BETWEEN FRAGMENTATION AND CIRCULARITY:

DESIGN DIRECTIONS FOR THE TRANSITION OF ITALIAN FASHION

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Abstract

The transition to circular models in Italian fashion is not primarily a technical challenge, but a systemic one. In the context of an industry characterised by fragmented production, local SMEs and distributed knowledge, circularity primarily emerges as a widespread capacity for coordination, resemantisation of value, and integration between technological innovation and local skills. Based on the analysis of three case studies (a community platform, an automatic classification technology system, and a material processing company) and ethnographic observations of creative micro-enterprises, this article analyses how services, organisational configurations and local infrastructures enable or hinder the circular transition in the Italian context. The study identifies four interconnected barriers (economic, technical, cultural, and regulatory) that require coordinated action. In response, it proposes three design directions: (1) enabling infrastructures that bring together fragmented actors without imposing centralisation, (2) re-semantisation of value through narrative and experiential design, (3) configuration of hybrid technological-artisan processes. This study highlights how integrated design approaches, rather than isolated technical innovation, are the critical lever for making circularity economically sustainable, culturally desirable, and operationally feasible in the context of Italian territorial SMEs.

Keywords: *Fashion circularity, Design for sustainability, Fragmented supply chains, Enabling infrastructures, Territorial governance*

INTRODUCTION

The Italian fashion industry represents a productive and cultural ecosystem deeply rooted in the national territory (Bertola & Linfante, 2015), characterised by specific peculiarities including the concentration of specialised technical skills in industrial districts (Brun & Castelli, 2008), the prevalence of SMEs and the recognised symbolic association between product quality and the Made in Italy brand (Pinchera & Rinallo, 2022). Based on this structural model, the Italian fashion system has historically built its competitive advantages through differentiation, innovation in design (Bertola & Colombi, 2024) and positioning in the mid-to-high and premium segments of the market (Runfola et al., 2022). Today, in a critical transition phase in which manufacturing longevity must be reconciled with the environmental and social constraints affecting the entire supply chain, these competitive advantages need to be reconsidered and renewed in light of emerging sustainability and responsibility criteria. In this context, the Italian fashion system operates as a heterogeneous ecosystem distributed throughout the country, connecting historic textile and manufacturing districts (Rinallo & Golfetto, 2006), metropolitan creative hubs (d'Ovidio, 2015), and emerging digital native companies (Colombi & D'Itria, 2023), thus forming a complex and interconnected network of actors that is grafted onto global value chains but maintains strong local roots. As is well known, globally, fashion is responsible for significant environmental and social

impacts throughout the entire product life cycle (Niinimäki et al., 2020), contributing significantly to carbon emissions, water consumption and textile waste generation (Peters et al., 2021; Shirvanimoghaddam et al., 2020), as well as perpetuating often critical working conditions (Bick et al., 2018) at various points in the supply chain. The Italian fashion system, with its specific production and cultural characteristics, is also affected by these dynamics (Tebaldi et al., 2022): dependence on global value chains, increased competitive pressure and the development of models for rapid market entry cumulatively lead to the perpetuation of unsustainable conditions that put pressure on the classic model of qualitative excellence.

At the same time, the Italian fashion system is structurally embedded within a broader European context of commercial and regulatory relations, in which the European Union acts as a promoter of new and stringent sustainability standards and requirements for the entire textile and clothing sector. European initiatives – from the EU Strategy for Sustainable and Circular Textiles to the proposed Ecodesign for Sustainable Products Regulation (ESPR) – are introducing, among other things, requirements for eco-design, durability, extended producer responsibility and traceability (European Commission, 2020), which require the Italian fashion system to realign its organisational models and design cultures while maintaining both competitiveness and cultural authenticity. Nevertheless, the application of these principles is hampered by structural issues that have to be understood and dealt with, particularly in fragmented production contexts such as Italy.

This article is situated within the national research project PRIN 2022 PNRR "ResHaping made in ITAly (RHITA). Circular models for Italian fashion heritage and manufactures through digital inclusivity and conscious innovation", which addresses the transition of Italian fashion towards circular and inclusive models by leveraging design-driven innovation across distributed manufacturing ecosystems. In this complex transition scenario, the article investigates how Italian fashion is finding its own way to reorient itself towards more sustainable and circular models, focusing in particular on forms of innovation capable of redesigning organisational configurations, business models, and processes. Starting from an analysis of three circular fashion organisations operating in Northern Italy, complemented by observations on creative micro-enterprises and independent designers, the research investigates how particular infrastructures and ecosystems facilitate such a transition. Specifically, the research addresses three main issues: (i) analysing how the transition to circular fashion models is manifesting itself today in the Italian context, highlighting emerging trajectories of organisational and business innovation; (ii) exploring the economic, technical, cultural and institutional barriers that hinder this transition, highlighting how these barriers are intertwined in territorially rooted production systems; (iii) identifying design directions capable of strengthening the circular transition in Italian fashion, consistent with the fragmentation of the supply chain and the forms of relational governance that characterise the Italian production system.

