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Can fashion be sustainable? Trajectories of change in organizational, products and processes, and socio-cultural contexts

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ABSTRACT

This article conducts an in-depth exploration of the current landscape of fashion sustainability, providing a comprehensive framework that contextualizes the subsequent contributions that comprise this Special Issue. By delineating three pivotal dimensions of action, we set the stage for a nuanced examination that reviews the realms of organizational change, innovation within fashion products and processes, and the tangled interplay of socio-cultural transformations. These dimensions collectively lay the foundation for a holistic analysis of how the fashion industry navigates the complexities of sustainability, encompassing shifts in management paradigms, advancements in design and production, and cultural factors that underpin the sustainable fashion discourse. Through an extensive analysis, the article not only presents a panoramic view of the current state of the art regarding fashion and sustainability but also constructs a robust conceptual framework that serves as a guiding compass for navigating the subsequent sections within this Special Issue. This framework is designed to encapsulate the multiple facets of sustainability within the fashion domain, acting as a roadmap to discern and understand the evolving landscape. This lens invites readers to journey beyond the surface, delving into the perspectives that define the transition toward a more sustainable fashion future.

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Introduction: a holistic approach to fashion sustainability

Global fashion, as part of the cultural and creative industries (CCI), represents a rich and advanced manifestation of contemporary culture and simultaneously embodies a complex and layered set of socio-technical relationships. On one hand, fashion is a sophisticated expression of our society that is a melding of different languages and artistic disciplines, widely perceived as a “cultural media,” and pervading and informing social practices and dynamics. Indeed, it has been an important component of societal evolution and costumes have always been important elements of acculturation processes of all communities. In its contemporary manifestation, fashion is a “tool” of cultural mediation between the individual and the social environment, contributing to defining subjective and collective identities.

On the other hand, fashion is one of the oldest manufacturing sectors in Western countries, part of their industrial roots, and still a critical component of economies with a globally significant scale of impact. The industry has been at the core of several

consecutive technological revolutions, contributing to – and sometimes accelerating – globalization processes, producing various deleterious effects through concurrent processes of cultural homogenization and impoverishment, as well as deeply affecting the quality of the environment to the point where today it is the second most polluting industry in the world (Huynh 2022).

These two dimensions of fashion are currently colliding because of the rise of digitalization and the increase in access to information. Electronic communication channels have been amplifying the friction between fashion narratives, the extensive and pervasive impacts of the industry and its allied activities, and the search for authenticity. The public has begun to demonstrate heightened awareness and these new sensibilities have begun to change customers’ attitudes toward consumption choices, thus increasing the demand for transparency on the part of commercially visible brands. In the face of these challenges, the established pillars of the global fashion industry have struggled to reinvent their business models and related modes of storytelling and the

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prevailing situation has given rise and legitimacy to several alternative voices.

These novel expressions are emanating from a lively ecosystem of startups that are organized around new sets of values informed by sustainability. Further disruption is being driven by the activities of a growing community of “fashion activists” and nongovernmental organizations (NGOs) which are reframing the global discourse. The COVID-19 pandemic has quickened ongoing transformation and overturned preexisting commitments. The global fashion system – comprising both its facets of production and consumption and its negative social and environmental consequences – is being critically questioned even by authoritative figures at the center of some of the most iconic and successful brands. Therefore, the quest for more equitable and sustainable fashion consumption-production practices and models is of paramount contemporary relevance.

Originating in the 1980s (WCED 1987), the notion of sustainable development has undergone significant evolution over the intervening decades. Initial attempts to define its parameters were made through various lenses of social, political, economic, and ecological thought. These perspectives, though insightful individually, failed to coalesce into a comprehensive and unified understanding of sustainability that encompasses the intricate web of social dynamics, the delicate balance between humans and nature, and the underlying values and beliefs that shape our worldview.

In some instances, sustainability has been subsumed within existing economic frameworks, merely serving as a rhetorical flourish rather than an actionable principle. This is particularly evident in neo-classical economics, where sustainability is often relegated to a secondary role, failing to prompt substantial changes in actual practices.

When engaging with the concept of sustainability today a fundamental factor is the intrinsic interdependence and interrelations that pervade the systems under consideration. This acknowledgment gives rise to the characterization of these systems as holistic in nature, wherein the components and constituents cannot be contemplated in isolation, but rather must be comprehended as integral parts of a unified whole.

Within the context of sustainability, a holistic orientation is imperative (Williams et al. 2019), extending its significance to both theoretical frameworks and practical applications. What does the embrace of such an approach entail? It underscores that each notion, venture, and attempt undertaken carries ramifications that reverberate through the entirety of the encompassing system. The profound implications arising from this interrelation imbue

the realm of sustainability with richness and complexity.

In essence, a holistic approach obliges a departure from reductionist thinking – wherein isolated components are dissected and analyzed out of context – to a comprehensive understanding of systems as cohesive wholes. Such a holistic framework acknowledges that any alteration, regardless of its scale, within a particular facet of a system, ripples throughout the entirety of that system, generating repercussions that are elaborated and often unforeseeable. Thus, any pursuit of sustainability mandates cognizant consideration of this profound interconnectedness.

This holistic perspective becomes particularly salient in the domain of sustainability. It highlights the interconnections of ecological, social, economic, and cultural elements, emphasizing their symbiotic interactions. Environmental changes cascade through socio-economic structures, cultural shifts influence resource-consumption patterns, and economic decisions shape and are shaped by ecological trajectories. Consequently, adopting an integrative perspective serves as a compass with which to guide sustainable efforts.

A holistic approach to sustainability introduces a transformative paradigm. Central to this approach is the concept of a more-than-human conception that overrides the human-nature dualism (Abram 1996, 2012; Bellacasa 2017; Haraway 2008, 2015). It entails a comprehensive restructuring of societal frameworks, one that bridges the chasms between environmental protection, economic viability, social equity, and cultural preservation.

The holistic perspective on sustainability places a premium on respecting environmental quality and the natural limits of our planet. This fundamental ethos is interwoven into every facet of society, from economic structures to political frameworks, educational systems, and cultural narratives.

First, environmental sustainability encompasses humanity’s adeptness at abiding within delineated biospheric parameters, concomitantly acknowledging the demarcated planetary confines, as articulated by Rockström et al. (2009). This construct intertwines with ecological precepts and diverse methodologies that inherently validate humans as one of the constituents of the natural order, but not the only one.

Second, economic sustainability refers to the ability of individuals to maintain living standards within agreed-upon limits, considering factors like wages relative to living costs and income disparities. This concept promotes a balanced relationship between productivity, employment, and economic status.

Third, social sustainability involves a community’s ability to interact harmoniously, fostering a sense of unity. It encompasses various settings – such as places,

communities, and organizations, whether formal or informal – along with their available resources, opportunities, and challenges. This concept revolves around empowering diverse individuals to express themselves and take independent actions, all while maintaining a harmonious coexistence with others.

Finally, moving from the publication of Agenda 21 (United Nations 1993), the addition of cultural sustainability (Hawkes 2001; Nurse 2006; UCLG 2010; Sabatini 2019) as a fourth pillar to the triple-sphere framework encompassing ecology, economy, and equity completes a contemporary holistic vision of sustainability. Cultural sustainability involves creating inclusive systems that appreciate and foster diversity. This applies to various communities, places, and belief systems and it includes using different methods to protect the cultural heritage, beliefs, practices, and histories of the different communities. The goal is to ensure the continued existence of these communities while respecting their integrity and including them in the discourse.

Based on these four pillars, the holistic perspective reframes sustainability as a complex and multifaceted development paradigm. This multidimensional model strives to harmonize economic progress and human activities with the regenerative capabilities of nature. Anchored at its core is the aspiration to uplift the human condition through social and human development, while concurrently upholding respect for environmental well-being and the boundaries set by nature. This holistic vision ushers in fundamental shifts across social, economic, political, and cultural domains, necessitating the transformation of present-day society itself.

A fundamental shift underpinning the holistic approach is the recognition that sustainability hinges on interconnectivity and coordination among diverse agents and factors. This demands a recalibration of power dynamics in decision-making, fostering collaboration between public and private sectors, international bodies, local communities, and other stakeholders. In this manner, the holistic framework acknowledges and honors the interests, values, and knowledge of all involved parties.

Another core facet is the imperative to reshape wealth-distribution patterns, ensuring greater equity and the eradication of unjust economic practices. This involves dismantling systems that perpetuate inequality and poverty on a global scale, ultimately striving to satisfy the needs of all individuals, especially the marginalized.

The holistic approach additionally underscores the need to redefine humanity's relationship with nature. It urges a shift away from viewing nature and its resources as limitless tools for human gain. Instead,

nature's intrinsic purpose, independent of human needs, is emphasized. This reorientation away from an anthropocentric view fosters a universalistic perspective that interlinks all planetary elements in a harmonious, interdependent whole.

The principles of intergenerational equality and ecological responsibility further underscore the holistic approach. Respect for both the rights of both current and future generations to a healthy environment is paramount, necessitating productive systems that coexist harmoniously with nature's regenerative capacity.

Furthermore, a new international order must be established, characterized by just global wealth distribution and equitable relations among nations. The holistic framework also places ecological limitations at the forefront, requiring economic growth to be aligned with nature's capacity for self-regeneration. Moreover, the empowerment, self-sufficiency, and preservation of the cultural identity of local communities are integral aspects. The holistic approach champions strengthened decision-making capacities within communities, bolstering their ability to chart their own paths to sustainable development. Finally, and crucially, the holistic process embodies an inseparable union between theory and practice, continually evolving and refining as circumstances change.

Redesigning the fashion system within this holistic sustainability framework is imperative due to the profound environmental, social, and ethical challenges posed by the traditional manifestations of the industry. The current fashion system is characterized by a linear model of production and consumption often known as "take-make-dispose," where resources are extracted, garments are manufactured, and the clothing is ultimately discarded after a short lifecycle. This approach leads to excessive resource utilization, significant waste generation, and pollution, contributing to environmental degradation and climate change. Moreover, the fast-paced nature of the fashion industry promotes overconsumption, exploitation of labor, and a lack of transparency throughout supply chains. These issues perpetuate social inequalities and human-rights violations, especially in low-wage garment-producing regions.

Embracing sustainability necessitates a systemic shift that rethinks every facet of the fashion ecosystem. Redesigning the fashion system means adopting circularity principles, where materials are reused, recycled, and regenerated to minimize waste and extend product lifecycles. It entails fostering transparency and ethical practices throughout the supply chain to ensure fair labor conditions and to promote social justice. Additionally, it involves considering the broader ecological impacts of production, distribution, and consumption, with a focus on

minimizing carbon emissions, water usage, and chemical pollution.

This work to reconfigure the fashion system aligns with the broader global effort to achieve the United Nations Sustainable Development Goals (SDGs), addressing issues such as climate action, responsible consumption and production, decent work and economic growth, and reduced inequalities. As consumers become increasingly conscious of these issues, fashion brands that prioritize sustainability not only contribute to a healthier planet and society but also position themselves for long-term success in a changing market landscape. This transformation is essential to create a fashion ecosystem that operates in harmony with people and the planet.

The triple transition

Development of the notion of a triple transition stems from the concept of transformation toward more environmentally sustainable frontiers promoted by the European Union to overcome the past and future emissions risks burdening our climate (Fouquet and Hippe 2022). In this scenario, many sectors negatively affect the global environment. Within the fashion system, the fast-fashion model is heavily criticized from the standpoint of environmental and social sustainability. It is characterized by its extremely complex supply chain and particularly intensive production and consumption cycles (Niinimäki et al. 2020).

Despite the strategies implemented within the fashion system in recent years to reverse its consumerist inclination, analysts define fashion as the most change-intense category by the very nature of the meanings attached to it. Indeed, the consumption of fashion products is motivated by a perpetual need for style renewal under the pressure of new trends. In this regard, an alarming prediction estimates that the global annual consumption of garments will reach 62 million tonnes by 2030 (Hur and Cassidy 2019). This ephemeral character *de facto* has made the fashion industry, as mentioned above, the second most polluting industrial branch in the world (Huynh 2022), and it stands out for being the most intensive manufacturing sector in terms of water consumption. The fashion industry additionally is responsible for 20% of water pollution due to fabric-dyeing processes and contributes 35% to ocean contamination because of the dispersal of microplastics that derive from the industry's production and waste. Fashion moreover accounts for 10% of global production of greenhouse-gas (GHG) emissions (Niinimäki et al. 2020).

This worrying data highlights the urgent need for an effective transition to a circular economy, as a

restorative economy that relies on renewable energy and is oriented toward eliminating toxic substances as well as minimizing and addressing waste through careful design (EMF 2013). This type of economy can be driven by circular business-model innovation capable of channeling within it the threefold aspect of the economic structure, based on the mutual relationship between the economy, environmental issues, and sustainability (Pieroni, McAloone, and Pigosso 2019).

This shift toward a greener economy can be concretely supported by a second key driver of transformation, namely digital innovation and its related emerging technologies which can enable effective reduction of industrial environmental impacts (Muench et al. 2022). The aim of this strategic intervention aspires to minimizing the use of virgin resources and drastically reducing the production of new waste by focusing on the core concepts of reduction, reuse, recycling, recovery, and remanufacturing, thus shifting the focus from the linear “take-make-dispose” model to the circular “make-use-return” paradigm (Huynh 2022). Notwithstanding the necessity of this structural change, it must be noted how its actualization is antagonistic to the fashion economy. The term “sustainable,” as associated with longevity and durability, stands in a paradoxically contrasting relationship with what turns out to be the consumerist prime mover of the fashion sector, namely continuous renewal of stylistic criteria (Hur and Cassidy 2019). This observation highlights the need for a parallel reconfiguration of the fashion-value chain to effectively innovate its business model.

To facilitate the transition to a circular paradigm, the European Commission outlined a new growth strategy in 2019 called the “European Green Deal” to encourage the evolution of European Union (EU) member states to become promoters of a new model of fair, prosperous, modern, resource-efficient, and economically competitive development, intending to bring GHG emissions to zero by 2050 (European Commission 2021).

This intervention is an integral part of the action plan to implement the United Nations 2030 Agenda and the sustainable development goals (SDGs). The driving force behind the profound socio-economic changes that underpin the European Green Deal is a process of digital transformation and an associated toolbox (European Commission 2019). Diffusion of these instruments is intended to enable a shift from the current linear economy model to a circular model, characterized by the use of resources in a closed and continuous cycle, thus giving rise to a new economic paradigm (Ortega-Gras et al. 2021).

The massive adoption of technological resources (e.g., artificial intelligence, 5G networks, Internet of Things) in the process of transformation implies a

twofold effort that is summarized by the challenge of the digital and green transition, termed the Twin Transition (European Commission 2022a). The combination of these two phenomena with profoundly diverse natures and structures allows them to reinforce one another through integration and mutual support. The role of technological assets within this changing context is to offer new forms of concrete support for supervision of the production chain, employing the creation of digital passports and greater accessibility to data control and automation of processes, to foster innovation and enrich processes and production with new values (European Commission 2022a).

A third component promoting transformation, namely resilience, has been added to the ecological and digital dimensions of change, thus effectively moving from a Twin Transition to a Triple Transition (European Commission 2022b). The need to implement the transformation strategy with this element of stability has become quite evident in the last five years. Indeed, the recent Russian invasion of Ukraine has highlighted the urgency of developing a structured and resilient energy-supply system. In addition, the emergency caused by the COVID-19 pandemic already shifted the policy and planning focus to the need to rely on a more robust logistic structure and supply-chain relations (European Commission 2022a). While originally developed in the early twentieth century, the concept of resilience was mainly inherent to materials science, in particular textile research, as it was defined by Hoffman (1948) as “the ability of something to return to a reference state following a disturbance of some sort” (Thorén 2014). During subsequent decades, the concept has been extended over time to various fields, particularly within the disciplines of psychology and ecology. In both cases, the connotation attached to the word has some common features. In the case of the human mind, it refers to the ability of individuals to recover following trauma, to withstand stress and people’s ability to progress through the stages of psycho-cognitive development despite an adverse environment (Thorén and Persson 2015). In the ecological sphere, the word usually refers to the work of Holling (1973) who distinguished resilience from stability, attributing to the latter a pivotal role within a system as it is capable of absorbing and reacting to changes (Thorén 2014; see also Folke et al. 2010).

The fundamental pillars of resilience in this sense are adaptivity (the ability to elaborate responses concerning external agents and internal forces) and transformability (the ability to cross the boundary to develop new trajectories) (Folke et al. 2010). This

reading of the phenomenon is what allows for the definition of its role within the triple transition, as a link between the two trajectories of innovations identified by the European Union. Resilience appears to be necessary because of the support it offers to cope with the extremely precarious and frail condition of the contemporary context and to reestablish the center of equilibrium in the changing socio-economic paradigm, generating new solutions in response to possible instabilities afflicting the structure of the system (Folke et al. 2010).

Given this background of change and the consequent new openings by the European Commission, the “New European Bauhaus” strategy occupies a central position, designed to be the catalyst for the objectives of the “Green Deal” and to make them tangible and consistent with the cultural and human dimension (European Commission 2023). It is a medium that aims to incorporate and convey within it the various dimensions of sustainability, the prospect of technological development, and the quality of living in the environments in which people inhabit, through the concrete creation of a new lifestyle based on “good design” as a promoter of sustainability values (European Commission 2023).

The concept behind this strategy is to repropose in a contemporary key the main idea and theoretical basis of the historical “Bauhaus” which introduced in the period following World War I and the first two industrial revolutions a new paradigm of disciplinary transversality involving the scientific, socio-cultural, architectural, and design dimensions of the contemporary era (Sadowski 2021).

Similarly, the configuration of events characterizing the last 25 years, such as the climate crisis, the COVID-19 pandemic, and the introduction of new and advanced technologies, provided the impulse for the definition of a novel conception of the “New European Bauhaus” presented in 2020 by the President of the European Commission, Ursula von der Leyen, to repropose the conjunction between, on one hand, the worlds of science and technology and, on the other hand, that of art and culture (Ness 2021). The similarities between the two institutions are not limited to disciplinary transversality but extend to a desire to seek a coupling between digital innovation and the arts within the framework of a contemporary changing society.

According to interpretation, it is possible to hypothesize a connection with what were the three characteristic phases of the Weimar movement, passing from Walter Gropius’ transdisciplinary vision, to Adolf Meyer’s interest in collective well-being, and finally to Ludwig Mies van der Rohe’s emblematic concept of “less is more,” applicable to the current

view of resource preservation in terms of design planning (Ness 2021). At the heart of this new European strategy, design assumes the role of a new idea incubator, with a dedicated focus on sustainability through social participation (Rosado-García et al. 2021), effectively rethinking the relationship between economy, culture, and society and fostering recognition of culture as the fourth pillar of sustainable development, alongside the social, environmental, and economical pillars. Referring to the status quo, culture can be framed as a mediating force encompassing cross-sectionally with all the other pillars to achieve a comprehensive understanding of sustainability.

