes a secondary raw material, the trade and shipment of sorted fraction between recycling hubs have to overcome numerous administrative hurdles (Global Fashion Agenda, 2024a; Manshoven et al., 2019). Secondly, the absence of fully operational and harmonised EPR frameworks creates ambiguity, leading to the adoption of cautious and limited investment strategies (Zero Waste Europe, 2022).
- **Economic viability:** The lack of a viable economic model for circularity is one of the most persistent constraints under current market conditions. This negative or challenging business case is due to the cost

competitiveness of virgin material (Global Fashion Agenda, 2024c), the higher cost of collection and sorting in comparison with potential sales income and the financial barriers to achieve the needed infrastructure to reach economies of scale (BOF, 2024; Fashion for Good, 2022).

- **Material complexity:** The composition of current textiles acts as a disruptor to circularity. This includes the material complexity of the blends with small percentages of components such as elastane, or the presence of hardware disruptors like buttons, zippers or sequins, that have to be manually removed to prepare items for recycling processes. Similarly, NIR limitations and the fact that reuse-oriented sorting is still largely manual and experience-based are critical technological challenges for CBM scalability (Fashion for Good, 2022).
- **Market fragmentation:** Global export markets, on which the reuse system and its economic viability depend, are critical—especially in the case of low-value reusable textiles (Pal et al., 2025). This end-of-life supply chain is fragmented and, in some cases, opaque; a severe lack of traceability and the presence of informal actors taking part may hinder potential ecodesign efforts to close the loop (Global Fashion Agenda, 2024b, 2025c).
- **Consumer paradox:** The attitude-behaviour gap – where consumers express environmental concerns but still base purchasing decisions on price and trendiness – remains a critical barrier (Manshoven et al., 2019). This is compounded by persistent social stigmas related to hygiene and status which some consumers still associate with second-hand garments (Sepe et al., 2025).

5 Conclusions

Summary of key findings

This report provides an up-to-date picture of the European circular textile business ecosystem to inform the co-design of sustainable business models for TexMat's automated textile collection and sorting solutions. It draws on a literature review combined with consortium input to deliver an accurate picture of today's stakeholders, business models, regulations and the market and socioenvironmental logics that shape the ecosystem, specifying key enablers and hindering factors.

The literature identifies strong stakeholder interdependency, as no single actor can achieve circularity alone. There are nine stakeholder groups: consumers and users, brand owners, PROs, collection and sorting operators, reuse and second-hand operators, recycling operators, technology providers, public authorities and policymakers and civil society organisations.

In addition, the study draws on three national ecosystems to illustrate and expand the generic actor interdependencies identified by recent literature. In this sense, these actor types remain embedded in a predominantly linear system. Consequently, this report describes four CBMs as a means to reach different circular goals needed for a circular shift. These models are longevity and durability, access-based models, collection and resale and recycling and material reuses. These models are illustrated through real business cases, including three TexMat consortium partners.

Additionally, this review identifies a systemic mismatch that stems from a paradox of consumption and recycling potential. Whilst the textile industry is amongst the most environmentally intensive consumption areas in the EU, with growing per capita consumption and postconsumer waste, the separate collection and fibre-to-fibre post-consumer recycling rates remain low, all this whilst the exportation of used textiles outside the EU is increasing. Against this backdrop, there is a rapidly expanding compliance ecosystem of EU policies (Textiles Strategy, ESPR, revised WFD with mandatory EPR and the DPP), identified as the main structural driver making ecodesign, traceability and producer responsibility central. In this context, market logics create space for experimentation, but they cannot overcome the negative business case and the infrastructure gaps on their own given the existing financial and logistical barriers. In this sense, digitalisation potentially serves to implement the essential data architecture to bridge knowledge gaps and connect fragmented waste handlers, providing transparency and traceability. In addition, the social and environmental mission logics of NGOs, social economy

entities and critical research add a social justice lens which posits that some recycling, reuse and export practices can simply displace impacts rather than reduce them. This reinforces the need for European-wide resale and reuse solutions and the informal sector's formalisation to ensure a truly just and accountable circular transition.

Implications for CBM co-design

This report reveals a set of implications for CBM co-design that should be taken into consideration for the following TexMat tasks. Effectively introducing circularity in business model design requires shifting from the transaction approach to lifecycle value. Essentially, in terms of value proposition co-design activities, the latter should focus on circular goals, whilst value creation should integrate upstream ecodesign approaches and value capturing should decouple revenue from virgin resource consumption.

CBM co-design must focus on operationalising EU regulations, meaning that TexMat should be framed as a service that helps brands, PROs and authorities to meet ecodesign, separate collection, traceability and ecomodulated fee requirements.

Given the actors' interdependency, CBMs must be networked by nature and co-designed as part of a wider compliance and data infrastructure. The challenge of managing and steering flows across reuse and recycling processes in a complex multi-actor system requires using data that remains usable throughout the chain. Accordingly, co-design should focus on a multi-stakeholder approach, including digital platforms to connect fragmented actors' material flows and providing the corresponding data transparency to ensure proper traceability. In addition, co-design should provide the necessary incentives so that each actor has a clear role, revenue logic and risk sharing arrangement in the TexMat solution.

This study also identifies that the current business case for circular textiles is weak. Therefore, it needs to include hybrid value capturing strategies that combine EPR funding, service fees, long-term offtake agreements for recycled materials, possible public support and efficiency gains from automation and digitalisation, rather than relying solely on commodity revenues. More specifically, the intensity of labour required, and the cost of manual sorting are major barriers to profitability. In this sense, CBM co-design should focus on alternative solutions such as automated pre-sorting leveraged by technologies like AI or NIR. Furthermore, it could explore different revenue streams, capturing value from post-consumer textiles, reuse and resale to recycling markets.

Consumers should also be considered as active circularity co-producers. This implies the co-design of engagement strategies to promote circular practices by different means, such as user-friendly digital applications and incentive schemes.

Finally, CBM co-design should consider the social aspects related to textile waste management, from the role of the social economy to the avoidance of models that contribute to consolidate low-value exports to third countries.

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