CIRCULARITY IN FASHION: ECOSYSTEMS, DESIGN AND FRAGMENTATION

The literature on fashion and sustainability highlights how circularity has become one of the main strategies for reducing the environmental and social impacts of the sector (de Aguiar Hugo et al., 2021), acting on production and consumption models (Mukendi et al., 2020) and textile waste management. Within this debate, work on circular fashion highlights the existence of multi-level barriers – economic, technical, cultural and institutional – that hinder the widespread adoption of more sustainable and circular practices throughout the supply chain (de Aguiar Hugo et al., 2021; Mishra et al., 2020; Schiaroli et al., 2025). In the Italian context, several studies show how the circular transition is linked to a production system characterised by manufacturing districts (Brun & Castelli, 2008), strong territorial roots and a prevalence of SMEs (Runfola et al., 2022), forming a fragmented supply chain that is nevertheless rich in local skills (Aage & Belussi, 2011; Colucci & Vecchi, 2021; Rinallo & Golfetto, 2006). While Made in Italy has become a symbolic competitive factor, implementing a circular approach is hampered by structural constraints on resources, relational governance, and the complexity of coordination across multiple scales (Tebaldi et al., 2022). At the same time, the new regulatory environment in the European Union, and its new Action Plan for a circular economy in particular, is increasingly

forcing a reorganisation of the textile and fashion sectors through eco-design rules, extended producer responsibility, digital product passports, etc., in order to translate environmental goals into business constraints (European Commission, 2020; Götz et al., 2022). This combination of top-down regulatory drivers and widespread production skills makes the Italian case particularly relevant for studying how circularity is translated into organisational configurations, business models and service infrastructures capable of coordinating supply chain actors (Colucci & Vecchi, 2021). This highlights the need to understand the barriers and operational configurations that characterise the circular transition in fragmented and territorially rooted production ecosystems. The design for sustainability approach shows how design action must gradually shift from the product level to supply systems and socio-technical transitions (Ceschin & Gaziulusoy, 2016), linking material devices, services (Vezzoli & Manzini, 2008), and organisational configurations (Rocha et al., 2019). In the fashion industry, this shift implies considering designers not only as creators of collections, but as actors capable of orchestrating platforms, services and infrastructures that enable circular practices along the supply chain (Dan & Østergaard, 2021) - from designing for durability and repairability (Kozlowski et al., 2018) to managing post-consumer flows (Aakko & Koskennurmi-Sivonen, 2013).

The literature on sustainable and circular business models emphasises the role of supply schemes that combine products, services, and networks of actors to slow, close, or restrict resource flows (Bocken et al., 2014, 2016; Coscieme et al., 2022). In particular, studies dedicated to fashion highlight the emergence of platforms and service solutions – such as circular marketplaces, rental models, and advanced collection and sorting systems – as enabling infrastructures that redistribute fixed costs and logistical complexity (Huynh, 2021), making reuse, upcycling and recycling practices in SME contexts (Colucci & Vecchi, 2021; Dragomir & Dumitru, 2022; Todeschini et al., 2017). However, the literature only addresses in a fragmentary way how systemic design approaches (Ceschin & Gaziulusoy, 2016) and circular business models (Bocken et al., 2014) are concretely translated into territorial organisational configurations in the contexts of Italian fashion SMEs and micro-enterprises, where production fragmentation and relational governance (Aage & Belussi, 2011) are structural elements.

METHODOLOGY

The research adopts an exploratory qualitative approach based on multiple case studies (Yin, 2009) to investigate how the transition to circularity in Italian fashion manifests itself operationally. To this end, and through a theoretical sampling aimed at representing complementary configurations of scale, organisational model and positioning in the supply chain, three circular fashion organisations operating in Northern Italy were selected. At the

Organization	Type	Main Service	Scale	Material Inputs
Appcycled	Digital Platform + community	Marketplace, pop-up, workshop	National (Italy)	Deadstock fabrics, production waste
Atelier Riforma	Tech provider B2B	AI Classification + marketplace B2B	National/EU	Post-consumer garments
Pulvera	Material innovation	Textile pulverisation and consulting services	National/EU	Pre-consumer textile waste
Indipendent Designers	Creative Micro-enterprises	Upcycling, repair, and bespoke services	Local (Milan)	Scraps, deadstock, and second-hand clothing

Tab.01

same time, observations were collected on creative micro-enterprises and independent designers in order to understand how circular practices based on small-scale initiatives and design or craftsmanship knowledge intertwine with the innovation trajectories identified in the primary case studies, helping to shape a heterogeneous territorial ecosystem of services, relationships and infrastructure to support the transition. [Tab. 01] The empirical material was collected between May and October 2025 through three sources:

- Semi-structured interviews (approximately 45 minutes) with one or more founders of the three organisations, covering topics such as operational configuration, stakeholder relations, challenges and perceived barriers.
- Documentary analysis of websites, social media, and public reports to enable triangulation and reconstruction of information relating to the organisations.
- Ethnographic observations of micro-enterprises and independent designers in Milan, focusing on upcycling, repair and transformation of waste materials. These observations were useful for understanding the local context and highlighting the diversity of operational scales within the Italian circular fashion ecosystem.