The contextualization of these criticalities and the analysis of the newly emerging trajectories of innovation leads to the recognition of a gap which can be addressed through design to identify a new strategic model able to provide concrete support to sustainable transformation. The theme of the triple transition can be debated via design-driven innovation as a methodology capable of depicting environmental and social evolution, identifying cultural and technological drivers and patterns of change, and guiding – through the stages of the design-thinking process – the innovation of products, services, systems, and processes toward a more equitable and sustainable vision of the future.

Modeling the triple transition through design

Within the above-mentioned framework, design thinking performs the role of the driver of innovation. While four different pivotal factors – social transformation, cultural revolution, technological/digital innovation, and environmental change – lead to value-driven innovation through the design approach. The specific nature of this type of innovation is its ability to recognize and acquire awareness not only concerning the utilitarian, but also the emotional, psychological, and socio-cultural contemporary value-reference system (De Goey, Hilletoft, and Eriksson 2019). Furthermore, due to its ability to combine and recombine resources during transformation phases in addition to its human-centered focus, the design-thinking process turns out to be particularly effective in analyzing and capitalizing on opportunities arising from digital innovation and converting them into valuable solutions for consumers (Magistretti, Pham, and Dell’Era 2021).

In facing the complexity of the system with its interconnected structure, design can rely on its intrinsic dynamic capabilities (Magistretti, Pham, and Dell’Era 2021) that include extending the knowledge base considering how digital innovation interacts with the whole context, debating and mediating

between the interests of internal and external stakeholders to achieve more robust insights, selecting the most meaningful data guiding innovation, interpreting the collected signals leading to the anticipation of future scenarios and, finally, recombining the obtained information and considerations to foster digital transformation.

Referring to these intrinsic specificities it is possible to sequence the process as a series of emblematic phases, namely researching, framing strategies, envisioning, and developing, all of which constitute the design-thinking approach. These steps lead to the creation of a structure that can generate value in an inclusive and transversal way for all the elements outlined within the scheme. The dynamism of the method offers a new reading of sustainable development starting from an imaginative space – in which different perspectives are incorporated to achieve an effective visualization of possible solutions – that can be tested and implemented (Buhl et al. 2019). The ability of this approach to read signals in their entirety of meanings makes it a particularly effective tool applicable to the evolving context of the triple transition.

As Figure 1 illustrates, the main forces for change can, in turn, be categorized into enablers and drivers of innovation. The enablers – cultural revolution and technological/digital innovation – describes the necessary and copious conditions fostering innovation, leading to product and process innovation, by intervening both in terms of products and services offered and proposed methodologies to maximize efficiency in goal fulfillment (Kahn 2018). The drivers – social transformation and environmental change – indicate its main supporting elements (Bashir, Naqshbandi, and Farooq 2020), leading to actual business-model innovation. Concerning the climate crisis, pressures coming from outside in terms of new laws and regulations are promoting a change in the business structure (Todeschini, Cortimiglia, and de Medeiros 2020). The transition to sustainable business models has also become manifest in terms of competitive advantage and in how companies generate value, considering the growing and burdening pressures on limited natural resources. The circular economy-oriented business-model innovation can be driven by the intention of “boosting resource efficiency and effectiveness (by narrowing or slowing energy and resource loops) and ultimately closing energy and resource flows by changing the way economic value and the interpretation of products are approached” (Pieroni, McAloone, and Pigosso 2019, 201). Geissdoerfer, Vladimirova, and Evans (2018) propose an alternative definition of sustainable business-model innovation that focuses mainly on

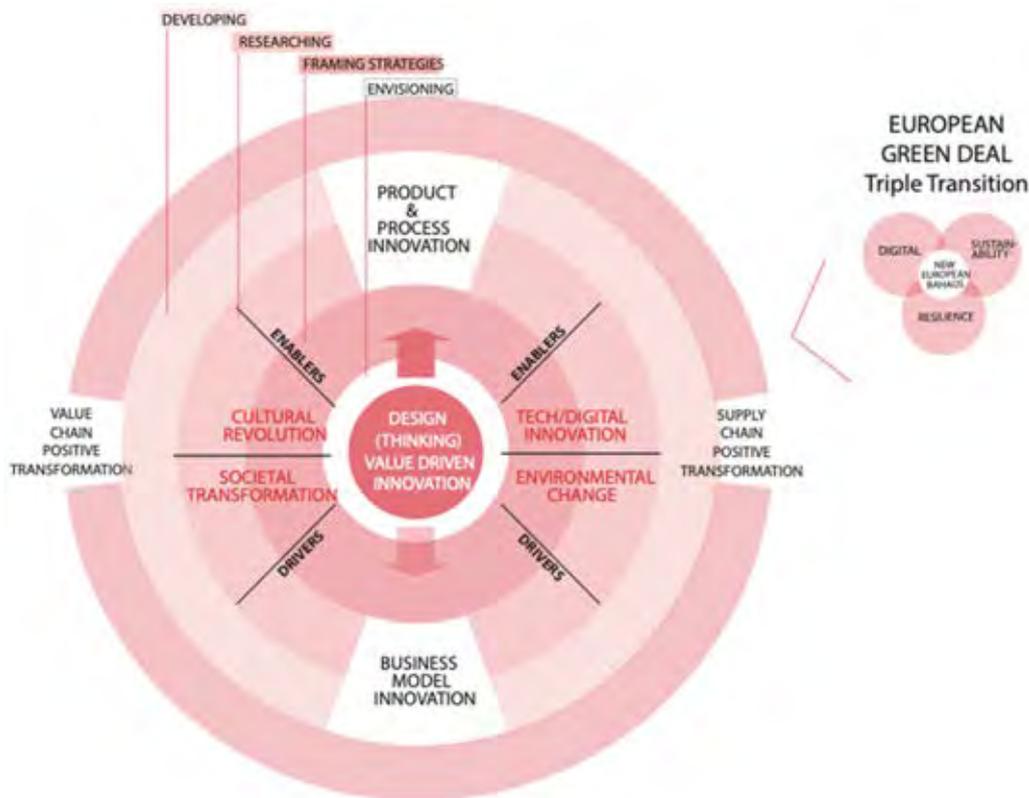


Figure 1. Triple transition through design.

the beneficial impact that sustainable development can have in terms of the value proposition and value creation toward society, environment, and the long-term organization of prosperity. Nonetheless, its main specificity within this context of profound change promoted by the current critical situation is to create and distribute value to customers, local communities, governments the natural environment, and society due to support provided by digital innovation (Biloslavo et al. 2020).

While environmental pressures can be a driver toward adopting more sustainable models, technological research provides concrete support for change. The development of new advanced equipment enables improvements in the production process, facilitating cost-cutting through improved alignment of production and market demand, thus employing the main use of information technology which enables agile data processing (Broccardo et al. 2023).

Figure 1 also provides an assessment of the impact of the four identified factors – cultural revolution, societal transformation, technological/digital innovation, and environmental change – by pairing the drivers with the enablers. Indeed, the cultural revolution and societal transformation intersect resulting in positive value-chain modification. The socio-cultural matrix resulting from the abovementioned intersection intervenes directly with the societal intangible value system. The impact of the current

climate crisis is operating promptly on the collective perception of the very climate crisis, creating a virtuous circle of mutual influences between the measures taken at the government level to limit the damage of the environmental emergency (for example the “European Green Deal”) and the orientation of consumer choices (Marsh et al. 2022).

Instead, the crossroad between technology-digital innovation and environmental change gives rise to a favorable change in the supply chain. The environmental change is pressing for structural renewal within the supply chain. A concrete answer to this urgent request comes from the technological evolution, which is operating for the digitalization of the supply chain, making sustainable solutions economically viable (Marsh et al. 2022).

The analysis of the scheme draws attention to how a reciprocal interdependence bond connects the value chain and the supply chain. In terms of the fashion sector and the models guiding the business, the figure shows that process and business innovation directly impact the value and supply chain, driven by the forces of change within the industry framework.

The immaterial shift in terms of meanings is grafted starting from the consumer’s demands within the supply chain. The latter, on the contrary, describes the tangible part on which it is possible to intervene concretely through instruments capable of reorganizing the business structure as a whole. In

support of this evidence, Casciani, Chkanikova, and Pal (2022) highlight how the digital transformation occurring within the fashion sector through the adoption of 3-dimensional virtual and digital (3DVD) technologies is reestablishing the customers' value chain and consequently creating new opportunities to foster a reconfiguration of the supply-chain system, thus operating on a general redefinition of the fashion-system structure.

In the proposed model, which examines how design can intervene within the context of the triple transition, it is necessary to explain the role of resilience within business dynamics. Its peculiar function is to protect the apparatus from shocks and stressors which may attack the business model. As a non-tangible expression of interactions, including the resilience component within the value model allows the simultaneous prevention of risks and the absorption and recovery of the danger possibly damaging the organization (Linkov et al. 2020). In addition to this analysis of the model, it is useful to highlight how nowadays design can be positioned at the heart of innovation. The characteristics of this methodology previously highlighted underline its ability to extricate within a complex system of references to identify a common trajectory that orients us toward a more sustainable future.

The perspective of design-driven innovation emerges as a vehicle to effectively tackle the challenges posed by the triple transition and allows action within the pillars of a holistic approach. In fact, design-driven innovation involves using design-thinking methodology (Cross 2011) to identify and analyze emerging cultural, social, and technological trends and drivers, and then applying these insights to develop new and improved products, services, systems, and processes that meet the evolving needs and desires of consumers.

The fashion industry thrives as a creative and cultural domain, where both tangible and intangible attributes of products, coupled with distinctive modes of production, jointly convey cultural and symbolic connotations to consumers (Bertola et al. 2016). Accordingly, a design-driven innovation perspective allows producers to capture changes in society by recognizing emergent patterns of cultural and technological advancement and to reframe political, economic, societal, environmental, legal, and ethical issues and to orient decisions toward possible solutions.

Innovation trajectories of fashion sustainability

This Special Issue on sustainable redesign of the global fashion system explores the organizational,

technological, and socio-cultural dimensions of transformation and is structured around three pivotal dimensions of action that contribute to the complexity of fashion sustainability.

First, fashion sustainability revolves around the essential realm of organizational change. This focus transcends business strategies and delves into profound reconfiguration of the very DNA of fashion entities. It encompasses the adoption of sustainable business models, the reevaluation of supply-chain practices, and the integration of ethical considerations into the core organizational ethos. This dimension entails a profound metamorphosis that signals a seismic shift from conventional practices to a holistic approach that harmonizes business aspirations with environmental and social responsibilities.

Second, this Special Issue devotes attention to the landscape of innovation within fashion products and processes and recognizes that sustainability is not merely an abstract concept but an actionable imperative that necessitates reimagining how fashion is conceived, designed, and manufactured. From the selection of eco-friendly materials to the implementation of energy-efficient production techniques, this dimension underscores the catalytic role of innovation in crafting a sustainable future for fashion. It also acknowledges the burgeoning potential of disruptive technologies in reshaping industry norms, creating cascading effects that extend far beyond the confines of design studios and factories.

Finally, we focus on the realm of socio-cultural transformations. This dimension recognizes that fashion is embedded within the stratified layers of culture and intertwines with social norms, values, and perceptions to influence consumption patterns and confronts questions of cultural appropriation, socio-economic disparities, and the role of fashion as a reflection of societal priorities. It grapples with the profound responsibility of preserving cultural heritage while simultaneously promoting ethical consumerism. This dimension concedes that fashion does not exist in a vacuum but is a mirror that reflects and shapes the world it inhabits.

Redesigning the fashion system: navigating organizational transformation

Exploration of fashion change traverses different organizational dimensions underpinned by the profound shift toward systemic transformation. Within this discourse lies a critical investigation into the effectiveness of organizational strategies and supply chain-management models that pave the way for an enduring metamorphosis toward sustainability.

Central to this analysis is inquiry into the viability of specific organizational strategies and supply chain-management paradigms as potent conduits for a much-needed transition to sustainability. In an era of heightened environmental consciousness, a pressing question emerges: To what extent do these strategies succeed in orchestrating a paradigm shift, dismantling conventional frameworks that fostered unsustainable practices? By scrutinizing evidence, this exploration aims to critically assess the potential of these strategies in steering the fashion industry away from its traditional trajectory, nurturing a system that is equitable, ethical, and ecologically responsible.

Moreover, the discourse delves into the growing emphasis on circularity and its pertinence within the global fashion ecosystem. The ascendancy of circular fashion is not merely a fleeting trend but rather a pivotal movement that underscores the industry's collective endeavor to mitigate environmental impact. To what extent does this circularity-centric approach permeate the complex web of the fashion industry's global operations? This section of the Special Issue seeks to dissect the concept of circularity, unveiling its potential to drive a shift from the linear "take-make-dispose" model to a regenerative, closed-loop paradigm.

The reshoring of production operations emerges as a compelling proposition in the realm of fashion-system transformation. As we scrutinize the footprints of globalization for their environmental and social ramifications, a critical lens is turned toward localized production. The exploration probes the potential implications of reshoring. Does it hold the promise of bolstering local economies, minimizing carbon footprints, and fostering a renewed sense of craftsmanship? By dissecting this phenomenon, the contributors to this section of the Special Issue contemplate the role that proximity and regionalization play in the larger sustainability equation.

At the core of this investigation is recognition that evolving business models and emerging best practices are intertwined with a robust understanding of sustainability imperatives. Business paradigms are no longer confined to the concept of profitability but are evolving into multifaceted constructs that meld economic viability with social responsibility and ecological stewardship. The articles comprising this section dissect the extent to which these business models are informed by a holistic comprehension of sustainability, emphasizing the pivotal role of ethical consciousness and environmental considerations.

The exploration delves into this organizational facet of the fashion industry, accentuating the role of strategies, supply chains, circularity, reshoring, and evolving business paradigms in fashion's systemic

transformation. Through a rigorous examination, the authors seek to shed light on the mechanisms that drive fashion's metamorphosis toward sustainability and contribute to shaping a fashion system that echoes the ideals of equity, ethics, and environmental stewardship.

In the first article in this section of the Special Issue, Miriam Bodenheimer, Johannes Schuler, and Thekla Wilkening, in their contribution titled "Drivers and barriers to fashion rental for everyday garments: an empirical analysis of a former fashion-rental company" scrutinize the online business-to-consumer (B2C) fashion-rental domain, drawing from an in-depth study of a former German fashion-rental firm. Focusing on everyday clothing rentals for both children and women, they employ a holistic approach merging business data, managerial insights, and customer surveys. By juxtaposing retailer and consumer perspectives, the authors identify challenges in the business models. The company's downfall was linked to deteriorating inventory quality and hurdles in acquiring and retaining customers. These obstacles underscore the need for targeted marketing, emphasizing high-end fashion, to heighten awareness and mitigate reservations about fashion rental. They discuss that integrating diverse data sources unveils the factors underpinning the success or failure of online-rental models.

The second contribution by Sophie Buchel, Aniek Hebinck, Mariangela Lavanga, and Derk Loorbach is "Disrupting the status quo: a sustainability transitions analysis of the fashion system." The authors conduct a multi-level analysis, grounded in collaborative research with the Laudes Foundation (formerly C&A Foundation), revealing the industry's entrenched state of disconnection, extraction, and disposability. They propose several strategic transition pathways to expedite the shift to sustainable fashion, acknowledging the urgency of system-wide change. This contribution is especially pertinent to the European Commission's 2020 Circular Economy Action Plan that prioritizes the textile industry and aims for a sustainable and circular strategy which is vital for necessitating innovation in design, technology, and practices.

Luca Coscieme and colleagues then introduce a framework to advance circular business models, exploring durability, access, collection, and recycling approaches. In their article titled "A framework of circular business models for fashion and textiles: the role of business-model, technical, and social innovation" they outline a framework focused on elucidating and advancing the proliferation of circular business models. It delves into four distinct approaches within the fashion and textiles domain: durability-based models, access models involving renting and sharing, garment

collection and resale, and recycling of materials. Within each model, the discourse covers facilitators encompassing technical and social innovations, policy changes, behavioral shifts, and educational initiatives. The proposed framework integrates these pivotal components, offering a systemic analysis tool for circular business models. It accentuates the need for policies orchestrating consumer-behavior shifts, promoting sustainable design, and instituting alterations in production methodologies.

Ermina D'Itria and Reet Aus next turn their attention in "Circular fashion: evolving practices in a changing industry" to considering how brands are transitioning from profit-driven to purpose-driven strategies, with the circular economy gaining prominence as a solution. However, current implementation of circular economy strategies faces challenges with respect to environmental, economic, social, and cultural sustainability. The article examines ongoing adoption of circular practices and their relevance globally, showcasing how design practices aid companies in holistic sustainability. The authors introduce a taxonomy of effective strategies, the so-called "mini-loops," that contributes to incremental advances toward a circular economy. Their study also envisions potential pathways for the fashion system to fully embrace circularity, addressing its current linear limitations.

This section of the Special Issue also includes a contribution developed within the context of a research project sponsored by the European Union which is an important stakeholder committed to supporting and driving sustainable changes in the fashion industry. The article by Jesse Marsh and colleagues is titled "A value-driven business ecosystem for industrial transformation: the case of the EU's H2020 'Textile and Clothing Business Labs'" and highlights the outcomes of their TCBL project that successfully established a network of textile and clothing-business labs. These labs aim to transform the environmentally and socially problematic textile industry through stakeholder engagement. This approach has fostered systemic shifts in business models, prioritizing knowledge, collaboration, and shared values over price competition.

Claudia Eckert, Philippa Crommentuijn-Marsh, and Sandy Black then tackle sustainability from the perspective of the UK in which the fashion industry represents a unique economic driver and as well a world-renowned cradle of creativity. Their article titled "The role of networks in supporting micro- and small-sized sustainable fashion businesses" examines the support systems that underpin micro- and small-sized sustainable fashion enterprises in the country. Drawing from investigations of 27 firms,

and including designers and product developers, their study illuminates formal and informal networks through actor-network theory. Supply-chain ties, professional networks, and chance personal and online contacts shape these networks. The article highlights the significance of trust and shared values, spotlighting how these networks drive sustainable practices and deepen designers' understanding of their craft. Geographical and cognitive proximity are explored in the context of informal networks.

In their article "Fashion in turmoil: impact of the COVID-19 pandemic on Finland's textile and fashion industry" Teresa Haukkala, Kirsi Niinimäki, and Linda Lisa Maria Turunen report on how, in the face of ongoing climate change, both consumers and fashion businesses are reevaluating their practices. The pandemic was a pivotal moment that deeply disputed the textile and fashion sector and shed light on its vulnerabilities. The study employs path-dependence theory to dissect the effects on the industry in Finland, revealing past shocks as transformational junctures. Historical analysis unveils the transformational effects of prior external events while empirical data from Finnish companies elucidates the pandemic's more recent impacts. Innovations emerged across design, manufacturing, sales, and marketing in response to the crisis, aligning with more sustainable practices, local production, and responsible business models. The authors also contemplate the post-pandemic prospects for the industry.