Finally, the data acquired was compared with the theoretical framework and the themes that emerged were grouped into three areas: organisational configurations for circularity; multi-level barriers (economic, technical, cultural, institutional); emerging design directions, understood as possible lines of development for services, business models and territorial infrastructures.

ORGANISATIONAL CONFIGURATIONS FOR CIRCULARITY IN ITALIAN FASHION

This section presents an analysis of three Italian entities with distinct approaches to circularity: a community platform that integrates small upcycling designers, an AI-driven technological classification system for post-consumer textiles, and an industrial-scale material processing company. Alongside these structured cases, observations on micro-enterprises and independent designers in the Milan area complete the picture of the Italian circular ecosystem. The concluding section (4.4) summarises the cross-cutting barriers that emerge from all contexts.

COMMUNITY-SCALE ENABLING INFRASTRUCTURE: APPCYCLED

Founded in 2020, Appcycled operates as a digital platform and physical space that connects designers specialising in upcycling with recycled materials, jointly addressing the valorisation of textile surpluses and supporting small, independent designers. The organisation faces a twofold challenge: on the one hand, providing visibility and sales channels for emerging designers who work with waste, deadstock, and end-of-line stock; on the other, channelling unsold fabrics and production stock towards creative reuse rather than disposal. Appcycled integrates three complementary levels of service: a digital marketplace that enables the direct sale of upcycled products; temporary physical spaces (pop-up stores, exhibition events) where designers can present their collections and meet potential customers; and a "community infrastructure" consisting of workshops and informal events that - even indirectly - can support knowledge sharing, peer learning and mutual support. As one of the co-founders points out, over time, the platform has built "a community so that emerging designers feel a little less alone", allowing them to collectively access resources that are difficult to sustain on an individual level. At the same time, it has expanded to a community of "non-professionals" interested in the creative reuse of high-quality materials at reduced prices. In this perspective, Appcycled acts as an intermediary between outgoing textile flows – unsold inventory, production waste, materials from closing ateliers – and designers or hobbyists seeking quality materials for upcycling.
The organisational model allows, at least in part, for the sharing of specific resources and skills among designers – in particular, collective visibility through the platform, joint communication activities and opportunities for collaboration on services such as photoshoots – only partially alleviating the burden of having to manage all the activities associated with creative micro-entrepreneurship alone. Nevertheless, the economic scalability of unique pieces or small batches remains structurally problematic: as one of the interviewees pointed out, "the costs of photo shoots, online cataloguing, social media

sponsorship for a single piece... all this erodes the profit margin of the individual garment", making it difficult for these independent designers to achieve economic sustainability. Appcycled thus tends to position itself in a relatively narrow market segment, consisting of consumers interested in sustainability – mainly young people – but also price-sensitive, and designers engaged in circular practices operating on limited margins.

Observations regarding independent design and small-scale creative initiatives in the Milan area suggest that similar models exist, based on the recovery of unused stock, direct sales to consumers and community involvement through workshops, but that they are scattered and, in some cases, lack a consistent infrastructure. In this context, Appcycled's role can be seen as an attempt to formalise and promote scattered initiatives by providing a common platform to support community involvement in the wider circular fashion system.

From a design perspective, Appcycled demonstrates how community-based platforms can partially offset the structural diseconomies of scale in artisanal upcycling, but they also risk remaining confined to a niche segment if not supported by broader enabling infrastructure and mechanisms.

TECHNOLOGICAL INNOVATION AND SUPPLY CHAIN COORDINATION: ATELIER RIFORMA

Founded in 2019 as a start-up and now operating as a social enterprise, Atelier Riforma positions itself as an "enabler" of circular fashion, with a specific focus on managing post-consumer textile flows. At the heart of the organisation is Re4Circular, a patented, proprietary, artificial intelligence-based automatic classification technology that improves the process of cataloguing post-consumer garments, extracting and recording their relevant characteristics, and directing them towards the most suitable circular path (reuse, upcycling, recycling), overcoming the limitations and time constraints of manual selection. Re4Circular operates through two integrated approaches: on the one hand, it supports organisations and cooperatives that manage the collection of used clothing, enabling them to classify garments and direct them towards circular destinations automatically; on the other hand, it provides entities such as upcyclers, recyclers and reuse operators with a supply infrastructure that makes available a "sustainable inventory" suited to different process requirements. In this sense, Atelier Riforma is defined by its founder as a "facilitator" that channels as much post-consumer textile waste as possible to appropriate destinations, helping to build an infrastructure that remains fragmented today. According to the founder, the increased focus on circularity over the last five years is only partly due to a change in awareness within the fashion supply chain. Instead, it seems to be driven more strongly by an "external regulatory push", namely European regulations that require the textile and fashion industry to reduce waste and encourage reuse, recycling and upcycling practices. In this way, the technological strategy proposed by Atelier Riforma responds to a new need for operational instruments capable of turning a regulatory need into a specific process for the management and improvement of post-consumer flows.

The platform's experience also highlights specific constraints in the post-consumer segment, first and foremost, the technical challenges associated with managing garments produced before the introduction of eco-design principles (desirable, but still not structurally adopted today), which make it challenging to recover garments designed for a linear life cycle. In this scenario, Atelier Riforma's contribution should be seen as an attempt to build a digital and market infrastructure capable of making the post-consumer circularity opportunities opened up - but not guaranteed - by European regulatory developments operational in the Italian context.

INDUSTRIAL-SCALE MATERIAL PROCESSING: PULVERA

Launched as a start-up in 2024, Pulvera draws on over 70 years of experience from Casati Flock&Fibers, a company operating since 1952 and specialising in the pulverisation of textile fibres for applications across a wide range of sectors. In line with this industrial tradition, Pulvera is repositioning existing technologies and value chains in order to enhance the value of pre-consumer textile waste from the fashion industry. The aim is to "find a new life for textile waste" through pulverisation and the identification of new applications. The service offering is organised around this objective comprehensively and includes waste analysis and consulting services, pulverisation, and new product design. Pulvera

thus operates across multiple stages of the process, both upstream and downstream of production, collaborating with companies that "do not know how to use their textile production leftovers" while offering "tailor-made solutions for the recovery of textile waste". In this way, the company supports its partners in defining more effective separation flows and designing tailor-made applications that reintroduce waste into new value chains. The co-founder emphasises that part of the work consists of showing that, by initially dedicating time to mapping and correctly sorting waste, "it is then possible to implement many more recycling solutions", preventing large volumes of material from remaining undestined. The co-founder also points out that direct observation of production sites reveals that waste generation is often more of an organisational than a technical problem. Processes historically configured for a strictly linear production model seldom provide for the systematic separation of waste by composition and colour, even for more easily recyclable single-material streams. This compromises the quality of the available material and limits its possible applications. The interviewee points out that if waste were sorted not only by composition but also by colour, it would be possible to "avoid the entire dyeing process", maintaining the colours already applied and reducing the use of water and dyes in solutions developed with textile powder. Compared to other cases, Pulvera's material-centric strategy highlights how organisational routines and sorting practices upstream in the supply chain can unlock or block circular opportunities, suggesting that designing for circularity must also address "invisible" process conventions rather than just visible products and services.

BARRIERS TO THE CIRCULAR TRANSITION IN THE ITALIAN CONTEXT

Based on the analysis of the three cases and observations on micro-enterprises, four categories of multi-level barriers that limit the development of circularity in fashion have been identified and summarised as follows.

- Economic and structural barriers: Circular processes (collection, sorting, repair, transformation) tend to be more intensive and operate mainly at a small scale, resulting in higher costs than linear alternatives that benefit from established economies of scale. This results in an accessibility gap that impacts, among other things, the niche market of consumers interested in sustainability – particularly younger people, who are highly sensitive but have low purchasing power - further reducing demand for "sustainable fashion". Furthermore, and even more significantly, in a production system dominated by SMEs, micro-enterprises and craft initiatives, the distribution of these costs has a particularly onerous impact on small operators (independent designers, workshops, community platforms) whose economic sustainability often depends on access to informal support networks and the use of shared spaces and infrastructure. This asymmetry also affects circular B2B operators, for whom "using existing material as an alternative to virgin material is even more expensive than virgin material", exposing models based on recycling and reuse to the risk of not being sufficiently competitive.

- Technical and material barriers: The characteristics of existing materials in circulation - namely mixed fibres, non-dismantlable designs and complex surface finishes - resulting from decades of linear design practices that did not include eco-design principles - significantly limit the use of circular reuse cycles, particularly in the recycling and transformation of post-consumer streams. Furthermore, from a purely technological standpoint, existing recycling technologies are, in some cases, costly or limited to specific categories of materials. For these reasons, implementing circular solutions requires initial organisational investments - sorting and screening infrastructure, information systems, staff training, and process redesign - which companies tend to postpone, despite the potential for medium- to long-term benefits. At the micro level, in production contexts characterised by widespread craftsmanship and micro-entrepreneurship, the scalability of circular

practices depends on the ability to translate tacit skills and case-by-case adaptations into replicable protocols and procedures: many of the services observed, based on the localised skills of artisans, independent designers and micro-enterprises, struggle to transform themselves into models that can be transferred even between similar contexts, hindering the inter-local diffusion of technical innovations developed in the field.

- Cultural and perceptual barriers: In the fast fashion segment, the spread of consumption models based on very low prices, rapid cycles and broad availability has gradually normalised clothing as a disposable commodity, eroding cultural practices of care, repair and prolonging the useful life of products. In this segment, even when awareness of sustainability is high, it competes with economic pressures and daily uncertainties and is often postponed to the future, especially among young consumers who, despite being the most interested, do not have the resources necessary to bear the cost of more sustainable solutions The luxury market is characterised by another distinct yet equally complex cultural context. Recycled materials and the aesthetic of reuse are constantly at odds with existing biases, which perceive them as of poorer quality and with "less finished or compromised aesthetics". This perception limits the integration of recycled materials into main collections, sometimes confining them to experimental or communicatively "separate" capsules from the core business. Studies on micro-businesses and independent designers show a complementary dynamic in which access to circularity is driven more by experiential and identity factors rather than mere environmental drivers. Many consumers approach it through workshops, self-production practices and the purchase of "unique pieces", valuing craftsmanship, uniqueness and relationships activated around objects; in this context, the most effective circular services in Italy are those that intertwine aesthetic and relational values with sustainability objectives.