In a further contribution to this section of the Special Issue, Chiara Di Lodovico and Alessandro Manzi discuss the multifaceted nature of sustainability, exploring insights from five influential players in the cultural and creative industries. Their article titled "Navigating sustainability in the fashion industry: insights from entrepreneurial perspectives on collaborative approaches" highlights challenges, coping strategies, and other factors associated with the collaborative pursuit of sustainability and underscores the tension between the urgency of change and the industry's inherent complexity. They emphasize the pivotal role of networks along with the need for dialogue between innovative practices and regulatory frameworks.

This section on the organizational dimensions of sustainability transformation in the fashion industry concludes with Brief Reports outlining three sets of personal reflections. The first of these contributions by Francesca Romana Rinaldi, Claudia Di Bernardino, Virginia Cram-Martos, and Maria Teresa Pisani, titled "Enhancing traceability and transparency of sustainable value chains in garment and footwear," examines the impact of Recommendation No. 46 that was ratified by the United Nations Center for

Trade Facilitation and Electronic Business (UN/CEFACT) in April 2021. Developed under the United Nations Economic Commission for Europe (UNECE) in partnership with the International Trade Center (ITC) and the European Union, the document responds to how the COVID-19 pandemic exposed the weak and opaque value chains that characterize the production of garments and footwear. The report discusses how customer engagement, societal inclusiveness and traceability and transparency policies need to be leveraged to facilitate a sustainable transition of the global garment and footwear system, activating new alliances between industry and civil society. To support these points, the report also introduces the tools developed by UNECE to activate a circular and sustainable economy in the analyzed sectors.

The final two voices to contribute to this section are, respectively, Ezio Manzini and Kate Fletcher. Manzini describes in his Brief Report, “Fashion as diversity and care,” potential pathways for redefining fashion, reshaping its societal and cultural role in alignment with more sustainable paradigms and Fletcher, in a commentary titled “Perspectives: Earth rising” introduces the notion of “Earth Logic” as a novel approach that centers on Earth and its inhabitants, including humans, to rejuvenate fashion within planetary boundaries. This evolving fashion landscape encompasses current and emerging players, clothing, and organizational methods, adapted with revised principles to harmonize with this alternative view.

Innovating fashion products and processes: a design practice exploration

The focal point of this second section of the Special Issue lies at the nexus of innovation and technological metamorphosis within the domain of fashion products and processes. This thematic trajectory serves as an intellectual forum for contributions that traverse the uncharted territories of fashion’s evolution, interrogating the transformative dynamics that innovation and technology bestow upon this creative ecosystem. In adopting an academic lens, this exploration seeks to unmask the intricacies encapsulated within these intersections, thereby fostering a comprehensive understanding of their implications for sustainable paradigms.

Central to this academic pursuit is the interrogation of the most efficacious design methodologies, approaches, and practices that proactively kindle innovation within fashion’s realm. This analytical voyage endeavors to elucidate the mechanisms that render design a powerful agent of change, capable of steering the industry toward novel pathways of sustainable growth. Through a multidimensional

investigation, the contributors aim to unravel the interplay between creativity, functionality, and environmental stewardship – forging a harmonious synthesis that encapsulates both esthetic allure and ethical responsibility.

Intertwined with this discourse are pivotal inquiries into the role of design as a catalyst for sustainability within the expansive milieu of fashion. The lens turns toward the dynamics where design transcends esthetics to encompass ethical considerations and ecological consciousness. These treatments delve into how design creativity merges with its capacity to instigate change, becoming a vanguard that propels the industry’s transition from a linear to a regenerative framework.

Further enhancing the intellectual trajectory is the examination of a new generation of products and processes that emerge as harbingers of opportunities for pursuing sustainability. The section discusses state-of-the-art innovations, spotlighting their potential to recalibrate industry norms. These beacons of sustainable innovation provide insights into the nexus of form, function, and environmental responsibility, highlighting how their inherent design principles enable a harmonious merging of esthetics and ethics.

Venturing deeper into the exploration, the contributors redirect the focus toward emerging technological innovations that stand poised to serve as agents of sustainable system change. They dissect the intersection of technology and sustainability to unravel the latent potential of innovations that can fundamentally reshape the fashion landscape. The authors further explore the catalytic role that technological advancements play in transforming manufacturing, supply chains, and consumer behaviors, ultimately propelling the industry toward more regenerative trajectories.

Moreover, the realm of digital transformation influences the mitigation of the social and environmental impacts of fashion. This facet contemplates the catalytic potential of digital technologies in rendering the fashion ecosystem more transparent, accountable, and aligned with sustainable imperatives. It probes how the mechanisms of digitalization foster informed consumer choices and facilitate data-driven solutions, underscoring the synergy between technological innovation and ecological stewardship. This section unfolds across the diverse perspectives of innovation in fashion products and processes, traversing dimensions of design, sustainability, new generation products, technological innovation, and digital transformation.

Daria Casciani, Olga Chkanikova, and Rudrajeet Pal begin by offering an encompassing survey of the digital revolution within the fashion sector, highlighting its effects on supply chains, business models, and sustainability-focused advancements. Through desk research, the authors examine enterprises actively employing 3-dimensional virtual and digital technologies (3DVD), encompassing 3D modeling, virtual reality (VR), augmented reality (AR), two-dimensional (2D) and three-dimensional (3D) scanning, and digital twinning. Their article titled “Exploring the nature of digital transformation in the fashion industry: opportunities for supply chains, business models, and sustainability-oriented innovations” underscores the potential for digital tools to reshape conventional supply chains, mapping transformative shifts across processes, products, and services. Implementation of 3DVD by fashion entities unlocks avenues for product/service innovation, process optimization, and multifaceted business-model changes. Moreover, it reveals the interconnected impact of digital transformation on the four dimensions of sustainability, with cultural sustainability emerging as a pivotal concern. The 3DVD technologies catalyze shifts in design processes, consumer behavior, and corporate ethos, mirroring wider transformations in the industry’s structure.

In “Materials biography as a tool for designers’ exploration of bio-based and bio-fabricated materials for the sustainable fashion industry,” Valentina Rognoli, Bruna Petreca, Barbara Pollini, and Carmem Saito discuss how the fashion industry’s profound environmental impact has prompted growing recognition of the pressing need for sustainable transformation. Amid intensive research into alternatives, this article conducts an exhaustive analysis of these socio-environmental challenges. It investigates collaborative efforts among governments, industry, and designers to address the crisis and highlights a range of bio-based and bio-fabricated materials that could steer fashion toward sustainability. With 24 case studies categorizing novel materials by origin, five “materials-biography categories” emerge, aiding comprehension and communication. This taxonomy supports circular economy concepts, offering a material passport for enhanced communication, traceability, and user awareness. The concept of “materials biography” proposes a comprehensive framework for stakeholders to navigate this emergent landscape.

The final article in this section is by Elisabeth Eppinger and titled “Recycling technologies for enabling sustainability transitions of the fashion industry: status quo and avenues for increasing post-consumer waste recycling.” This work embraces the same

systemic approach as deployed earlier in the Special Issue by Casciani and colleagues and discusses the environmental toll of garment production, namely the surge in textile waste that underpins the urgency for sustainable shifts in the fashion sector. This study evaluates the viability of scaling recycling technologies in textiles, examining collection, sorting, and reuse processes. Findings from case studies and expert insights reveal existing impediments and prospects for technology diffusion. While promising initiatives abound, reconfiguring industry structures, designs, and models is essential. Critically evaluating the singular focus on recycled polyester, the article advocates for broader recovery and reuse improvements. Eppinger urges fashion brands and retailers to use their influence to drive sustainability norms in recycling.

Reshaping fashion cultures: exploring the socio-cultural dimension of fashion sustainability

As outlined in earlier sections of this article, a pivotal shift is underway in the realm of fashion, marked by a growing emphasis on sustainability. This paradigmatic transformation underscores the interplay between socio-cultural dynamics and the pursuit of fashion sustainability. This discourse aims to unravel the trends that serve as the bedrock for a more reflective consumer society that critically evaluates the prevailing models of mass consumption dictated by the fashion industry. A key query emerges: To what extent do these trends serve as the foundation for a conscientious consumer ethos that challenges the tenets of fashion-driven excess?

The contributions that comprise this section of the Special Issue describe the fabric of social practices and behaviors, as well as institutional adaptations, that act as conduits for promoting fashion sustainability. The authors raise pertinent questions about the viability of integrating eco-consciousness into the very nature of fashion-related practices, engendering a shift from ephemeral trends to enduring practices aligned with ecological and ethical considerations. The emergence of sustainable fashion initiatives necessitates meticulous examination of their potential to permeate the socio-cultural milieu, inducing transformative changes that transcend mere tokenism.

Central to the sustainability narrative is the false paradox of preserving the intrinsic cultural dimensions that define fashion while simultaneously fostering an awareness of the perils of cultural appropriation and commodification. The act of borrowing and integrating elements of cultural heritage within the realm of fashion is inherently intricate, often teetering between homage and exploitation. As such, probing the mechanisms that can effectively bridge

cultural appreciation and ethical sensitivity becomes indispensable. How can fashion serve as a conduit for cross-cultural dialogue while mitigating the risks of decontextualization and erasure?

Furthermore, this discourse posits a critical inquiry into strategies that catalyze sustainability-oriented innovation within the realm of fashion design. Amid the clamor for novel esthetics and cutting-edge trends, there lies a pivotal opportunity for designers to channel their creativity toward sustainable practices. As stakeholders supporting and promoting technological, esthetic, and meaning innovation, designers wield the power to redefine industry norms. Exploring the nuances of sustainable design processes, materials, and production techniques, this exploration aspires to unravel the potential for fashion to serve as an avenue for groundbreaking advancements, spearheading a shift toward harmonizing esthetics with ethics.

In essence, the transformative journey of fashion toward sustainability entails a negotiation between cultural heritage, ethical considerations, and innovative paradigms. The academic exploration of this first innovation trajectory seeks to unravel the complex tapestry of socio-cultural dynamics intertwined with fashion, offering insights into the trends, practices, and adaptations that can reshape the very contours of fashion cultures. Through a meticulous analysis of these intersections, this discourse aspires to contribute to a comprehensive understanding of fashion's potential as a catalyst for both cultural preservation and sustainable evolution.

In this regard, Sass Brown and Federica Vacca's reflections are rooted in the consideration that overhauling the fashion system demands a radical shift toward cultural sustainability and material preservation. Conversations around heritage preservation necessitate resurrecting ingrained cultural beliefs and meanings within traditional crafting. Local traditional craftsmanship is branded as a seemingly enduring cultural repository. Their article titled "Cultural sustainability in fashion: reflections on craft and sustainable development models" interprets evolved craft-based tactics in fashion to ostensibly drive positive, sustainable changes and disentangle from cultural appropriation. Selected case studies on fashion, design, and craftsmanship serve as the foundation for an interpretative model promoting cultural sustainability through traditional craft, emphasizing material practices and design's role in innovation. This speculative model centers on experimentation, innovation, and sustainability through a creative process guided by cultural heritage techniques, offering an array of potential outcomes that amplify innovative support for tradition while adhering to its entrenched norms.

The next contribution in this section by Otto von Busch, "What is to be sustained?" perpetuating systemic injustices through sustainable fashion," challenges us with a provocation, reflecting largely shared facts in regard of the specific model of fast fashion. The fashion system and academia seemingly concur that fast fashion lacks sustainability. The surge in consumption of affordable attire correlates with global extraction and pollution. Solutions proposed often shift blame to consumers, fostering an uneven dialogue. Sustainable consumption by the affluent is praised, contrasting with judgment on aspirational consumption of the less privileged. This article critiques how sustainability discourse perpetuates inequality and demeans lower social tiers. By invoking the French psychoanalyst and philosopher Felix Guattari's "three ecologies," von Busch highlights industrial emphasis, democratic erosion, and emotional degradation. He contends that these aspects mirror sumptuary laws, limiting societal progress. While unintended, shortsighted criticism of fast fashion curtails agency and accountability for sustainability, urging closer examination of its premises. However, these considerations seem to be valid for the fashion system in its entirety.

In fact, over the past three decades, concern for sustainability across wide sections of the fashion industry has grown. Despite acknowledging the need to address the social and environmental impacts of apparel production and consumption, consensus on the meaning of "sustainability" remains elusive. In the final contribution to this Special Issue, "Selling sustainability: investigating how Swedish fashion brands communicate sustainability to consumers" Taylor Brydges, Claudia Henninger, and Mary Hanlon highlight that definitions are context-dependent, making them subjective. The authors focus on brand-sustainability communication to consumers, examining the case of the Swedish fashion industry, which offers both the example of a fast-fashion colossus and the virtuosity of the northern European sustainable lifestyle. The authors illustrate how brands define sustainability diversely across websites, social media, and in-store campaigns. Given past greenwashing, defining industry sustainability is crucial, especially considering the initial and echoing impacts of the COVID-19 pandemic. The article emphasizes the necessity of setting and holding businesses to a solid sustainability standard for both theory and practice.

Conclusions

In summary, this Special Issue explores the multifaceted aspects of transforming the fashion system sustainably. It delves into three critical dimensions: organizational

change, product and process innovation, and socio-cultural transformation. The organizational aspect probes deep changes in fashion companies, blending sustainability with business strategies and ethical values. Product and process innovation emphasize tangible actions, from materials to energy-efficient techniques, triggering industry-wide shifts boosted with the use of digital technologies. Finally, the socio-cultural dimension explores fashion's link with society, addressing ethical consumption, cultural preservation, and the industry's influence on social norms.

Moreover, the Special Issue emphasizes the need for harmonized policy strategies that span entire fashion-value chains, advocating for the adoption of new consumption behaviors, innovative manufacturing and distributing models, and tailored solutions for sustainable fashion.

In this Special Issue, the exploration of fashion sustainability in its three critical dimensions highlights significant strides, yet equally underscores prevailing limitations within the industry's current applications and practices. The examination of organizational change extends beyond superficial business strategies, advocating for an intrinsic alteration in the operational DNA of fashion entities. This necessitates embracing sustainable business models, reevaluating supply chains, and embedding ethical considerations into the core ethos. However, these efforts, while substantial, unveil an arduous transformation that signifies a seismic shift but also exposes the vast chasm from conventional methods to a comprehensive approach aligning commercial aspirations with social and environmental duties.

In parallel, the focus on innovation acknowledges the essence of fashion sustainability as a tangible, actionable imperative. It emphasizes a rethinking of materials, endorsing eco-friendly alternatives, and revolutionizing production methodologies to be more energy efficient. Nonetheless, while this dimension spotlights the catalytic role of innovation, it also identifies the limitations of its widespread application, recognizing the necessity for broader implementation and more industry-wide engagement to foster more extensive change.

The socio-cultural dimension navigates the intrinsic links between fashion and societal norms, unveiling its influence on consumption patterns and societal reflections. It confronts critical quandaries such as cultural appropriation and socio-economic disparities, acknowledging the dual responsibility of preserving cultural heritage while concurrently advocating for ethical consumerism. Here, the dimension highlights the complexities and the industry's social influence, challenging the need for a more profound, more nuanced approach in understanding societal reflection and fashion's role in shaping societal ideals.

The current practices in the industry represent substantial progress, yet they inherently reflect significant gaps in achieving comprehensive sustainability. The need for further interdisciplinary research and collaboration across industry and civil society becomes evident to bridge these gaps. It is essential to penetrate deeper into the limitations within the existing practices and to push the boundaries further to integrate fashion's responsibilities more adeptly within societal and environmental paradigms. This comprehensive approach stands to leverage the synergies across these domains, addressing limitations, and steering the industry toward holistic sustainability. However, as we navigate the intricate landscape of transforming the fashion system sustainably, it becomes imperative to acknowledge and grapple with the inherent challenges and drawbacks elucidated by this Special Issue. The examined organizational changes, though advocating for intrinsic alterations in the operational DNA of fashion organizations, reveal the uphill battle of transitioning from conventional business models to those seamlessly blending commercial aspirations with heightened social and environmental duties. Similarly, while innovation in materials and production methodologies is underscored as a tangible imperative, the limitations in its widespread application underscore the need for more extensive industry-wide engagement and commitment to foster meaningful change. Furthermore, the socio-cultural dimension, while shedding light on the industry's influence on societal norms, also unearths the complex quandaries of cultural appropriation and socio-economic disparities, urging us to recognize the dual responsibility of preserving cultural heritage while concurrently advocating for ethical consumerism. Therefore, this expanded perspective not only accentuates the strides made in the pursuit of sustainable fashion but prompts us to confront the considerable gaps and challenges, urging further interdisciplinary research and collaboration to propel the industry beyond its current limitations and into a more comprehensive and truly sustainable future.

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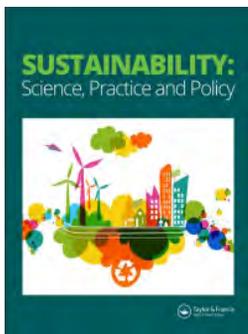
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Drivers and barriers to fashion rental for everyday garments: an empirical analysis of a former fashion-rental company

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ABSTRACT

We analyze the business models of online business-to-consumer (B2C) fashion rental and share challenges and lessons learned from an in-depth case study of a former German fashion-rental company. The firm focused on renting everyday, rather than special occasion, clothing, thus increasing the potential sustainability impact of its offer significantly. We also examine drivers and barriers of both an everyday children's wear and a women's wear rental model by incorporating both retailer and consumer perspectives through business data, manager interviews, and consumer surveys with customer and target groups. All data were merged into a single, in-depth analysis of the business models. By combining the complementary viewpoints of retailer and consumers, we were able to more precisely pinpoint the locations of the difficulties in the business models. The main barriers to success were the worsening quality of the company's inventory and its difficulty acquiring and retaining customers, due both to a lack of familiarity with the concept of fashion rental and the poorly perceived price-performance ratio of fashion rental. These issues suggest that online-fashion rental should begin by focusing on special occasion rentals with more high-end fashion options and should plan a sizeable budget for marketing to raise consumer awareness of alternatives to traditional retail models and alleviate customer concerns. If such a rental model is successful and establishes a stable customer base, everyday fashion-rental options could be explored as a supplement. The article demonstrates the importance of integrating different data sources to obtain a comprehensive understanding of why online-rental models fail or succeed.