- Regulatory and institutional barriers: The most significant regulations in the European regulatory framework - extended producer responsibility, eco-design regulations, durability and repairability criteria, and digital passports - are often seen as a burden for fashion industry operators. This view can lead to a focus on marginal, low-cost changes rather than on different business models and value chains. On the other hand, for small-scale circular businesses working with heterogeneous waste streams, traceability and documentation requirements translate into administrative burdens that are difficult to sustain when the origin of materials is partial or non-standardised. Furthermore, the geographical limitation of regulations - "the problem with European regulations is that they are European" - creates asymmetries between EU and non-EU operators in a globally delocalised production sector, generating competitive distortions without, in itself, guaranteeing the elimination of unsustainable practices along international value chains.

Together, the three cases outline intentionally complementary paths towards circularity: Appcycled operates at the community and micro-enterprise level, Atelier Riforma focuses on infrastructure and data-based coordination of post-consumer flows, while Pulvera deals with the industrial transformation of materials. By looking at circularity from these different positions in the value chain, the analysis shows that there is no single solution to resolve the systemic misalignment between circular ambitions and existing organisational configurations, and that multi-scale design interventions are needed.

DESIGN DIRECTIONS FOR A CIRCULAR TRANSITION

Empirical analysis shows that barriers to circularity in Italy are primarily systemic – production fragmentation, structural diseconomies of scale, cultural resistance – rather than technological. These interconnected obstacles require design interventions that go beyond individual products, addressing the configuration of integrated value ecosystems. Based on the three case studies and observations, three strategic directions emerge.

ENABLING INFRASTRUCTURE TO DECOUPLE CREATIVITY AND MANAGEMENT COMPLEXITY

In the context of fragmented supply chains, design could focus on the configuration of shared infrastructures for access to centralised services for low-specificity but highly complex logistical functions, such as collection, sorting, traceability and marketing, thus allowing small operators to concentrate on high-specificity activities - creativity, repair, processing. Platform solutions similar to those observed could help redistribute fixed costs (digital infrastructure, communication, market visibility) across groups of microenterprises, transforming fragmentation from an economic weakness into a systemic resource. This would allow for the redefinition of "network economies of scale" without requiring vertical integration, while maintaining the territorial specificity of the Italian productive system. A first project direction could be the development of "minimum" standard rules and formats that make it easier for different actors to cooperate without flattening their specificities. This would involve identifying a few dimensions to be standardised – for example, how to code materials or describe the condition of garments – while leaving other aspects flexible to manage the heterogeneity of circular flows without sacrificing local specificities.

A second direction could involve the design of hybrid physical nodes that integrate circular back-end functions (preliminary collection, sorting, repair, material transformation) with front-end experiences (retail, workshops). Observations of independent designers' spaces suggest that the visibility of upcycling and repair processes can significantly change consumers' perception of value; consciously designing these places as interfaces between reverse logistics and cultural experience could therefore be an important lever for the legitimisation and dissemination of circular practices.

RE-SEMANTISATION OF VALUE THROUGH DESIGN AND NARRATIVES

Since in various market segments, particularly premium ones, secondary materials tend to be associated with inferior quality or aesthetic compromise, design could aim to construct new cultural meanings around circularity. From this perspective, recovered material can be interpreted not simply as "upcycled waste", but as reinterpreted heritage, bearing history, skills and links to specific production contexts. Empirical evidence also suggests that when circularity is proposed as a creative and identity-building experience (including, for example, upcycling workshops, self-production, and the purchase of unique pieces), it also attracts consumers who do not primarily define themselves as being motivated by environmental concerns. A first direction could concern the design of an "aesthetics of traceability", in which the heterogeneity of the recovered materials is not masked but made legible as an attribute of uniqueness and craftsmanship excellence. According to this approach, an item made from waste or archive materials should not be defined as "second-hand", but rather in relation to the curatorial and design processes that give the material its symbolic meaning. A second direction could focus on designing traceability processes to build an emotional link between the user and the recovery chain. In addition to the data needed to ensure regulatory compliance, the data disclosed can and should shed light on the material's history, its origin, the local skills involved, and the environmental impacts avoided, to shift the logic of competition from price to value.

CONFIGURATION OF HYBRID TECHNOLOGICAL-ARTISAN PROCESSES

The technical barriers associated with managing heterogeneous textile flows suggest the need for a "systematisation" of functions that aims to enhance the integration between emerging technologies – such as automatic classification systems, visual recognition, industrial transformation of materials – and widespread craftsmanship skills. Design could focus on defining interface points that make these technologies accessible to small-scale operators and, at the same time, enhance the irreplaceable contribution of creative judgement and manual intervention. A promising

direction could be the design of protocols for transitioning between technology-mediated and more "traditional" phases, capable of maintaining continuity of information and meaning throughout the material's life cycle when garments or textile waste pass from automatic classification, sorting or industrial processing systems to repair, upcycling or creative design practices, the information collected (composition, origin, treatments) could accompany the material in a form that is readable and actionable for those working on the piece. Symmetrically, creative intervention, including the changes made, the methods used, and the aesthetic and cultural values integrated, can also be reintegrated into information systems to enable traceability, communication, and further processes. In this context, hybrid processes that blend technology and craftsmanship do not replace human labour with technology, but rather complementarily articulate different sets of skills to improve not only the operational feasibility of circular services, but also the aesthetic and symbolic value of their products.