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Introduction

The European Union has recently estimated that between 2% and 10% of the negative environmental impacts of consumption by member states is associated with the fashion industry (Sajn 2019), partly due to the sheer quantities of clothing that are produced and consumed each year. At the same time, the potential for resource savings in this sector is substantial, since on average one in three garments is never worn or is worn less than once in three months (Wahnbaeck, Brodde, and Groth 2015). Moreover, "less than half of used clothes are collected for reuse or recycling when they are no longer needed" (Sajn 2019, 1). To address these issues, solutions are needed that increase the number of uses per item of clothing; in other words, there is a requirement to intensify the use of each garment and thus reduce the demand for further production. This requires either that a single user wears a piece

of clothing longer (and buys fewer of them) – in other words an uptake of "slow fashion" – or that the item is used by multiple users consecutively. This is the case with fashion rental-business models where consumers rent clothes for short periods and these same items are then rented out to other consumers, thereby intensifying the use of garments. Reaching greater sustainability in the fashion industry will likely require a combination of all of these approaches, since each strategy has its unique appeal to consumers and thus different use cases.

In this article, we analyze the business model of online business-to-consumer (B2C) fashion rental and share specific challenges and lessons learned from an in-depth case study of a former German fashion-rental company, Relenda. The company offered several linked fashion rental-business models that were on the market in Germany from 2014–until 2020, including both subscription models and single-item rentals for children's clothing

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(“Kilenda”) and a subscription model with or without curation for women (“Stay Awhile”).¹ The focus was on everyday fashion rather than special occasion couture, which made the business models particularly relevant from a sustainability perspective. This study summarizes the results of extensive interviews with the company’s managing director, two surveys that recruited active and former customers as well as two non-customer target-group surveys representative for the German population.

An overview of prior studies can be found in Supplemental Material A. This work has focused extensively on consumer acceptance of circular fashion consumption, including fashion rental (e.g., Armstrong et al. 2016; Borg, Mont, and Schoonover 2020; Camacho-Otero, Boks, and Pettersen 2019; Clube and Tennant 2020; Lang, Seo, and Liu 2019; Lee and Chow 2020; McNeill and Venter 2019), and to a much smaller degree on business perspectives pertaining to this type of business model (e.g., Adam, Strähle, and Freise 2018; Arrigo 2021; Jin and Shin 2020; Pedersen and Netter 2015; Gyde and McNeill 2021). However, to our knowledge there have not been any studies incorporating primary empirical data from both the retailer and consumers of a single specific business model. Moreover, many prior studies have focused on rental models that offer primarily high-end, luxury, or special occasion wear (Adam, Strähle, and Freise 2018; Arrigo 2021; Gyde and McNeill 2021; Jin and Shin 2020; Lang, Seo, and Liu 2019) rather than everyday fashion, even though from a sustainability perspective, the rental of everyday clothing would likely have a larger impact (Gyde and McNeill 2021). In fact, some researchers have found that consumers explicitly see rental fashion as being less ideal for everyday clothing (Armstrong et al. 2016; McNeill and Venter 2019). We seek to close these two gaps in the literature by combining empirical data from both the complementary business and consumer perspectives into a single study. Moreover, we use this data to examine the applicability and relevance of the drivers and barriers of fashion-rental models that have been considered in prior studies to a model focusing exclusively on everyday fashion.

The outline of the article is as follows. The next section reviews prior literature and is followed by a brief overview of our data and methodology. Thereafter we first present and then further discuss our results before concluding.

Fashion rental as a business model

In contrast to traditional fashion-sales models that are product-centered and follow a take-make-waste logic, B2C fashion rental is instead a use-oriented

product-service system (Mont 2002) that follows a “service logic of consumption” (Todeschini et al. 2017, 764). Depending on the precise logistics of the model, customers can either rent clothing items individually for a period of time (usually a week or a month) or enroll in a monthly subscription or membership that entitles them to the rental of a specific number of fashion items per rental period (e.g., three items per month). Some models offer the option to buy favorite items at the end of the rental period for a reduced price (rent-to-own). Additionally, some companies regularly sell off past rentals or items from older collections to generate additional income and to make space for updated inventory (Arrigo 2021). Most fashion-rental companies target young (25–35) or middle-aged (30–50) women (Arrigo 2021; Pedersen and Netter 2015) and a few also focus on children’s clothing (Pettersen and Riisberg 2017). Other characteristics, such as income, style, and sustainability preferences vary strongly based on each model. Fashion rental requires a complex set of in-house or third-party services to provide the associated support, including two-way distribution logistics, cleaning, and repair (Gyde and McNeill 2021). Numerous studies have examined specific drivers and barriers to fashion-rental models both from a consumer and business perspective and we survey some of this work in the following sections.

Consumer perspective

Drivers

In prior studies, the most commonly cited driver from the consumer perspective is the ability to experiment with new styles or brands and to frequently change one’s wardrobe without guilt (Armstrong et al. 2016; Becker-Leifhold and Iran 2018; Borg, Mont, and Schoonover 2020; Camacho-Otero, Boks, and Pettersen 2019; Lang, Seo, and Liu 2019; McNeill and Venter 2019; Mukendi and Henninger 2020). These activities are commonly associated with fun, pleasure, and enjoyment. The second-most popular driver is saving money (Adam, Strähle, and Freise 2018; Armstrong et al. 2016; Arrigo 2021; Borg, Mont, and Schoonover 2020; Camacho-Otero, Boks, and Pettersen 2019; Lee and Chow 2020; Mukendi and Henninger 2020), which is particularly relevant in the context of rental for special occasions or one-time use, including high-end or luxury fashion items that users would not normally be able to afford if acquired on a purchased basis (Armstrong et al. 2016; McNeill and Venter 2019; Mukendi and Henninger 2020).

While some authors mention sustainability and the reduction of resource consumption as drivers

(Borg, Mont, and Schoonover 2020; Lang, Seo, and Liu 2019; Lee and Chow 2020; Mukendi and Henninger 2020) and such claims are often deployed for marketing and promotional purposes, sustainable consumption and its social consequences tend to be a rather weak motivator for consumers to opt for fashion-rental models (McNeill and Venter 2019). As Todeschini et al. (2017, 767) point out, “many sustainable and innovative business models have failed to convince consumers about the benefits of sustainable fashion products.”

The clear communication of a rental company's service offer and associated conditions is generally not a driver to partake in fashion rental per se, but does serve an important role in alleviating consumer concerns, especially regarding product quality and issues of liability (Adam, Strähle, and Freise 2018; Camacho-Otero, Boks, and Pettersen 2019).

Barriers

While a wide variety of new, digitally-based fashion rental-business models have arisen on the supply side, the uptake from the demand-side so far has been slow (Clube and Tennant 2020). Consumers' reluctance may be in part due to inertia in adopting new ways of consumption and overcoming routines (Catulli, Cook, and Potter 2017), but also can be attributed to a number of specific concerns about rental models. Most case studies have found that fashion rental requires a different approach to customer relationships than traditional retail and in fact comes with a number of challenges.

The most commonly cited consumer concerns relate to hygiene and health, with customers mistrusting the overall cleanliness of rented garments and worrying about disease transmission or unpleasant odors (e.g., Adam, Strähle, and Freise 2018; Clube and Tennant 2020; Lang, Seo, and Liu 2019; Roux 2010). Some studies describe an overall lack of trust in rental providers, with consumers uneasy not just about hygiene, but also about the quality of rented clothing and the reliability and continuity of service delivery (e.g., Adam, Strähle, and Freise 2018; Lang, Seo, and Liu 2019; Mukendi and Henninger 2020). A particularly strong point of concern is the question of consumer liability in case of loss or damage. Another issue is the lack of ownership in access-based models as the desire to own is still strong for many customers (e.g., Armstrong et al. 2016; Becker-Leifhold and Iran 2018; Borg, Mont, and Schoonover 2020; McNeill and Venter 2019). Likewise, many prospective clients are concerned about the ease of use of such services, including whether styles and sizes will be readily available when they are needed and the added effort and transaction costs involved in renting rather

than buying (e.g., Becker-Leifhold and Iran 2018; Camacho-Otero, Boks, and Pettersen 2019; Mukendi and Henninger 2020).

Studies to date have furthermore found little willingness to pay extra for rental-based models (e.g., Armstrong et al. 2016; Borg, Mont, and Schoonover 2020; McNeill and Venter 2019). At the same price point, consumers prefer to purchase an item of clothing rather than rent it and many may dislike the continuous reminders about the cost of rental that take place through recurrent payments. It is also more difficult for customers to compare prices between items for sale and items for rent.

Less common barriers from the consumers' perspective include concerns about their personal image and social standing if their social contacts find out that they rent clothing (Becker-Leifhold and Iran 2018; Lang, Seo, and Liu 2019; McNeill and Venter 2019), a general lack of understanding of use-oriented product-service systems, and corresponding hesitation to try them out (Arrigo 2021; Borg, Mont, and Schoonover 2020; Todeschini et al. 2017). Moreover, there is some anxiety about the high speed of fashion cycles, which could lead to quickly outdated rental collections (Borg, Mont, and Schoonover 2020). Finally, several authors have stated that consumers cannot imagine using rental services for everyday clothing (Arrigo 2021; Borg, Mont, and Schoonover 2020; Todeschini et al. 2017; Armstrong et al. 2016).

Business perspective

Drivers

Sustainability is increasingly considered one of the central drivers for fashion rental from a business perspective (Arrigo 2021; Borg, Mont, and Schoonover 2020; Todeschini et al. 2017). Increasing the intensity of use of a single garment through repeated rentals to a series of consumers reduces its environmental footprint, assuming the item is rented often enough to offset the increased emissions from transport. Some scholars also argue that rental businesses can reduce their stock requirements as compared to traditional retail and that excess inventory is therefore less of an issue for them (Jin and Shin 2020; Todeschini et al. 2017). Finally, procurement models of the fashion assortment for rental vary. Some fashion-rental platforms are able to put together a part of their collection with free clothes from young designers interested in generating publicity for their collection. Other service providers incorporate secondhand fashion items from their members so that only a part of the collection has to be paid for, often at wholesale or otherwise reduced prices (Arrigo 2021).

While not a driver for the business model per se, effective curation of the fashion assortment on offer is an essential prerequisite for success. Rental requires long-lasting, high-quality fashion items as profits in the system are generated by maximizing the number of rentals per single item before it has to be discarded (Gyde and McNeill 2021). This is generally easier to achieve with adult clothing than with children's garments.

Barriers

The barriers to rental-business models from a business perspective relate to consumers' concerns, expectations, and behavior, on one hand, and to the products and services being offered on the other hand. With regard to consumers, rental companies must contend with all of the issues detailed above. These challenges include raising awareness for the terms and conditions of rental models and resolving misunderstandings (Arrigo 2021; Todeschini et al. 2017), as well as clearly communicating the benefit-for-cost service proposition and why it should outweigh the benefit of purchasing clothing for the same cost (Becker-Leifhold and Iran 2018). In turn, the elevated price sensitivity of customers leads to firms feeling pressure to keep their rental prices as low as possible, for example through low cost-inventory management or by cross-financing their rental business with the resale of secondhand garments (Gyde and McNeill 2021).

For rental companies that use the sustainability of their model as a selling point, some sustainability-minded customers may pose unrealistically high expectations toward the performance of such a business model (Todeschini et al. 2017). Conversely, studies show that customers generally take less care of rental items than those they own, which also holds for fashion rental (Gyde and McNeill 2021). This disparity may lead to a conflict of interest between business and consumer, especially with regard to luxury or special occasion rental. While these types of more expensive fashion items often include "delicate fabrics and complex treatments such as hand embellishments," they are generally less durable, harder to clean, and require particular care in handling (Gyde and McNeill 2021, 7). These characteristics are the opposite of what makes for an ideal form of rental.

The size and nature of the fashion assortment on offer by rental companies also poses certain challenges. Interest from consumers increases once the stock selection is large, but this requires significant investment at an early stage and consequently sizable amounts of starting capital. Further on, new stock can be financed with the profits from existing rentals, although the rapid pace of fashion cycles

can lead to ongoing short-term financial strains if a company's inventory is strongly trend-based (Gyde and McNeill 2021). Studies vary greatly in how they describe the relationship between rental companies and designer brands. While Arrigo (2021) describes up-and-coming designers that see rental offers as free marketing for their brand, Gyde and McNeill (2021) instead report that rental firms encounter resistance when trying to acquire garments from certain designers who refuse to sell to rental companies because they see their own sales-based business model as being threatened by rentals.

Finally, fashion rental entails complex two-way logistics including recollection and (re-) distribution, cleaning, repair, and finally disposal of clothing. Models vary in the extent to which these logistics are outsourced to third parties and how much they perform them in-house, although the collection of rented-out items from customers poses a challenge for all models. Likewise, the reliability and vulnerability of this complex set of logistics can be a barrier to such business models (Becker-Leifhold and Iran 2018; Gyde and McNeill 2021; Todeschini et al. 2017).

Methodology

We used a mixed-methods case-study approach to explore different perspectives (business and consumer) of several linked business models in their real-life context (Simons 2009). We collected both quantitative and qualitative data and brought these together to craft our final analysis (Yin 2009). While we performed only a single case study, the generalizability of which may be called into question, we compare and contrast our findings in detail with the results reported by other researchers. This approach enables us to tease out similarities and differences between our case study – unique in its focus entirely on everyday garments – and other business models that focus on special occasion or luxury items.

The case study is centered on the Relenda GmbH in Germany, which we selected at the start of this research project because it was at the time the leading fashion-rental company for everyday clothing on the German market. Because the company was willing to cooperate with us on this three-year undertaking, the case study provided a unique opportunity to investigate the business model in great detail. In exchange for a well-founded assessment of the sustainability of its business model, the company gave us a detailed look at its finances, business practices, and customer base and used its own communication channels with customers to distribute and encourage participation in customer surveys. As a company that was strongly

sustainability-driven and rented out everyday garments, it also presented added value to prior case studies in the literature that mostly concentrate on special occasion or luxury fashion rentals. Our results come from three separate data sources.

Data from and interviews with Relenda

Prior to its closure, Relenda was the primary industry partner in the research consortium underlying this article. We conducted in-depth interviews with the company's managing director during its routine operations in September 2019 (full-day) and again online immediately prior to the company's shutdown in September 2020 (approximately two hours). Additionally, Relenda provided us with detailed quantitative data in writing regarding company performance. Details on the interviews are provided in Supplemental Material B.

Customer surveys

During August 2020, we conducted two customer surveys for the business models Kilenda and Stay Awhile. Participants were approached twice through email by Relenda and offered a 20% discount for the business models' online shop in return for participation in the online survey. Of the 277 Kilenda participants, 206 parents were using single rental, 46 had an active monthly subscription, 10 were at the time pausing their subscription, and 15 parents had ended their subscription. Of the 42 Stay Awhile subscription model participants, 18 were active customers, six had a subscription on hold, and 18 had ended their subscription. Customers in both surveys replied to questions regarding their acquisition of respective clothing and handling of garments, motives to use or not use the respective rental model, and sociodemographic information. It should be noted that participants selected themselves into the two customer surveys. This could possibly bias the results if the subgroup of customers completing the surveys differs systematically from all customers. Due to the small number of Stay Awhile respondents, these results should be interpreted with caution. More details on recruitment and sample selection can be found in Supplemental Material C.

Target-group surveys

In addition to the customer surveys, we performed two target-group surveys for the same business models. While customer surveys offer insight on the user experience and satisfaction with the service, surveys directed at target groups can provide feedback on possible reasons (e.g., false beliefs, effort)

that hinder potential customers from using a service. In sum, both groups have different knowledge backgrounds (based on experience vs. based on description) and deliver different perspectives about the business model (customer satisfaction and experience vs. customer extension). For the Kilenda target group, survey responses were collected in September 2020 from 1,324 parents with children aged zero to eight who were involved in the acquisition and selection of their clothing. The target group was representative for the distribution of German household net income of families (see Supplemental Material D for subgroup distribution). From the aforementioned group, 64% reported to have one and 31% to have two children. Only 2% had already used a fashion-rental model for themselves or their children and 42% had previously heard of such business models. A total of 54% could imagine using a rental model for their children and 44% ($N=583$) could envision not only using a rental model in general, but in addition, were predisposed to use a subscription-based rental model such as Kilenda. For the Stay Awhile target group, survey responses were collected in January 2020 from 1,171 female participants aged between 20 and 59 years. The target-group sample was representative of the German female population regarding both age and education (see Supplemental Material D for subgroup distribution). Among 1,171 participants, only 0.6% had already used some sort of fashion-rental model. However, 32% declared that they could imagine using a rental model in the future and 20% ($N=233$) stated they could both anticipate using a rental model in general and, more specifically, signing up for a subscription-based rental model such as Stay Awhile.

Respondents in both surveys were asked about their attitudes on fashion-rental models, their fashion-acquisition behavior, personal consumption habits, and handling of garments. Furthermore, we asked for sociodemographic details and how much they would agree on several possible motives to use or not use rental models in the fashion sector. More details on recruitment, sample selection, and representativeness can be found in Supplemental Material D.

Results

In this section, we provide a brief overview of Relenda's business model before integrating and analyzing the information from our company interviews with Relenda with the results of the customer and target surveys and comparing the resulting insights with previous research.

Relenda's business model

Relenda offered several different fashion-rental models: a subscription model and single-item rentals for children's clothing ("Kilenda") and a subscription model with or without curation for women ("Stay Awhile") (Figure 1). We focus primarily on the subscription models. The children's fashion assortment was mostly mainstream brands and a small number of eco-fashion options, while the women's assortment offered exclusively brands certified to be sustainable.

In the children's subscription model, customers received a selection of seven items, were allowed to choose four to keep and exchange them whenever they wanted, but not more often than once a month. In the women's subscription model, customers received only four items, which they could either choose directly via the company's website or receive a box curated by a stylist based on their submitted preferences. All four items could be exchanged once a month. Packages were exclusively dispatched within Germany the day after the order was received using DHL Go Green, which led to average wait times of approximately 3–4 days. Based on company data shared during interviews, items were exchanged on average every 1½ months for both models, though customers had the option of keeping some items while exchanging others – always retaining a total of four items per month after the exchange. With regard to longevity, Relenda calculated that it could rent out children's clothing on average four times per item and women's clothing, which generally suffers less wear and tear, on average ten times per item.

Relenda's data further indicated average company costs of just under €5 per item to cover shipping and supplies as well as personnel costs for shipping and receiving, visual inspection of the returned items, laundering, and repackaging. Laundry was done in-house with industrial washing machines



Figure 1. Logos of the two Relenda business models.

and dryers to avoid an increased environmental footprint due to dry cleaning.

Consumer perspective

In contrast to prior literature, our study includes data that allows us to compare sociodemographic factors between the total representative samples in Germany (the target groups), the interested subgroups within the target groups, and the actual Stay Awhile and Kilenda customers. A share of 20% of the total Stay Awhile target group of female participants aged between 20 and 59 years reported being able to imagine renting clothes and, more specifically, signing up for a subscription-based rental model (interested subgroup). A closer look at these interested potential customers who could be induced to use the business model showed no relevant differences in age compared to both the target group and current customers (see Table 1). However, the educational level of the Stay Awhile target group deviated quite substantially from those that were either interested or already customers. The latter groups were on average better educated, spent more money on clothing each month, and reported a higher net income than the target group consisting of German women between 20 and 59 years old. Regarding the business model, this means that the interested subgroup for subscription-based clothing rental models has a slightly higher socioeconomic status and is not limited to a certain stage of life. Regarding the customer segment of such a business model, this is advantageous, because it provides the benefit of a substantial share of potential customers (nearly 20% of the target group) with above average purchasing capacity.

For children's clothing, 44% of German parents with children below eight years of age could imagine using a subscription-based rental model. In contrast to the Stay Awhile subsample, a closer look reveals no substantial difference in number of children, net income, age, or share of participants living in urban areas compared to the entire target group (see Table 2). In other words, although the interested subgroup is slightly better educated and spends more on children's clothing, those interested in using a rental

Table 1. Comparison of sociodemographic factors between total sample and interested subgroup of potential Stay Awhile customers, as well as actual Stay Awhile customers.

	Age (years)	Education (share of participants with higher education)	Clothing expenditure (in Euro per month)	Net income (in Euro per month)
Target group	41.4	37%	€75	€2,200
Interested subgroup	39.4	47%	€102	€2,515
Stay Awhile customers	40.7	86%	€105	€4,395

Note: The total representative sample of German women between 20 and 59 years consisted of 1,171 participants, out of which 19.9% ($N=233$) could imagine using a rental model in general as well as signing up for a subscription-based rental model such as Stay Awhile. This group of potential customers comprises the interested subgroup. "Education" indicates the percentage of respondents that have a university degree in the respective sample; for Stay Awhile customers, "Education" indicates the percentage of respondents that have at least a university-entrance qualification.

Table 2. Comparison of sociodemographic factors between total sample and interested subgroup of potential Kilenda customers, as well as actual Kilenda customers.

	Number of children	Age (years)	Education (share of participants with higher education) (%)	Clothing expenditure (in Euro per month)	Net income (in Euro per month)	Living environment (share living in cities larger than 100,000) (%)
Target group	1.43	37.2	39	€8	€3,145	38
Interested subgroup	1.45	36.7	45	€100	€3,225	42
Kilenda customers	1.74	34.7	66	€93	€4,800	44

Note: The total representative sample of German parents with children aged zero to eight that were involved in the acquisition and selection of their clothing consisted of 1,324 participants, out of which 44.0% ($N=583$) could imagine using a rental model in general as well as signing up for a subscription-based rental model such as Kilenda. This group of potential customers comprises the interested subgroup. "Education" indicates the percentage of respondents that have obtained a university degree in the respective sample.

Table 3. Average rating of drivers for fashion rental among interested and not interested subgroups for Kilenda (children) and Stay Awhile (women), as well as active customers.

	Kilenda target group (mean)		Kilenda customers ($N=252$)	Stay Awhile target group (mean)		Stay Awhile customers ($N=18$)
	Not interested ($N=741$)	Interested ($N=583$)		Not interested ($N=938$)	Interested ($N=233$)	
I would not need to buy clothes I only need once	–	–	–	3.98	4.63	3.72
I can try out new styles and brands without commitment	2.95	3.67	3.37	3.37	4.31	4.22
Renting garments is better for the environment	3.19	4.02	4.39	3.24	4.25	4.61
I avoid buying clothes that are hardly ever worn	3.16	3.87	3.96	3.43	4.21	4.22
I have more variety in my closet	–	–	–	3.13	4.17	4.67
I save money in the long run	2.78	3.62	3.17	2.13	3.08	2.89
By renting garments I can reduce the production of new garments under inhumane conditions	3.10	3.93	4.14	–	–	–

Note: Statements were rated on a 5-point scale from "completely disagree" (1) to "completely agree" (5).

model do not differ notably on specific sociodemographic characteristics. Current customers, however, generally have more children, are slightly younger, are better educated, and have a significantly higher income than the German average. Nevertheless, having 44% of parents who can imagine using a rental model for children's clothing lays the cornerstone for the economic viability of such a business model. In sum, our analysis shows that there are sufficient potentially interested customers for both Kilenda and Stay Awhile for the business model to be economically viable. While renting clothing for children has significant appeal for young parents across all socioeconomic levels, renting clothing for women specifically attracts a subgroup of women with higher income.

Drivers

Table 3 shows the average rating of drivers for fashion rental among the three groups described above. Two of our findings are particularly interesting. Consistent with Mukendi and Henninger (2020), but contrary to other prior studies (e.g., Borg, Mont, and Schoonover 2020; McNeill and Venter 2019), we found that sustainability-related motives were highly rated both among actual and potential customers interested in using a rental model on a subscription basis for children's clothing and women's clothing. By contrast, saving money was

consistently rated as the attribute with the lowest relevance across all groups and offers. This contradicts findings from earlier research where saving money was deemed to be a strong motivator (Borg, Mont, and Schoonover 2020; Camacho-Otero, Boks, and Pettersen 2019; Mukendi and Henninger 2020). The disparity may stem from the fact that these studies focused more on luxury or special occasion wear, whereas our research spotlights everyday garments. In line with prior studies, those groups interested in rental, but that have not yet tried it out, value being able to rent clothing they only need once and are attracted to the idea of being able to try out new styles and brands, but these drivers play a much smaller role for actual customers.

Barriers

Table 4 shows the average rating of barriers among the different survey groups. Customers who canceled or paused their subscription were asked for their reasons for doing so. The strongest barrier was clearly that renting (everyday) clothes is seen to be too expensive. The lack of trust described in prior literature can also be confirmed (e.g., Armstrong et al. 2016; Borg, Mont, and Schoonover 2020; Camacho-Otero, Boks, and Pettersen 2019), with a concern for liability in case of damages being the biggest hurdle for the interested subgroups both for women's and children's clothing. For those not

Table 4. Average rating of barriers to fashion rental by interested and not interested subgroups for Kilenda (children) and Stay Awhile (women), as well as inactive/former customers.

	Kilenda target group (mean)		Kilenda customers (N = 25)	Stay Awhile target group (mean)		Stay Awhile customers (N = 24)
	Not interested (N = 741)	Interested (N = 583)		Not interested (N = 938)	Interested (N = 233)	
The garments could show signs of use	3.46	3.04	1.88	3.60	3.17	1.87
I want to own the clothes, not just rent them temporarily	3.52	2.70	1.96	4.03	3.07	2.46
I (my child) do (does) not want to wear clothes that strangers have worn	2.70	2.07	1.20	3.45	2.47	1.29
Renting clothes is too expensive in the long term	3.59	3.16	3.48	3.59	3.25	2.96
The rental system seems impractical to me	3.35	2.59	2.28	3.34	2.36	2.25
I am afraid of having to pay for possible damages to rented garments	3.65	3.38	1.76	3.95	3.70	2.00
The price/performance ratio is not right for me	3.61	3.20	3.12	–	–	–

Note: Statements were rated on a 5-point scale from “completely disagree” (1) to “completely agree” (5).

interested in fashion rental, the desire to own clothes rather than to rent them temporarily was particularly strong, again supporting prior studies (e.g., Adam, Strähle, and Freise 2018; Arrigo 2021; Becker-Leifhold and Iran 2018). While our survey did not specifically ask about hygiene, it did include the item “I do not want to wear clothes that strangers have worn,” which addresses a similar point. For children’s clothing, this was the lowest ranked item across all groups and did not play a strong role for women’s clothing either. This is surprising, given that concerns regarding hygiene are the most frequently cited barrier in the literature. A mid-level barrier for former customers of both models was the perceived impracticality of the rental system.

Our survey also addressed the type of garments that women would like to rent for themselves and found that Stay Awhile’s business model does not necessarily meet consumers’ wishes.² Among those female consumers who could imagine using a rental model (N = 372), 94% would rent dresses or special occasion wear, 49% would access maternity wear, and 48% would use rental services for business clothing. However, only 32% stated an interest in renting everyday clothing. Although this share was slightly higher among respondents who could also imagine using subscription-based rental models (40%), this only amounts to 8% of the total female target group who would be interested in a model like Stay Awhile, where customers can rent everyday clothing via a subscription-based rental model.

In addition to the surveys, the interviews with Relenda’s managing director also included questions on why the company struggled with customer retention. Its own analyses likewise indicated that customers felt that renting clothes did not provide enough advantages to justify the additional costs or the change in habits. Additionally, customer feedback and survey comments revealed that customers often wanted more choices, more garments from current collections, more sustainable shipment, or

faster delivery. Concerns that clothing could have traces of prior use or doubts about the hygiene of rental items proved to be less relevant for customers. While sustainability-related drivers scored highly in the survey, interviews with the company indicated that the environmental benefits of rental models did not seem to be a driving force for use but were rather seen as a supplementary factor, which matches findings from prior studies. From the company’s perspective, convenience and possible savings were clearly the dominant motivation for most customers.

Business perspective

Drivers

As mentioned in prior studies (Arrigo 2021; Borg, Mont, and Schoonover 2020; Todeschini et al. 2017), company interviews revealed that the central driver for Relenda to rent out clothing was the intention to increase sustainability by making the fashion market more circular and increasing the intensity of use for each garment. From a business perspective, there did not appear to be any other drivers truly inherent to the business model itself.

In terms of factors that supported the business model, for Stay Awhile, which explicitly rented out sustainable fashion, the company was able to buy out dead stock (unsold items from previous collections). As a result, the company obtained more favorable conditions, paying only 50% of wholesale prices with payment due after six months – when the items had ideally already been rented out several times. However, this form of procurement is very labor-intensive and not scalable to higher volumes. Relenda purchased its children’s clothing entirely at trade fairs and at wholesale prices, sometimes with volume discounts, with mostly mainstream brands and only a smaller set of ecological and/or fair-trade items.

Also helpful for the fashion assortment for the Kilenda model was a relatively high churn rate of approximately 1.05 items per customer per year, with another 10% of rented items being bought by customers via rent-to-own at reduced sales prices.³ Between replacements for defective and sold items, approximately two-thirds of the inventory of children's clothing was replaced each year, thus automatically helping to keep the collection up to date. For Stay Awhile, the churn rate was somewhat lower at 0.8 items per customer per year, whereas more items – 15% of those rented – were bought by customers via rent-to-own at reduced sales prices.

It is clear from the very brief list of drivers found both in prior studies and communicated to us during our interviews with the company that fashion rental as a business model, especially for everyday garments, is primarily motivated from an environmental standpoint and somewhat less so from a business perspective, though it is of course still a for-profit model.

Barriers

The barriers described by Relenda during the in-depth interviews revealed that the company struggled with three overarching issues: customer acquisition and retention, inventory management, and making its business model profitable while still offering attractive rental prices to customers.

The customer-acquisition cost was extraordinarily high for the company even though a wide variety of different marketing channels had been tested throughout the startup phase. These costs ranged between €60 and €120 per customer depending on the marketing channels, and conversion rates indicating the proportion of Relenda's website visitors that turned into customers ranged between 0.3% and 0.5%. In other words, cold customer acquisition was often not successful. Moreover, customer retention was very difficult: only 20–30% of the new customers stayed longer than two to three months, thus not even leading to a return on the acquisition investment. These specific business aspects have not been discussed in prior research on clothes rental.

Part of the problem during acquisition is that the logic and procedure of rental models are barely known among potential consumers, a dilemma also cited by prior studies (Arrigo 2021; Borg, Mont, and Schoonover 2020; Todeschini et al. 2017). For example, 56% of the parents in the target-group survey had never heard about renting children's clothing before. Relenda would therefore have needed to significantly increase its investment in marketing to eliminate doubts about the model and to build up a solid customer base. When potential customers learned about the model through the survey, many

could imagine renting clothes once in a while (54% for Kilenda; 32% for Stay Awhile).

Relenda also faced significant challenges with regard to its inventory. First, to provide customers with a wide selection of rental items, the company had to overstock by about 20% at all times, an issue also cited by Gyde and McNeill (2021). Second, the rental of seasonal items, like winter coats or snow suits, is particularly attractive in the children's segment, because these items are usually only needed for a short period of time and can only be worn for one season when children are growing quickly. In the winter, such items therefore have to be in stock in sufficient quantities to cover demand, but then cannot be rented out again for 6–9 months, thus increasing carrying costs without generating revenue. In turn, if such items are out of stock when customers need them, this erodes their trust in and commitment to the rental model as a viable alternative to traditional shopping options. This aspect has to be factored into decisions regarding pricing and warehousing capacities for such items. Since few studies focus on the rental of everyday garments, such issues have not been discussed in earlier studies.

Finally, the most serious inventory problem was that the stock of clothing invariably became more unattractive over time. In Relenda's experience, between 15% and 30% of new additions to the inventory are "flops," meaning that customers neither want to rent nor purchase these pieces. Another 15–30% are "hot picks," in other words they are very popular among customers, which means that they are quickly rented out and then usually bought via rent-to-own and no longer available for re-rental to others. The difference between flops and hot picks can be minor – the same item with a different color or motif can be a hot pick in one season and a flop in the next. The remaining 40–70% of new additions are the "gray mass," often basic or less interesting pieces that are sometimes used to "fill up" an order, but are never attractive enough to motivate customers to begin renting fashion. With time, more and more of the existing stock inventory consists of flops and gray mass, which not only take up space but also generate additional costs: the few times these items are rented out, they then have to be washed and repaired again. Contrary to some prior studies (e.g., Arrigo 2021), Relenda was hesitant to sell these items off at a discount without prior rental, since they were afraid of being seen as a cheap retailer rather than a subscription-fashion service, thus undermining their own (intended) business model. In theory, this cost of item unpopularity would have had to be factored into the pricing strategy, but this would have made

subscriptions even more expensive and led to even fewer customers and rentals.

Discussion

In contrast to most prior studies, our analysis focused on business models exclusively offering everyday garments, which is reflected to some degree in the drivers and barriers we identified from the consumer perspective. Contrary to most earlier research, sustainability was a more significant driver in this instance from the consumer perspective than saving money. This makes sense in context, as the financial savings for everyday clothing are much smaller than, for example, for luxury items or special occasion wear, while the sustainability impact is, in turn, much higher. In fact, the perception that renting clothing is too expensive in the long term was the most important barrier to renting clothes, even though the financial aspects were not paramount for the customers at the beginning. For those who have not yet tried fashion rental, lack of trust in the service provider and the importance of ownership were significant hurdles, as has also been described in prior studies.

Other research to date has presented detailed analysis of barriers to the business model of fashion rental from the retailer's perspective. Most barriers that are discussed are, in one way or another, related to consumers (Becker-Leifhold and Iran 2018). From our study, we can likewise confirm the difficulties resulting from a lack of consumer familiarity with and trust in the rental model. Only one prior study – Gyde and McNeill (2021) – discussed inventory issues as a problem, though they focused mostly on the need to overstock to ensure a wide selection. The inventory problems encountered by Relenda were much more extensive and may, again, have been related to the fact that the company offered everyday clothing and not special occasion wear, which is both more versatile and more seasonal.

Our results show that there is a potential market for fashion rental among German consumers. Both potentially interested and actual customers are better educated and have a higher income than the average and are more strongly motivated by sustainability than those not interested in the offer. These characteristics may explain why saving money was not as strong a driver for actual and potentially interested customers, although former customers who had paused or canceled their membership did cite cost as their primary motivation for leaving. Moreover, for women, fashion rental is particularly attractive for items they only need once or for a short period of time, such as maternity wear, while only a very

small percentage of the potential target group can imagine renting everyday garments. Interestingly, while potential customers are particularly concerned about liability in case of damages as well as garments that show signs of use, these factors hardly play a role in motivating former customers to stop renting. This shows that actual experience with the rental service largely helps to eliminate these concerns, which are so often cited in the literature.

From a business perspective, the excessively high customer-acquisition costs and difficulty retaining customers that Relenda encountered reflect both the lack of familiarity with fashion rental as a service and the overall customer reluctance to rent everyday garments. An offer that is more closely tailored to customer wishes – special occasion and perhaps maternity wear and business-professional clothing – would likely improve customer-retention rates. However, it would still require extensive marketing to make the offer known in the first place so that acquisition costs are unlikely to decline significantly, at least initially.

Nevertheless, such an offer would also be more attractive in terms of its cost structures: Kilenda's single item rentals were generally rented out for 1/6 of the item's sales price and the company estimated handling and shipping costs of approximately €5 for each item. For a mid-range dress with a sales price of €300, paying €50 for a one-time rental would therefore be a win-win situation for both sides: The customer saves €250 on a dress she only needs for a single event and the company receives enough money to cover all of the logistics associated with the rental with money left over to pay off the item's original cost, or later on, to generate profit. Even assuming that more high-end clothing would require more professional and more expensive (chemical) cleaning services, the handling costs are unlikely to scale proportionally. For an everyday item whose sales price is only €30, by contrast, a €5 rental is barely enough to cover the operational costs it generates and does not suffice to even begin covering the cost of acquisition.

As a result, Relenda's managing director listed the following characteristics for making product groups well suited to rental: (1) products should be expensive to purchase, so as to make rental for a fraction of the price attractive to consumers; (2) products should not be subject to frequently changing fashions, so that they can be rented out for an extended time; (3) products should have a clearly recognizable rental use-case for customers, such as a one-time special occasion; and (4) products should be long lasting and require little repair. This matches insights from prior studies and shows that fashion rental is most likely to be profitable for

high-end and/or event-based items, such as evening wear, traditional folk costumes, or wedding attire, which are rented out frequently and for a short period of time (1–2 weeks). It should be noted, however, that this type of business model is not ideal for the goal of increasing the circularity and sustainability of the fashion sector, which would require an upscaling of the rental models to everyday clothing.

Conclusion

This article examined drivers and barriers of fashion-rental models. Its research contribution comes especially from three unique aspects. First, we incorporate primary empirical data related to the same business offering from both consumer and business perspectives rather than only focusing on one vantage point. Second, the article provides detailed quantitative survey results, including two target-group samples that are representative for the intended market in Germany. Finally, we analyze business models offering everyday garments rather than the much more common rental model for special occasion or luxury clothing.

By combining the complementary viewpoints of the rental-business together with feedback from both real customers and representative target groups, we were able to more precisely pinpoint where the difficulties in Relenda's business model were located and compare and contrast these problems with prior studies on fashion-rental models. The primary driver for the business model is in increasing the sustainability of the fashion sector, which matches findings from prior literature. While this is a key motivation from a social and ecological perspective, it cannot make up for the missing economic drivers in the business models. We could not confirm earlier suggestions that overstock and excess inventory are less of a problem for rental models (Jin and Shin 2020). Rather the opposite was true in Relenda's case, as one of the main barriers to success was the worsening quality of the company's inventory over time. Confirming findings by Arrigo (2021), Gyde and McNeill (2021), and Todeschini et al. (2017), Relenda faced significant difficulties acquiring and retaining new customers due both to their general unfamiliarity with the concept of fashion rental and a poorly perceived price-performance ratio.