DISCUSSION AND CONCLUSION

This study suggests that, in the Italian context, the circular transition is taking shape as a distributed ecosystem of initiatives operating on different scales and levels of formality, in which local craft practices, experimental design spaces, technological intermediaries and collaborative platforms collectively support circular trajectories without converging into a single centralised model. This coexistence of heterogeneous initiatives – from the community to the industrial level – does not represent disorderly fragmentation, but rather an ecosystem where territorial specialisation, relational roots, and operational flexibility allow circular processes to be adapted to the specificities of different market segments and localised skills (Bertola & Colombi, 2024; Colucci & Vecchi, 2021). However, the distributed system is structurally vulnerable due to key connections and the reinforcement of economic, technical, cultural and institutional barriers listed in Section 4.4. Economic disadvantages, in the form of unit cost penalties due to circular processes, contribute to low adoption rates and the persistence of niche markets that are too small to achieve economies of scale. The lack of disassembly and non-standardised processes is further exacerbated by resistance to change in organisations. Cultural biases, in the form of the opinion that recycled products are of inferior quality, have been shaped by the historical acceptance of the idea that products are disposable and require continuous refutation (Ozdamar-Ertekin, 2016). Institutional or regulatory barriers, such as difficult traceability conditions regarding questionable sources and the spatial scope of EU laws, place excessive pressure on micro-enterprises and can therefore be considered an obstacle to effectiveness.

Fragmentation creates a contradictory dynamic that simultaneously displays resilience and vulnerability. Diversity allows for widespread experimentation and contextualised adaptation, but hinders infrastructure standardisation, structural economies of scale, and the construction of a shared public discourse able to give circular initiatives sufficient visibility and legitimacy. The three cases represent efforts to manage these complexities at different levels—community, technological, and material—but sustainability depends on collective transformation across all four dimensions: economic, technological, cultural, and institutional. Furthermore, the three case studies show that the circular transition in Italian fashion revolves around three critical and interconnected aspects. Firstly, from the analysis, it can be deduced that, in the context of fragmented systems such as Made in Italy, the design of circular services is not simply a matter of isolating processes, but rather a matter of developing infrastructural ecologies that act as a bridge between the various autonomous actors, in order to allow them to participate in circular dynamics without losing their autonomy and specificity. At the same time, a problem arises, as the most efficient platforms (such as Atelier Riforma) exhibit a certain degree of standardisation, while more local projects (such as Appcycled) struggle with economic scalability. This suggests that the design of infrastructure for fragmented systems requires a dynamic balance between coordination and autonomy, which is difficult to achieve. Secondly, the article highlights that the cultural and semantic dimensions of value precede and enable economic scalability, contrary to what the literature on circular fashion often assumes (which often focuses on recycling and logistics technologies). As evidenced by the Pulvera cases and observations on independent designers, the re-semantisation of recovered material is not an optional strategy, but a precondition for justifying the premium price necessary to cover

the real costs of circular processes. In the luxury segment, this means radically transforming the cultural meaning of recycled materials—from "environmental compromise" to "reinterpreted heritage" steeped in history and expertise. In creative niches, it involves emphasising uniqueness, identity, experience and community participation as forms of value commensurate with price. However, this re-semantisation remains fragile: it depends on the narrative consistency maintained by individual actors and on the consumers community' ability to recognise and value these alternative meanings (Fletcher, 2016; Mazzarella et al., 2019). The risk is that without infrastructure to support this collective narrative, re-semantisation will remain confined to isolated niches. Thirdly, the design of hybrid technological-artisan processes offers a means to mediate the tension between technological standardisation and territorial uniqueness, though its practical implementation poses significant challenges. In the Italian context, both advanced technological innovation (AI for classification, blockchain for traceability) and localised artisan skills are present and strategically important. The conscious merging of these aspects has the potential to deliver unique value; however, as the cases demonstrate, it is not necessarily an automatic process. The example of Atelier Riforma shows that technology can increase the efficiency of the selection process; however, the inconsistent quality of incoming materials remains an issue linked to suppliers' organisational and cultural practices. Similarly, the artisan workshops observed use digital traceability tools sporadically, often for regulatory compliance rather than strategic value. This suggests that technological-artisanal hybridisation requires not only skills, but also a redesign of workflows that is not yet systematic.