All of these issues support the conclusion that future fashion-rental models (at least in Germany) should begin by focusing on special occasion rentals with more high-end fashion options. Regarding procurement, they should consider several strategies. First, fashion-rental entrepreneurs should create partnerships with upcoming designers and luxury

brands interested in showcasing their creations and increasing their visibility and thus potentially willing to sell their items at a reduced price or even donate a part of their collection for free, as has been done in Italy and Scandinavia (Arrigo 2021; Pedersen and Netter 2015). Second, prior season dead stock from high-end brands may be another source of procurement to reduce costs. Third, if the rental concept is still largely unknown in a country, significant funds should be budgeted for marketing and publicity campaigns to raise customer awareness of alternatives to traditional retail models and to alleviate consumer concerns regarding product quality and liability, as has previously been suggested by Arrigo (2021) and Todeschini et al. (2017). Fourth, if a special occasion rental model is successful and has an established and stable customer base, everyday fashion-rental options could be explored once again as a supplement with a view to increasing circularity and sustainability in the fashion sector. Fifth, we recommend that retailers and rental companies invest in critical infrastructure for cross-collaboration between retailers/rental companies and textile services, such as tailoring, dry cleaning, and repair. The wider availability of these services would make it easier for customers to access them (rather than always buying new clothing) and, when incorporated directly into rental-business models, would also help to reduce concerns regarding liability in case of damage. Given that we identified liability as one of the main obstacles in the target-group survey, trust is a major component in business models of the sharing economy and showing customers that the garments are well taken care of ensures confidence in the service.

This article has demonstrated the benefit of linking different sources of data and perspectives rather than analyzing rental platforms only from the consumers' or retailers' perspective (e.g., consumer acceptance of rental models). The discrepancies and contradictions provided valuable insights for our research, including how the rental of everyday garments as opposed to luxury or special occasion wear changes the challenges of the business model. In this vein, we would also emphasize the difference between interviewing target groups versus actual customers for new business models. While customers can provide an inside perspective that draws on first-hand experience with the product, potential customers from a target group can provide insight on concerns that hinder a business model's growth from niche to mainstream. We believe that research directed at upcoming business models should benefit from these different perspectives by using multi-data approaches wherever possible. In our research, we focused only on a single company, which limits

the implications that one can draw for similar business models and the whole rental market. Future research could examine whether the findings are also applicable to other rental models for everyday clothing, to fashion-rental companies for special occasions and to further product groups. Subsequent studies should be conducted with attention to the business perspective, especially its challenges and possible solutions, which has so far been underrepresented. Finally, in-depth cross-country comparisons of fashion-rental experiences, both among consumers and firms, could serve to better understand the role of cultural factors in determining the success of the business model.

Notes

1. Prior to the outbreak of Covid-19, the company was already trying to reorganize and optimize its business models based on prior experience and overall lack of success on the market. During the first four weeks of the pandemic, Relenda lost 30–40% of its customers and did not recover during the following six months. The company chose to shut down in late 2020.
2. This question was not included in the Kilenda target survey, as categories such as special occasion, maternity wear, or business clothing play almost no role for children's clothing.
3. For example, the average number of clothing items that were beyond repair for the purpose of commercial rental, expressed on a per-customer basis.

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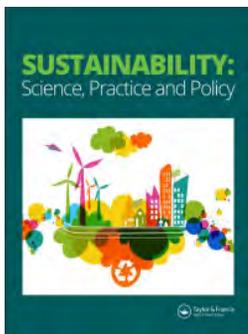
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Disrupting the status quo: a sustainability transitions analysis of the fashion system

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ABSTRACT

The fashion industry has developed into a complex global system with persistent social and environmental sustainability challenges. Private, public, and civil society actors have condemned these persistent problems and called for system change toward sustainable fashion. While alternative practices and industry collaborations have emerged throughout the system, they have not added up to a sustainability transition. Instead, the system shows signs of being locked into unsustainability. The aim of this article is to examine the state of transition of the fashion industry through a multi-level perspective system analysis, based on a co-creative research project with the former C&A Foundation, which became the Laudes Foundation in 2020. This transition analysis shows that the fashion system is locked into a state of disconnection, uncontrollability, extraction, growth-focus, and disposability. We build from analysis and present a set of strategic transition pathways that can be pursued today throughout the fashion system to accelerate the transition to sustainable fashion.

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Sustainability transitions;
fashion; lock-in; pathways;
system change

Introduction

The fashion industry is a complex system that is made up of global networks of actors that contribute to the diverse activities that allow for the creation, production, distribution, and consumption of “fashion.”¹ We consider the “fashion system” to unite diverse activities, such as the producing of fibers; the designing of clothes and fabrics; the manufacturing and shipping of garments; the distributing, marketing, and retailing of apparel; the formulating of policies to govern the industry; the consuming of fashion; and so forth. Garment production is the third largest manufacturing industry in the world in terms of annual revenues (Karaosman et al. 2016) and continues to grow rapidly (EMF 2017). As one of the most globally significant industries, it generated \$2.5 trillion in annual revenues (Amed et al. 2020) and provided employment for over 300 million people before the onset of the COVID-19 pandemic (EMF 2017). But the fashion industry also faces persistent social and environmental sustainability problems. Research highlights how the industry’s value chains are characterized by an asymmetric distribution of power (Hileman et al. 2020), major social injustices

(Ozdamar Ertekin et al. 2020), and widespread environmental impacts (EMF 2017; Sandin and Peters 2018; Peters et al. 2021).

After abundant criticism over the limited consideration of social and environmental issues by the industry in recent years (Niinimäki et al. 2020), the need for change toward sustainability in fashion is increasingly acknowledged by researchers (Bick et al. 2018; Fletcher 2010; Peters et al. 2021), activists (Fashion Revolution 2020), industry (Amed et al. 2020; Drew and Yehounme 2017), and policy makers alike (European Commission 2021b). However, there is no one clear definition of sustainable fashion, meaning efforts to achieve sustainable fashion materialize in various shapes and forms (Islam, Perry, and Gill 2021). Many terms and concepts have emerged in the past few decades to describe a movement toward greener, more ethical, slower, circular, and more transparent fashion (i.e., Clark 2008; Fletcher 2010; Ozdamar Ertekin and Atik 2015; Henninger et al. 2016; Brydges et al. 2014). To date, the most substantive change has been in response to incidents such as the Rana Plaza factory collapse in 2013, which stirred up debate about unethical industry practices. Calls for more transparency and traceability in the fashion

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industry have led larger fashion brands to commit to doing better. However, fast fashion, overproduction, and overconsumption still dominate the landscape and the fashion system has not been able to phase out unsustainable practices (Fletcher 2010; Peters et al. 2021). While engaging in corporate social responsibility (CSR) and developing responsible collections, the sustainability efforts of many large brands are still marginal and not at the core of their business models. The textile and clothing industry is still among the largest polluters in the world and its social and environmental unsustainability is not diminishing (Bick et al. 2018; Ozdamar Ertekin et al. 2020; Peters et al. 2021).

Private, public, and civil society actors increasingly condemn the issues in the sector and urge change toward a sustainable fashion industry. In response, opportunities for more sustainable fashion are emerging across the system, which in turn could become entry points for transformative change. These efforts include increasing pre-competitive business collaboration and consumer interest for sustainable fashion, as well as the emergence of alternative practices, materials, and business models. Regardless of these promising emerging practices, sustainability efforts have not yet added up to a transformation of the fashion system, which instead shows only slow progress at best (Global Fashion Agenda 2019). Beard (2008) highlights that one of the reasons why change is not happening or is happening at a very slow pace is linked to the fragmentation and complexity of the supply chains of a truly global industry. The textile and clothing industry is made up of hundreds of thousands of brands, wholesalers, and retailers; millions of workers; and billions of consumers worldwide (Mihm 2010).

This article takes a sustainability transitions perspective of the fashion system and an action-oriented understanding of processes of change within the industry. We use system-analysis methods to study the patterns and mechanisms that create inertia and possibilities for transformative change in such a complex societal system. The sustainability transitions perspective offers a system-level helicopter view rather than a deep dive into any specific theme within the fashion space. This transition approach contributes to an improved ability to unravel the complexity and inertia in the system and helps to find the entry points for change that are already present. We build on these opportunities by proposing pathways to move toward a more sustainable fashion system.

This article builds on a research project with the former C&A Foundation (now Laudes Foundation) which included co-creative sessions to define transition pathways from a system perspective toward a

more sustainable fashion industry. The discussion is structured as follows. First, we introduce the concept of a sustainability transition, including the multi-level perspective (MLP) for transition analysis. Second, we describe our methods. Third, we highlight our results by presenting the current state of transition of the fashion system and several co-created transition pathways forward. Finally, we draw our conclusions and identify avenues for future research.

A sustainability transitions perspective

Sustainability transitions research emerged in an attempt to understand the workings of societal transitions and to unearth points to address sustainability (Loorbach, Frantzeskaki, and Avelino 2017; Grin, Rotmans, and Schot 2010). This perspective begins with the notion that grand societal challenges are the result of the ways in which systems are structured and that create and reproduce persistent problems (Schuitmaker 2012). To address these challenges, radical changes to restructure the system are required, which over the long-term might unfold into a transition toward a more sustainable system. Such sustainability transitions are found to have a number of key characteristics that make them difficult to predict. They are understood as multi-dimensional, long-term, uncertain processes that involve multiple and diverse actors and their divergent values and understandings (Köhler et al. 2019). Various frameworks and approaches have been developed in attempts to better understand and influence these complex processes of change. We turn to a number of key concepts from the sustainability transitions literature to better understand the dynamics of change and sustainability in the fashion system.

Earlier transitions research set out a framework that helps to analyze systems in transition based on three key elements that together make up the MLP as shown in Figure 1. Researchers have developed and applied the MLP in the context of historical transitions and this work has uncovered a typical pattern of non-linear change between these three elements. First, the *regime* describes the dominant way of thinking and the rules that govern the system, as well as the infrastructures and the institutions that give shape to the overall system. Practices and responses initiated from within the regime generally seek to further stabilize and optimize the regime which can ultimately lead to a “lock-in” of the system (Frantzeskaki and Loorbach 2010; Klitkou et al. 2015). When lock-in occurs, the structures of the system have developed in such a deeply entrenched way that few alternative options have

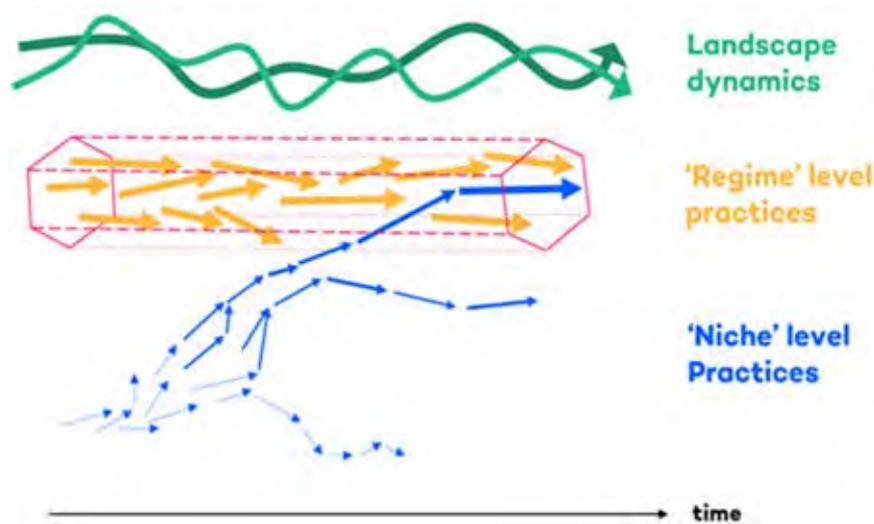


Figure 1. A multi-level perspective of how processes of change can lead to a transition in a societal system (adapted from Geels 2011).

room to grow. Sustainability transitions research aims to explore how a dominant and unsustainable regime that is locked-in can change into a sustainable one. For this we turn, second, to *niches*, which are understood as spaces outside of the regime that define alternative ways to think, govern, and shape the system. As their name already suggests, they aim to counter dominant modes, but are generally only considered viable in a specific, protected environment and under certain conditions (Smith, Fressoli, and Thomas 2014; Smith 2007; Sengers, Wieczorek, and Raven 2019; Raven, Van Den Bosch, and Weterings 2010). Nevertheless, some niches have the potential to grow in terms of relevance vis-à-vis the system and to survive outside of this protected environment. With that opportunity comes the possibility to challenge and overthrow the unsustainable regime in time or the “risk” of being co-opted by the regime. Finally, these processes do not take place in a vacuum but are subject to *landscape dynamics*. These are broad societal trends and processes that influence the entire system (and beyond), such as climate change or economic crises (Geels and Schot 2007; Loorbach and Lijnis Hufferreuter 2013). Landscape dynamics influence the stability of the structures that uphold both regime and niche practices, forcing processes of reconfiguration, transformation, substitution, or de-alignment (Geels 2011).

We understand societal transitions as non-linear patterns of change, which are the result of multi-actor, multi-level interactions: dynamics at the landscape level, disruptions of the path-dependency of the regime, and emerging niches that provide alternatives. These insights are the result of analyses of historical transitions, and these patterns allow us to better understand and support transitions-in-the-making. In fact, transition research has increasingly moved toward using and developing more action-

oriented approaches and methods (Köhler et al. 2019). Action research offers a way to acquire meaning and understanding through practice and interactions in a multi-actor context (Wittmayer et al. 2014). A key principle in action research is the understanding of knowledge as the product of interaction with societal actors, building on their understandings, experiences, and values. Such co-creative processes allow transition researchers to develop “action-oriented knowledge” that supports sustainability action (Clark et al. 2016; Caniglia et al. 2021). Multi-actor engagement enables participants to co-produce new knowledge with which to advance sustainability transitions, to make sense of transition dynamics, and to examine how innovative sustainability solutions operate and affect transitions (Frantzeskaki and Rok 2018).

Methods

This article contributes to the academic and industry debates on fashion and sustainability by presenting strategic pathways to sustainability reasoning from transition theory. It builds on insights from a transdisciplinary action-research project that set out to explore transitions to sustainable fashion through co-creation with diverse stakeholders from the fashion system. This project was concluded in 2018 and was commissioned by the former C&A Foundation and Fashion for Good. We published the results of this project in a report (Buchel et al. 2018) that the current article builds on and expands upon based on more recent literature and dynamics in the fashion industry.

We used various methods to get a better and more actionable understanding of the fashion system through a sustainability transition perspective. These can be divided into three subsequent parts:

(1) desk research and analysis, (2) stakeholder reflection and validation, mainly through interviews, and (3) a stakeholder co-creation process.

First, desk research was an essential part of the project and used analytical elements from the MLP to examine both academic and gray (industry) literature on the fashion system. The desk research was the responsibility of the researchers. It was intended to provide insights into current notions of sustainability in the industry and to outline the state of transition in the fashion system. Rather than conducting a retrospective analysis of a fulfilled transition, the research focused on finding signals for emerging pressures that have the potential to destabilize the existing fashion regime. In other words, the desk research applied a transition perspective to a “transition-in-the-making,” which meant that it set out to uncover *potential* current and future transition dynamics.

Second, stakeholder reflections were key for the validation of the desk research. Within the scope of the project this included informal talks with employees of the former C&A Foundation and Fashion for Good, as well as eight in-depth expert interviews. The experts came from knowledge institutes, industry sustainability initiatives, nongovernmental organizations (NGOs), brands, and retailers. The countries in which the experts operated were in North America, Europe, and Asia. The interviews allowed us to validate and reflect on transition insights and adapt where needed.

Finally, essential to the formulation of the transition pathways were the co-creation workshops with stakeholders from the fashion system. These workshops started from the transition analysis of the fashion system, asked the participants to critically assess and improve it, and further built from there. Two in-person co-creative workshops of approximately three hours were organized, with a total of 19 unique participants. Participants came from a broad range of organizations, including large brands and retailers, small innovative brands, NGOs, and knowledge institutes. Due to the in-person nature of the workshops that took place in Amsterdam, the geographical origin of the participants was limited to Europe. The first workshop featured a collective system analysis and visioning process to define the desired sustainable fashion system and to identify seeds for change among niches in the current system. The second workshop used backcasting and wildcards to strategically define steps from the desired system to the present, providing insights into multiple transition pathways. These were then further unpacked and summarized by the research team. A final, shorter, in-person session was organized in Copenhagen with 14 new participants from

industry sustainability initiatives, foundations, and NGOs (many of them with a global scope, but mostly with roots in Europe and North America) to validate the transition pathways. It must be noted that the results of each of these activities were outcomes of an iterative process. The MLP analysis of the fashion system was primarily made on the basis of the desk study and interviews and the transition pathways were co-created during the workshops. However, both outputs were further developed with the data gathered throughout the research process and have benefited from input by participants.

A multi-level transition analysis of the global fashion system

Based on the data generated in the research activities, we have conducted a transition analysis of the current global fashion system using the MLP. The results from this study are presented here, citing publications and references where applicable, but also including data from the expert interviews and workshops. We start by explaining in detail the structures, cultures, and practices that the regime encompasses. We continue with a categorization of emerging niches, and, finally, clarify the landscape dynamics that might influence and disrupt this broader system.

The dominant fashion regime

Dominant structure and practices

While fashion-supply chains are organized globally (Niinimäki et al. 2020), the system itself is very fragmented and includes many small and medium-sized enterprises (BCG 2016). The apparel-production chain is a classic, linear model that uses almost exclusively virgin materials from either organic or synthetic sources (Bick et al. 2018; Peters et al. 2021). It heavily depends on the use of nonrenewable resources (e.g., petrochemical products), intensive farming practices (e.g., using large volumes of fertilizers, pesticides, and water for cotton production), and chemical dyeing and is thereby responsible for considerable environmental impact (Bick et al. 2018; Niinimäki et al. 2020; Peters et al. 2021).

The fashion market is characterized by induced obsolescence (Christopher, Lowson, and Peck 2004; Raustiala and Sprigman 2006; Janssens and Lavanga 2020) and high demand uncertainty (Lavanga 2018; Pratt et al. 2012; Brydges 2018), not only in the case of fast fashion but in luxury fashion as well. Short lifecycles of garments, long lead time, and make-to-stock practices are at the core of the fashion system (Brun et al. 2008; Brandao, Godinho Filho, and Lago da Silva 2021). Production has shifted toward

locations where the labor costs are increasingly lower. Following cheap labor to enable the supply chain of fashion, materials, fibers, fabrics, and garments are shipped around the world (Fletcher 2007; Ozdamar Ertekin et al. 2020). Here the industry relies on people (mostly women) to work in sewing factories for the non-automated cut-make-trim step of the supply chain (Karaosman et al. 2016). Where traditional design-to-sales timelines need almost two years, the current dominant model demands only four months or less (Taplin 2014a). This leads to manufacturers subcontracting and relying on excessive overtime. This business model is prone to the exploitation of manufacturing workers resulting in issues like poverty-line wages, severe health and safety issues, and worker repression (Taplin 2014a).

The fashion market is highly competitive and luxury brands often outsource to low-cost countries, too. However, Brun et al. (2008, 562) highlight that while “the most critical production phases (e.g., the cutting phase) are to be kept in-house, the non-critical and most labor intensive phases (e.g., sewing) can be outsourced.” In particular, to ensure control and quality, “outsourcing strategies during the production phases in low-cost countries have been increasingly reviewed in this luxury segment, and this has led to a movement called reshoring emerging within this supply chain... However, a value-added strategy is to outsource a process to a highly specialized supplier that enhances quality attributes in the end” (Brandao et al. 2021, 866).

Fashion demand in emerging economies is soon projected to outgrow that of the most advanced countries (Amed et al. 2020). Overproduction and overconsumption are at the core of the fashion system, resulting in an increasing “clothing mountain” and waste (Maldini et al. 2019; Niinimäki et al. 2020). Though there is a small market for clothing resale either domestically or by shipping items abroad, 12% of worldwide textiles enter cascading recycling into lower-quality products like insulation materials, and less than 1% of textiles are recycled into new fibers or garments (EMF 2017). Moreover, retailers regularly dispose of unsold stock, contributing to high levels of waste generated by the industry. Repair, reuse, and resale are uncommon, meaning all other discarded apparel and textiles are landfilled or incinerated.

Dominant fashion culture

Fashion is a central part of consumer culture in higher income countries, and increasingly in emerging economies, allowing consumers to give shape to identity and culture (Niinimäki 2010; D’Souza 2015). The marketing by brands and retailers relies on this relationship to the consumer’s identity and

exposes consumers to advertisements across media and public space (Macchion et al. 2017; Langley and Rieple 2021). With the intertwining of fashion and identity, consumption has come to represent a bridge toward a desired lifestyle (Niinimäki 2010). However, the lifespan of garments has further decreased due to fast fashion, urging consumers to use it and dispose of it (Ozdamar Ertekin et al. 2020). In fact, producers and consumers increasingly treat garments as disposable products, demonstrated by the trend of declining clothing utilization (EMF 2017). Many brands and retailers argue that the inertia of the industry is due to the lack of consumer willingness to pay for sustainable products and the rising demand for affordable clothing supports this claim (Lehmann, Arici, and Martinez-Pardo 2019). However, the demand for guilt-free consumption is increasing, as 55% of people state they are willing to pay more for sustainable clothing (Gazzola et al. 2020). While consumer awareness is increasing, there is a considerable gap between sustainability intentions and behavior (McNeill and Moore 2015). When it comes to efforts to improve sustainability and ethics in the industry, brands and retailers are predominantly doing so in response to public attention by forming collaborative, industry-led sustainability platforms, and certification and benchmarking schemes, with many of these initiatives coming from sustainability intermediaries supported by the industry. Notable examples include the Sustainable Apparel Coalition, the Global Fashion Agenda, Fashion for Good, and the Organic Cotton Accelerator.

Emerging fashion niches

Throughout the system numerous niches have emerged as part of attempts to counter the dominant practices from the fashion regime and to address some of its sustainability challenges. Their innovations in terms of technologies and practices are aimed at making apparel production and consumption more sustainable and ethical, each innovation addressing separate sections of the fashion system (Gwilt and Anicet Ruthschilling 2019).² These initiatives have often been developed by independent fashion designers and small fashion brands who embrace a slow fashion movement (Leslie et al. 2014; Brydges et al. 2018). “Money doesn’t buy the lead. A lot of bottom-up, unexpected companies will make the change,” according to a workshop participant.

We have broadly characterized niches into four categories: (1) technology and fibers; (2) business models; (3) value-chain models and partnerships; and (4) consumer awareness. We categorize niches

as “alternative practices” compared to the “dominant practices.” Niches are not inherently sustainable per se, and research is needed to analyze these new practices. For example, while researchers have highlighted the emerging niche of fashion rental as a more sustainable practice than buying fashion (EMF 2017; Mukendi and Henninger 2020), a recent study suggests instead that out of five options, including discarding and recycling, renting clothes produced the most carbon emissions (Levänen et al. 2021).

Technology and fibers

A flurry of technological niches has emerged in apparel production in response to the fashion industry’s unsustainable use of resources and virgin materials for disposable fast fashion. Design for sustainability and circular design practices aim to reduce waste in design, sampling, and production processes (e.g., laser cutting, digital sampling, 3-D knitting, reuse of leftovers) as well as to extend the lifetime of garments through direct reuse, repair, and upcycling (Kant Hvass and Pedersen 2019; Earley and Goldsworthy 2015; Sandvik and Stubbs 2019). In particular, upcycling increases the value of a product by transforming it into a higher-quality product. “Upcycling is found to be the best alternative to close the loop, whereas direct reuse is considered to be the second most preferred alternative” (Paras et al. 2019, 406). Some interviewees saw a lot of potential in the circular economy, even beyond a materials perspective with one respondent observing that “in the circular economy you phase out anonymity in the supply chain. Everything needs to be traceable.”

In addition, there are niche practices that deal with innovations that reduce the environmental impact of the dyeing processes and water, energy, and chemical use (e.g., with bacteria, enzymes, and nanotechnology). At the same time, various innovations that enable the recycling of textiles have surfaced, such as automated sorting, chemical recycling, and the creation of new fibers from recycled plastic. There is also a growing number of niches of designers and startups that use or produce fibers from a variety of alternative materials (e.g., fruit leather, algae, or fungi).

Business models

“We built our business models based on infinite growth. There needs to be a new model that sells something different,” one interviewee said. To counter the dominant business model in which fashion is manufactured by anonymous producers and garments are disposable, novel business models have appeared throughout niches in the system. Here

fashion is considered a service, and longer-term relationships with customers are highly valued (Pedersen et al. 2018). Examples are companies that enable consumers to swap, lease, or rent clothing (e.g., VIGGA); produce garments on demand (e.g., Elsieen Gringhuis); allow for personalization; and reuse, remake, repair, or recycle garments (e.g., Nudie Jeans). These innovative business models are predominantly offered online and frequently make use of social media and direct-to-consumer sales (e.g., Vestiaire Collective, Comn).

Value-chain models and partnerships

Another development in the fashion system has been the emergence of ethical brands that respond to the social injustice that is persistent throughout the industry. These (often small) ethical brands value working closely with manufacturers and have set up shorter supply chains than conventional fashion producers. This has enabled consumers to have a closer connection to the manufacturer, as brands are able to provide more transparency regarding their production process. In combination with new business models, value-chain models that are centered on local-for-local (circular) production and reshoring are also increasingly apparent (e.g., Mud Jeans). In addition, in pursuit of transparency, various initiatives have emerged that form partnerships with brands (Hileman et al. 2020): such as environmental profit and loss accounting (e.g., Kering), transparency initiatives disclosing in which factories individual garments were made (e.g., ARKET), or even IT-based traceability through the use of blockchain systems (e.g., Bext360).

Consumer awareness

Finally, a key-niche development has been a shift in consumer awareness of sustainability issues in the fashion industry. Global consumer campaigns like #WhoMadeMyClothes and #WhoMadeMyFabric (by Fashion Revolution), for example, urge consumers to reflect on the social impacts of the clothes they own, to take a role in urging fashion brands to assume responsibility, and to improve their transparency and social and environmental sustainability practices. Alongside producer-facing consumer activism, recent social media trends feature aspects of the previously discussed niches from a consumer perspective: as a focus on quality and long-lasting garments (e.g., minimalism and capsule wardrobes) or moving away from “disposable” fast-fashion garments (e.g., zero-waste movement; fast fashion-detox challenges; clothes-swap parties). These trends, and the pressure they have put on the fashion system, show that niches in sustainability transitions are not always technology-, innovation-, or

market-based. Some niches rather involve new ways of thinking and doing led by consumers and activists.

In conclusion, there is plenty of diversity among innovative practices in niches across the fashion system. While novelties that focus on improving the environmental performance of a product, company, or value chain have been most dominant, there is increasing attention for issues of social justice. In fact, there is a growing trend of companies focusing on ethical production and good labor conditions for garment workers. While we can identify many innovations and initiatives as niches in the fashion system, these have not yet resulted in a larger shift of mainstream practices and have not been able to challenge the dominant fashion regime sufficiently to enact any movement toward system transformation. Countertrends that further entrench the fast-fashion regime can also be distinguished (Table 1).

Landscape pressures influencing the fashion system

The practices of the fashion regime and the emerging fashion niches do not play out in a vacuum. Instead, they are subject to landscape pressures that can be both enabling or disabling, and thus possibly accelerating transitions or further reinforcing an unsustainability lock-in. These landscape pressures can develop *outside* of the fashion system and come to influence it, such as an economic crisis. However, they can also develop *within* the fashion system and eventually become a source of global pressure that influences the entire system, such as the Rana Plaza factory collapse that put working conditions front and center. In this section we discuss several currently relevant landscape pressures and briefly reflect on how they influence both regime and niches.

Growing middle class

Global growth in population and wealth have led to a continuously expanding demand for a range of luxury items such as high caloric foods, clothing, and various technologies. This trend has been especially prominent in emerging economies which have seen rapid increases in the consumption of goods in the past decade. Furthermore, we are seeing a shift in the power dynamics in the broader fashion system, a spread of consumerist culture globally, and a strain on resources (Wubs et al. 2020). First, within the fashion industry these trends have especially led to changing power relationships in the regime. The overall market shares of brands and retailers in the global North are declining in the face of rapid growth in other parts of the world (Küpper et al. 2016; Amed et al. 2020). These shifts in global market shares have contributed to the loss of a leadership role on the part of large fashion companies based in the global North. Furthermore, the regime trend of consolidation among Chinese suppliers has shifted power over the supply chain from brands and retailers in the global North toward the suppliers and producers in China. The rapid bounce-back of China during the pandemic in 2020 compared to the rest of the world further strengthened the position of Chinese companies in the industry (Amed et al. 2021). Second, with a growing affluent middle class, consumerist culture has also expanded around the globe (Dobbs et al. 2016). The values and behavior associated with consumerist culture specifically feed into the business model that is dominant to the regime (Niinimäki 2010): it raises the demand for large quantities of new products at highly affordable prices. Finally, expanding consumption trends have increased the pressure on resources needed for the production process. As emphasized above, the modes of production in the fashion industry are contributing to the depletion and pollution of

Table 1. Regime vs. niche interaction with the system.

	<i>Regime practices</i>	<i>Niche practices</i>
<i>Dominant structure</i>	Just-in-time supply chains that are globally organized; start to finish	Practices specialized within certain sections and segments of the fashion system
<i>Perception of sustainability</i>	Supply-chain regulation for social impact; efficiency for minimizing environmental impact; CSR; siloed approach to addressing challenges	Minimal (or positive) impact on planet and people; re-usability; decent compensation for work
<i>Market dynamics</i>	Classic retail; trend-led marketing	Independent boutiques; online retailing; producer-consumer relations; transparency; service-based
<i>Cultural trends</i>	Fast fashion; cheap garments, race to the bottom; highly disposable garments	Slow fashion; durable, sustainable materials; rental; repair
<i>Industry and technological trends</i>	Cheap labor for cut-make-trim step; non-organic cotton and synthetic virgin fibers	Old and traditional crafts with new technologies; alternative fibers and materials; automation developments
<i>Ecological trends</i>	Intense use of nonrenewable resources and intensive farming practice; considerable environmental impact	Use of discarded materials, natural dyeing; renewable energy use and sustainable distribution
<i>Regulation and policy trends</i>	Regulated mostly for environmental production standards; working conditions are often on voluntary basis	New business models that feature shorter value chains, which enable transparency and consumer-producer relations

natural resources, thereby also posing an increasing threat to the natural capital on which the industry depends (Drew and Yehounme 2017; Niinimäki et al. 2020).

Global climate action

The increasing global urgency to deal with environmental issues and climate change is pushing governments to take measures to minimize the emissions of greenhouse gasses and to implement stricter environmental regulations. Global arrangements such as the United Nations Paris Climate Agreement intensify pressure on the fashion industry to address its environmental footprint. Moreover, the implementation of policies that integrate measures related to circular economy, such as applied to waste management, are increasingly common: for example, in the European Union (European Commission 2018), China (De Freytas-Tamura 2018), and India (Government of India 2020). In particular, the European Green Deal aims at making Europe the first climate-neutral continent in the world, with a target of 55% reduction of emissions by 2030 (European Commission 2021a). The textile and clothing industry is recognized as one of the sectors which can pave the way toward a carbon neutral and circular economy. Indeed, the European Commission identified the textile and clothing industry as a priority sector in its Industrial Strategy and it will publish in 2022 an “EU Strategy for Textiles” with sustainable textile-transition pathways (European Commission 2021b).³ At the same time, there is an ongoing policy debate around the role of extended producer responsibility (EPR) in textile products. The concept of EPR aims to ensure that producers take responsibility for the end-of-life phase of their products, in particular contributing financially to the costs of waste management. This policy can be an influential factor in driving change in the fashion industry, especially if it is designed for circularity and harmonized across European Union countries, as suggested by EURATEX (2020), the European Apparel and Textile Confederation.

These measures have the capacity to affect regime practices most strongly, as they often span the globe and are built on more competitive and extractive business models. “Governments have the possibility to become powerful actors in the fashion industry; they can ask for a different future,” said one of our interviewees. In comparison, most of the niche practices that we have shown are not particularly challenged by new measures: for some, the core of their business is oriented at keeping their environmental footprint as low as possible. In addition, there is a growing trend whereby consumers are similarly in pursuit of climate action and they gravitate more

and more toward environmentally responsible fashion actors. Interesting also is the changing role of NGOs which have emerged as influential and independent watchdogs to protect the environment and vulnerable populations of people. These NGOs are increasingly institutionalized within (voluntary) governance arrangements that prioritize transparency about the practices of fashion industries and include, for example, the Garments and Textiles Covenant, the Denim Deal, and the Dutch Circular Valley, all in the Netherlands.⁴

Social justice disasters

Like the global move toward climate action, social justice has been elevated by activists (Fashion Revolution 2020) and governments (European Commission 2021a) as a key concern and drives change at both niche and regime levels. Although calls for social justice are a growing global political trend across societal systems, in fashion it is also the result of dynamics that are endogenous to the fashion system, as these pressures arose from tragedies such as the 2012 Tazreen factory fire and the 2013 Rana Plaza factory collapse in Bangladesh (Taplin 2014b). At the regime level, these disasters prompted leading brands and local trade unions to form the legally binding Accord of Fire and Safety in Bangladesh (Ahlquist and Mosley 2021; Anner 2020; Oka et al. 2020). While in other countries, notably the UK, Germany, and the Netherlands, actors such as the private sector, NGOs, and the government have been working together to create non-binding agreements to address issues like unsafe working conditions and worker exploitation in the supply chain (Wu and Li 2019). Such agreements are often initiated from within the fashion system, in collaboration with other NGOs. As mentioned before, NGOs are increasingly taking on a more official role in holding the fashion industry accountable for their actions. In addition, these social justice disasters have also put a public spotlight on social conditions in the fashion industry, creating additional pressure for change by fashion consumers. This activity is visible in the growing number of consumer and activist movements that demand change from brands and companies to address social justice issues.

Digitalization, e-commerce, and social media

Digitalization and e-commerce have been major influences on the fashion system, to both regime and niche (Macchion et al. 2017; Brydges et al. 2021). While digitalization has challenged regime actors to adapt their dominant mode of physical retail stores, the shift to online retail and marketing has acted as a niche space for a wide array of

alternative fashion practices and even enabled them to accelerate (Brydges et al. 2018; Langley and Rieple 2021; Crewe 2013). The Internet initially allowed the fashion industry to expand internationally through e-retailing (Guercini and Runfola 2015). In recent years, the rise in e-commerce in fashion is associated with a department-store crisis, as brick-and-mortar (department) stores are outcompeted by online retail (Guercini et al. 2018). In general, e-retailing has promoted and perpetuated practices of overconsumption. In contrast, in the niches digitalization is a disruptive force that has allowed social innovations to flourish and alternative practices to emerge and scale up, such as peer-to-peer sharing and rental and (re)sale platforms (Langley and Rieple 2021). It has also enabled smaller sized fashion designers and producers to showcase their creations via social media and to sell directly to consumers; this development has enabled a degree of enhanced autonomy (Guercini et al. 2018). Social media has also allowed new players like fashion bloggers to emerge within the fashion system (Rocamora 2017). Successful fashion bloggers blur the line between marketing and consuming fashion products, allowing such individuals to influence consumer behavior and become online opinion leaders (Crewe 2013; Guercini et al. 2018).

COVID-19 pandemic

Many of these landscape pressures and their effects on the fashion industry have been amplified by the ongoing COVID-19 crisis. At the start of the pandemic and subsequent lockdowns, supply chains were severely disrupted as production and shipping were affected and brick-and-mortar retail venues around the world closed. These developments variously affected niche and regime actors throughout the fashion system, as economies and consumer behaviors rapidly changed, for instance by an initial dip in consumer spending and a general shift toward online retail and consumption (Amed et al. 2021). Many brands saw it necessary to cancel large orders that were already in production, due to the decline in demand, pushing financial risk further down the supply chain toward manufacturers in producing countries (Fashion Revolution 2020). While many regime-level retailers had already been making a shift toward more e-commerce and a stronger online presence, the COVID-19 pandemic has accelerated this dynamic. As physical retail was limited throughout 2020 and 2021, online retail has been vital for the industry to cope with these sudden changes (Fashion Revolution 2021).

Co-creating a response toward sustainability

From the transition analysis above emerged the question of where actors in the fashion system can intervene to create transformative change toward sustainability. Our work shows that the fashion industry is locked into unsustainable trends and has so far been quite resistant to change. However, rapid niche developments in combination with the increasing landscape pressures highlight some potential starting points for change within the system. Transition pathways offer a shared narrative connecting the desired system state to those transition dynamics currently present in the system that offer seeds of change. To support a transition in fashion, it is necessary for actors to collaboratively take action to disrupt current structures and to stimulate and scale innovation.

In the co-creation workshops, researchers and participants developed six transition pathways. These pathways were designed to break away from the lock-in the fashion regime currently faces, leveraging existing niches and landscape pressures to transform the industry into a force of positive change that enhances customer well-being, provides safe and just working conditions, captures the full value of materials, regenerates ecosystems, and strengthens economies and communities. These pathways can provide narratives to be used by industry actors and change agents to connect around, as well as a research agenda for researchers interested in studying the industry from a more systemic and transition-oriented perspective.