Overall, these three aspects suggest that the circular transition in the Italian fashion industry is not so much focused on the adoption of superior technologies or regulatory issues, but instead on the simultaneous design of hybrid infrastructures, meanings and processes.The advantage for industry players lies in recognising that their investment priorities must be balanced not only in the adoption of advanced technologies, but also in coordination tools, narrative re-semantisation, and environments that make circularity attractive and functional.The study acknowledges a significant methodological limitation as the sample consists of three organisations operating in Northern Italy. This territorial limitation means that the results cannot be generalised and leaves open the possibility that the dynamics may have different outcomes in other territorial contexts, as the characteristics of relational governance and productive roots may take other forms. Furthermore, the study focuses on the perspectives of circular intermediaries (platforms, tech providers, transformers), which means there is not an equally direct representation of the perspectives of more traditional manufacturing companies and end consumers. However, despite these limitations, the research puts forward a critical argument: the issue of circularity in the Italian fashion industry is not, in reality, a technical or regulatory problem, but rather an organisational and cultural one. The three case studies demonstrate that if the idea of circularity is developed as an integrated system that includes decentralised, coordinated infrastructure elements, narrative structures that legitimise the value of recycling, and processes that integrate craftsmanship and innovative elements, then it is not only possible but also desirable. In the Italian context, where the fragmentation of the sector into small and medium-sized enterprises, territorial entities and localised knowledge is a structural reality, the design of circularity can actually take advantage of this heterogeneity, in contrast to standardisation, which eliminates particularities, and instead focus on infrastructural and narrative projects that maintain the autonomy of the various actors and provide cultural legitimacy to the practices of transformation and longevity of materials. From this point of view, in fact, the very historical elements of the Italian production system, such as fragmentation, territoriality, and multiple scales and skills, can represent an opportunity to develop innovative solutions in tune with the sector's identity, rather than an obstacle to the realisation of circularity. In this sense, in the Italian fashion sector, circularity could find paths of implementation more consistent with the local productive fabric if conceived as innovation co-designed with local actors, rather than as external regulatory compliance.

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CAPTION

[Tab. 01] Summary of the characteristics of the organisations and micro-enterprises surveyed.

REFERENCES

Aage, T., & Belussi, F. (2011). From Fashion to Design: Creative Networks in Industrial Districts. In *Managing situated creativity in cultural industries*. Routledge.

Aakko, M., & Koskennurmi-Sivonen, R. (2013). Designing Sustainable Fashion: Possibilities and Challenges. *Research Journal of Textile and Apparel*, *17*(1), 13–22. https://doi.org/10.1108/RJTA-17-01-2013-B002

Bertola, P., & Colombi, C. (2024). Can fashion be sustainable? Trajectories of change in organizational, products and processes, and socio-cultural contexts. *Sustainability: Science, Practice and Policy*, *20*(1), 2312682. https://doi.org/10.1080/15487733.2024.2312682

Bertola, P., & Linfante, V. (2015). *Il nuovo vocabolario della moda italiana*. Mandragora.

Bick, R., Halsey, E., & Ekenga, C. C. (2018). The global environmental injustice of fast fashion. *Environmental Health*, *17*(1), 92. https://doi.org/10.1186/s12940-018-0433-7

Bocken, N. M. P., de Pauw, I., Bakker, C., & van der Grinten, B. (2016). Product design and business model strategies for a circular economy. *Journal of Industrial and Production Engineering*, *33*(5), 308–320. https://doi.org/10.1080/21681015.2016.1172124

Bocken, N. M. P., Short, S. W., Rana, P., & Evans, S. (2014). A literature and practice review to develop sustainable business model archetypes. *Journal of Cleaner Production*, *65*, 42–56. https://doi.org/10.1016/j.jclepro.2013.11.039

Brun, A., & Castelli, C. (2008). Supply chain strategy in the fashion industry: Developing a portfolio model depending on product, retail channel and brand. *International Journal of Production Economics*, *116*(2), 169–181. https://doi.org/10.1016/j.ijpe.2008.09.011

Ceschin, F., & Gaziulusoy, I. (2016). Evolution of design for sustainability: From product design to design for system innovations and transitions. *Design Studies*, *47*, 118–163. https://doi.org/10.1016/j.destud.2016.09.002

Colombi, C., & D'Itria, E. (2023). Fashion Digital Transformation: Innovating Business Models toward Circular Economy and Sustainability. *Sustainability*, *15*(6), Article 6. https://doi.org/10.3390/su15064942

Colucci, M., & Vecchi, A. (2021). Close the loop: Evidence on the implementation of the circular economy from the Italian fashion industry. *Business Strategy and the Environment*, *30*(2), 856–873. https://doi.org/10.1002/bse.2658

Coscieme, L., Manshoven, S., Gillabel, J., Grossi, F., & Mortensen, L. F. (2022). A framework of circular business models for fashion and textiles: The role of business-model, technical, and social innovation. *Sustainability: Science, Practice and Policy*, *18*(1), 451–462. https://doi.org/10.1080/15487733.2022.2083792

d'Ovidio, M. (2015). The field of fashion production in Milan: A theoretical discussion and an empirical investigation. *City, Culture and Society*, *6*(2), 1–8. https://doi.org/10.1016/j.ccs.2015.02.002

Dan, M. C., & Østergaard, T. (2021). Circular Fashion: The New Roles of Designers in Organizations Transitioning to a Circular Economy. *The Design Journal*, *24*(6), 1001–1021. https://doi.org/10.1080/14606925.2021.1936748

de Aguiar Hugo, A., de Nadae, J., & da Silva Lima, R. (2021). Can Fashion Be Circular? A Literature Review on Circular Economy Barriers, Drivers, and Practices in the Fashion Industry's Productive Chain. *Sustainability*, *13*(21), Article 21. https://doi.org/10.3390/su132112246

Dragomir, V. D., & Dumitru, M. (2022). Practical solutions for circular business models in the fashion industry. *Cleaner Logistics and Supply Chain*, *4*, 100040. https://doi.org/10.1016/j.clscn.2022.100040

European Commission. (2020). *A new Circular Economy Action Plan. For a cleaner and more competitive Europe*.

Fletcher, K. (2016). *Craft of Use: Post-Growth Fashion*. Routledge. https://doi.org/10.4324/9781315647371

Götz, T., Berg, H., Jansen, M., Adisorn, T., Cembrero, D., Markkanen, S., & Chowdhury, T. (2022). *Digital product passport: The ticket to achieving a climate neutral and circular European economy?* University of Cambridge Institute for Sustainability Leadership.

Huynh, P. H. (2021). Enabling circular business models in the fashion industry: The role of digital innovation. *International Journal of Productivity and Performance Management*, *71*(3), 870–895. https://doi.org/10.1108/IJPPM-12-2020-0683

Kozlowski, A., Searcy, C., & Bardecki, M. (2018). The reDesign canvas: Fashion design as a tool for sustainability. *Journal of Cleaner Production*, *183*, 194–207. https://doi.org/10.1016/j.jclepro.2018.02.014

Mazzarella, F., Storey, H., & Williams, D. (2019). Counter-narratives Towards Sustainability in Fashion. Scoping an Academic Discourse on Fashion Activism through a Case Study on the Centre for Sustainable Fashion. *The Design Journal*, *22*(sup1), 821–833. https://doi.org/10.1080/14606925.2019.1595402

Mishra, S., Jain, S., & Malhotra, G. (2020). The anatomy of circular economy transition in the fashion industry. *Social Responsibility Journal*, *17*(4), 524–542. https://doi.org/10.1108/SRJ-06-2019-0216

Mukendi, A., Davies, I., Glozer, S., & McDonagh, P. (2020). Sustainable fashion: Current and future research directions. *European Journal of Marketing*, *54*(11), 2873–2909. https://doi.org/10.1108/EJM-02-2019-0132

Niinimäki, K., Peters, G., Dahlbo, H., Perry, P., Rissanen, T., & Gwilt, A. (2020). The environmental price of fast fashion. *Nature Reviews Earth & Environment*, *1*(4), 189–200. https://doi.org/10.1038/s43017-020-0039-9

Ozdamar-Ertekin, Z. (2016). Conflicting Perspectives on Speed: Dynamics and Consequences of the Fast Fashion System. *Markets, Globalization & Development Review*, *1*(1). https://doi.org/10.23860/MGDR-2016-01-01-06

Peters, G., Li, M., & Lenzen, M. (2021). The need to decelerate fast fashion in a hot climate—A global sustainability perspective on the garment industry. *Journal of Cleaner Production*, *295*, 126390. https://doi.org/10.1016/j.jclepro.2021.126390

Pinchera, V., & Rinallo, D. (2022). The emergence of Italy

as a fashion country: Nation branding and collective meaning creation at Florence's fashion shows (1951–1965). In *The Brand and Its History*. Routledge.

Rinallo, D., & Golfetto, F. (2006). Representing markets: The shaping of fashion trends by French and Italian fabric companies. *Industrial Marketing Management*, *35*(7), 856–869. https://doi.org/10.1016/j.indmarman.2006.05.015

Rocha, C. S., Antunes, P., & Partidário, P. (2019). Design for sustainability models: A multiperspective review. *Journal of Cleaner Production*, *234*, 1428–1445. https://doi.org/10.1016/j.jclepro.2019.06.108

Runfola, A., Milanesi, M., & Guercini, S. (2022). *Internationalization of luxury fashion firms*. Springer.

Schiaroli, V., Dangelico, R. M., & Fraccascia, L. (2025). Mapping sustainable options in the fashion industry: A systematic literature review and a future research agenda. *Sustainable Development*, *33*(1), 431–464. https://doi.org/10.1002/sd.3129

Shirvanimoghaddam, K., Motamed, B., Ramakrishna, S., & Naebe, M. (2020). Death by waste: Fashion and textile circular economy case. *The Science of the Total Environment*, *718*, 137317. https://doi.org/10.1016/j.scitotenv.2020.137317

Tebaldi, L., Brun, A., & Bottani, E. (2022). Evidences on sustainability issues in the Fashion Supply Chain: An empirical study in Italy. *Sustainable Production and Consumption*, *33*, 651–663. https://doi.org/10.1016/j.spc.2022.07.032

Todeschini, B. V., Cortimiglia, M. N., Callegaro-de-Menezes, D., & Ghezzi, A. (2017). Innovative and sustainable business models in the fashion industry: Entrepreneurial drivers, opportunities, and challenges. *Business Horizons*, *60*(6), 759–770. https://doi.org/10.1016/j.bushor.2017.07.003

Vezzoli, C., & Manzini, E. (2008). *Design for Environmental Sustainability*. Springer. https://doi.org/10.1007/978-1-84800-163-3

Yin, R. K. (2009). *Case Study Research: Design and Methods*. SAGE.