The pathways serve as inspiration to move beyond optimization strategies, where currently significant effort is concentrated, and toward system transformation. The pathways can—and should—develop alongside each other, since they cover different aspects of the fashion system that need to be transformed. Indeed, many of these pathways are not exclusive to the fashion industry, but rather are part of other, larger transitions in various manufacturing industries, as well as sectors like energy, waste management, and agriculture. Many actors in these industries can be found innovating, investing, and experimenting in these spaces. These experiences can provide the fashion industry with valuable lessons and partnerships if actors (e.g., brands and retailers, innovators, suppliers, or manufacturers) are willing to look beyond the fashion industry for transformative power and to partner with others. Each pathway can make use of several change practices as transformative tools (see Figure 2). These are not new interventions per se. Since there are many actors and initiatives already working on mobilizing these practices, there is not always a need to duplicate efforts or reinvent the wheel.

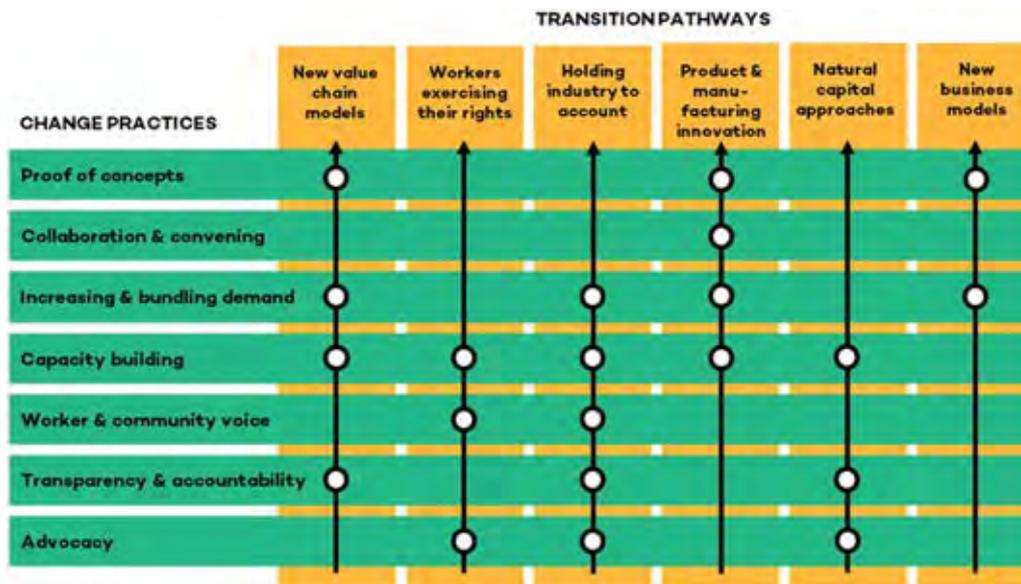


Figure 2. Transition pathways and levers for change.

However, fashion-industry actors (as well as governments, NGOs, and consumers) can connect and collaborate around suggested change practices and pathways and build on existing efforts to direct them toward shared narratives and to accelerate transformative change. As one of our interviewees stated, “The fashion system leaves capacities of people underutilized while exhausting natural resources. Humanity is smart enough to change this.”

Pathway 1: new value chain models

This pathway transforms business-to-business relationships in which supply-chain actors move beyond transactional relationships with strong power imbalances and toward partnerships based on connection, mutual understanding, and reciprocity. Supply-chain partners share risks and benefits, make joint investments in supply-chain innovation, and collaborate long-term to build capacities and to improve sustainability performance. Resources are allocated by supply-chain partners to enable all actors (including small- and medium-sized enterprises (SMEs) at a global scale) to change business-as-usual.

Indicators of progress for this pathway are the duration of supply-chain partnerships, the power balance in supply-chain partnerships (in terms of dependency or distributing the sales price throughout the chain, for example), the transparency of production chains, and the resultant changes in how materials are owned and managed throughout product lifecycles.

Pathway 2: workers exercising their rights

Workers (and community members) are empowered to exercise their rights to negotiate for the priorities they choose, including higher (living) wages, better

labor conditions, opportunities for growth, and healthier environments. The industry respects workers’ collective bargaining and advocacy to governments. Supply chains, working conditions, and purchasing practices are publicly disclosed, so employers and upstream buyers can be held accountable.

Indicators of progress for this pathway are the number of specialized jobs in the industry, the share of fashion-industry workers united in unions or other forms of worker collectivity, and the number of successful court cases with which communities prevent environmental degradation.

Pathway 3: holding the industry to account

The industry is no longer “footloose” due to increased oversight and regulation by governments that protect their environment as well individuals and organizations against pollution, health hazards, and exploitation. This situation means stricter environmental regulations for farming and manufacturing practices as well as facilitating good working conditions and wages. It includes implementing minimum social and environmental impact standards for garment import, use, and end-of-use. NGOs, investigative journalists, and individuals have a watchdog role, enabled by the movement toward industry-wide radical transparency that provides public access to the impact, origins, processes, costs, and value of products.

Indicators of progress for this pathway can be measured by looking at the presence of apparel-production measures in strong environmental policies, the decrease of the number of companies moving to other countries because of more limited regulations, the decrease of connectedness between industry stakeholders and policy makers, and the change in

consumers' attitude toward problematic practices in the fashion industry.

Pathway 4: product and manufacturing innovation

The industry moves away from the current linear take-make-waste model. This pathway leads to a circular system in which material loops are closed. Garments are made in clean-production processes and with regard for the materials and their full lifetime. They are viable assets in an economy that fosters reuse. Fibers and chemicals that cannot be part of a closed no-impact loop that upcycles materials are phased out. Production processes such as farming and manufacturing regenerate rather than pollute the environment. The industry is independent of fossil fuels and no longer contributes to micro-plastic pollution. Companies allocate resources to increase capacity for sustainable design, radical innovation, and knowledge about alternative practices.

Indicators of progress for this pathway are the pace of uptake of innovative and transformational technologies in the production chain; the amount and extent of collaboration between innovators and traditional regime actors; the accessibility of expertise, technologies, and finance for circular fashion innovation; the percentage of research and development budgets for radical innovation (as opposed to incremental innovation); and the cost of recycled versus virgin fibers.

Pathway 5: natural capital approaches

The sector moves toward natural capital assessment and radical transparency that provide details on the true cost of environmental impact, origins, and materials. Material and economic flows are combined in assessment and reporting tools. These data are captured by decentralized, open information technologies that financial actors can use for investment strategies and governments are able to access for crafting environmental policies, import limitations, and taxation.

Indicators of progress for this pathway are the market share of companies that report on natural capital impact throughout their supply chain, the extent to which data is shared transparently, the range of policies introduced that support natural capital accounting approaches, and the taxation of labor relative to the taxation of natural resources and capital.

Pathway 6: new business models

Consumers become "users" of fashion services rather than owners of garments. In the "next

circular economy" the use, adaptability, and convenience of products is valued. Local production enables brands and manufacturers to sell designs and (recycled, high-quality) raw materials directly to customers and SMEs. Tailoring, repairing, and customizing by retailers and local professionals make a return. Renting and reselling are common business models for brands. New service models turn supply-chain actors into asset managers rather than producers.

Indicators of progress for this pathway are the share of fashion-service revenues relative to total revenues, the accessibility of fashion services, the rate of clothing utilization and resale, and the extent of decline in new garment production and sales.

Discussion: a reflection on the state of transition

While the fashion industry proclaims to "do better" and some companies are making small steps toward more sustainable materials or products, not much has changed when it comes to the dominant fashion system (Global Fashion Agenda 2019). In fact, rather than transform the industry, efforts to push change have thus far led to optimization of the status quo. When we synthesize the dominant cultures, structures, and practices within fashion, we see a regime that is highly entrenched and resistant to transformative change. First, the fashion regime is *disconnected* because of its transactional relationships, fragmented supply chains, and unequal power structures which in combination allow for (financial) risk to be pushed further down the supply chain and encourage a collective sense of irresponsibility. Second, the fashion regime is *uncontrollable* as it operates within an unregulated global market that enables the industry to avoid accountability for social and environmental externalities. This situation enables the fashion industry to stay opaque and "footloose" by pursuing cheap and fast production around the world. Third, the regime is *extractive and growth-driven*, leading to high price competition. As such, sustainability is often considered a costly additional feature, meaning dominant fashion practices still heavily rely on nonrenewable fossil resources and virgin resource inputs. Finally, the dominant fashion regime is highly *disposable* in nature, enabling continuous and ever-changing consumer demand for quantity and novelty.

These four characteristics are highly interlinked and function as the design principles for how actors within the fashion regime think, work, and organize themselves. This regime has been developing path dependency in this direction for some decades, being clearly locked into this trajectory. Such a

“lock-in” is the result of positive feedbacks which reinforce existing and incumbent technologies and business models. These processes have become widely diffused and have made the regime stable and resistant to change (Klitkou et al. 2015). This state of lock-in leads to a “continuous empowerment of the existing infrasystem” (Frantzeskaki and Loorbach 2010) and helps explain the relatively marginal effect of attempts to move toward sustainability.⁵ Breaking out of lock-in then requires more radical approaches by system (governance) actors to rewire the structures and relations that govern the system. Furthermore, the changes introduced in the fashion system are often marginal and mostly improve and optimize the dominant structures, practices, and regime actors. This is visible in the sustainability efforts that are initiated within the fashion regime and that fail to address its complexity and incumbent nature (Taplin 2014a). For instance, the sustainability efforts of many brands only focus on using materials with a lower environmental impact, without addressing more systemic issues such as garment end-of-life or working conditions down the supply chain. However, commitments with a more systemic sustainability perspective are being made by leading brands, with the Fashion CEO Agenda prioritizing support between supply-chain partners for social justice, and a move toward circular production systems (Global Fashion Agenda 2018).

First, the persistent lock-in caused by these four reinforcing characteristics requires radical transformation of the fashion system and all its (governance) actors. However, to date the majority of sustainability efforts have only resulted in marginal innovations that have built on resources from within the regime. For instance, many companies are taking first steps into mapping their supply chains in an attempt to increase transparency (collaboratively developing standards and benchmarks), yet the practices that incentivize an opaque supply chain (short production times, low margins on products) have not changed. These changes have only further optimized the fashion regime’s dominant business model while presenting consumers with a veneer of ethics or sustainability through marketing. The true social and environmental costs of the fashion industry are still externalized, its supply chains and workers are exploited across the board, and a linear take-make-waste model with ever-faster turnover is still the norm.

Second, sustainability efforts tend to focus on technological innovation and present disjointed efforts that emphasize regulating single links within the supply chain. These interventions overlook the disconnected nature of the fashion system and

might even result in unintended consequences. For example, attempts to regulate manufacturing and use of chemicals or other illegal practices that are not yet regulated, have not resulted in the desired sustainability outcomes. In fact, the fashion system continuously adapts to increased regulation by moving production to countries that are cheaper and less regulated (like Cambodia or Ethiopia).

Third, persistent problems have often been uncovered by parties outside the industry such as NGOs or journalists. This has predominantly led to a reactionary response from both the fashion industry and governments. These defensive measures ultimately feed into optimization pathways and reinforce system lock-in. Despite improvement efforts to turn the fashion industry into a force for good, it seems that the mainstream industry’s development pathways remain along the lines of expansion, growth, low-cost production, and high consumption—while mitigating external pressures on the industry to become more sustainable with risk management, voluntary commitments, and marketing. This is largely due to the industry’s path-dependency: the established structures, networks, routines, technologies, and production processes that keep the fashion industry locked in. Rather than looking at the symptoms of unsustainability of these processes, we need to examine the underlying structural characteristics of the fashion industry that keep them locked in. Only when these fundamental persistent problems are structurally addressed by a significant number of actors in the system (e.g., in a transition) can the fashion industry secure a future where people can thrive.

We have explored the niche developments and landscape pressures that offer seeds for change and can create the momentum needed to disrupt the locked-in system. For the purposes of analysis, we used the MLP, a framework that makes a distinction between regime and niches. Such a heuristic is a useful tool for understanding system dynamics. However, it must be noted that the lines between regime practices and niche initiatives are not always clear-cut in reality. On top of this, even within a system as heavily laden with sustainability issues as the fashion system, not all regime dynamics are undesirable or harmful, and not all niche developments move toward a more sustainable system state. Building on the positive niches, niche-regime interactions, and change practices that can be seen within and outside the system, we offered six transition pathways that could provide guidance for systemic intervention by industry actors and innovators, as well as other governance actors (e.g., governments, NGOs, funders, activists, consumer groups) to accelerate transition. These pathways are

not silver bullets and need significant collaboration around them by many of these players around the world to destabilize the lock-in of the current system. Together the pathways could lead the way to an alternative regime state for the fashion system, in which the industry becomes a force of positive change that enhances customer well-being, provides safe and just working conditions, captures the full value of materials, regenerates ecosystems, and strengthens economies and communities.

Conclusion

We have described the fashion system and its persistent sustainability challenges through the lens of sustainability transitions. Using the MLP, we have shown the locked-in nature of the fashion regime, the opportunities for change that niches in the system provide, and the landscape pressures that challenge the current system and urge incumbent actors to change. Using this system perspective, we have co-created six transition pathways with industry experts that aim to transform elements of the regime and to build on niches and landscape pressures. The fashion system is disconnected, uncontrollable, extractive, growth-driven, and disposable; these elements make the regime resistant to change. Using the transitions perspective provides a new avenue for systemic, collaborative interventions to contribute to transformative change of the industry toward sustainability. This study used co-creative action research methods together with industry stakeholders.

The selection of participants for this study had limitations, and the results could benefit from validation and enrichment with a broader set of actors, especially from countries outside of Europe and North America, as well as involving governments, industry workers, consumers, and a broader range of companies. The pathways also suggest avenues for future research. The transitions perspective offers a birds-eye view and could be further developed by more in-depth interdisciplinary research that studies best practices from other sectors or industries that align with each pathway and focuses on niches that are experimenting with innovations suited to the pathways including, for example, innovative business models or government regulations. The transition pathways and analysis can be used as a foundation for system change.

Notes

1. Fashion is considered a “cross-sector concept” and refers to “several industries, such as apparel, footwear, leather, jewelry, perfumes, and cosmetics” (Brun et al. 2008; see also Macchion et al. 2015), although the main focus of this study was on the apparel industry.

2. Slow fashion has been described as “a philosophy of attentiveness” (Fletcher 2010) which is “mindful of its various stakeholders’ respective needs and of the impact producing fashion has on workers, consumers, and eco-systems” (Pookulangara and Shephard 2013). Slow fashion stands for high quality and long-lasting products, craftsmanship, and sense of care. During the past few decades, many independent fashion designers around the world have embraced slow fashion and carved out a niche in the global fashion market (Brydges et al. 2014; Leslie et al. 2014) in the global fashion market. Emphasis is put on local production, reshoring of manufacturing, ethical making and wearing, local heritage and fashion, and shorter supply chains and emerging new business models such as production-on-demand and rental. In this respect, the rise of slow fashion goes along with the growing popularity of the maker movement.
3. See https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12822-EU-strategy-for-sustainable-textiles_en
4. See Dutch Garments and Textiles Covenant (<https://www.imvoconvenanten.nl/en/garments-textile/agreement>), Dutch Denim Deal (<https://www.government.nl/documents/reports/2020/10/29/c-233-green-deal-on-circular-denim-denim-deal>), and Dutch Circular Textile Valley (<https://www.dutchcirculartextile.org>).
5. An infrasystem is defined by Frantzeskaki and Loorbach (2010) as “a special type of societal system that includes both the physical component that is the infrastructure, and the institutions regulating and managing it.”

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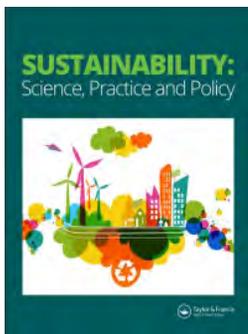
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A framework of circular business models for fashion and textiles: the role of business-model, technical, and social innovation

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ABSTRACT

The textiles production and consumption system is a priority product-value chain for the European Commission in its 2020 Circular Economy Action Plan. The Action Plan foresees a European Union strategy for sustainable textiles in a circular economy with the aim of creating markets for sustainable and circular textile products, services, and business models. The European Environment Agency (EEA) and its Topic Center on Waste and Materials in a Green Economy (ETC/WMGE) have shown that consumption of clothing, footwear, and household textiles in Europe is on average the fourth highest category of environmental and climate impacts from a consumption perspective and from a vantage point that considers the entire life cycle. The fashion industry is responsible for more than 60% of total textiles used and clothing is expected to remain the largest application of textiles in the future. To enable a sustainable and circular textiles system, a transformation of fashion production and consumption is needed. This transformation requires innovation in business-model design, technology, and social practices through the adoption of specific policy making, education, and behavioral change enablers. In this Brief Report, we present a framework to map and advance the implementation and scaling of circular business models. This is illustrated by exploring four different circular business-model approaches for fashion and textiles, including models based on product durability; access models based on renting, leasing, and sharing; garment collection and resale; and recycling and reuse of materials. For each business-model type, we discuss enablers based on technical and social innovations and policy, behavioral change, and education.

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Introduction

Textiles and fashion play an important role in the European economy and contribute to job creation within Europe and abroad. At the same time, garment production and consumption patterns generate significant and growing negative environmental, climate, and social impacts. Among all consumption domains in the European Union (EU), consumption of clothing, footwear, and household textiles is the fourth highest pressure category from a consumption perspective for use of primary raw materials and water, the fifth highest for greenhouse-gas emissions, and the second highest for land use after food production (EEA 2019a). Globally, the fashion industry is the second largest consumer of water (1.5 trillion liters per year), responsible for about 20% of industrial water pollution (GFA 2017), and contributes up to 35% (190,000 metric tons per year) of oceanic primary microplastic pollution (UNCC 2018; EEA 2021a). According to different

estimates, fashion production and consumption generate between 4 and 10% of global carbon-dioxide (CO₂) emissions (up to 1.7 billion metric tons annually) (Niinimäki et al. 2020; GFA 2020). Furthermore, many textile and fashion workers in the world are paid poverty wages and are subjected to conditions that breach international labor, health, and safety standards (HCEAC 2019; Remy, Speelman, and Swartz 2016).

To reduce the negative impacts of textiles while generating business opportunities and safe and just employment, circular business models can be implemented to keep products and materials “in-the-loop” for longer, allowing for extended use, repair, reuse, repurposing, and recycling, through the adoption of emerging technical and social innovations (EMF 2017; EEA 2021b). However, circular business models will require effective policies and changes in consumer behavior, among other enablers.

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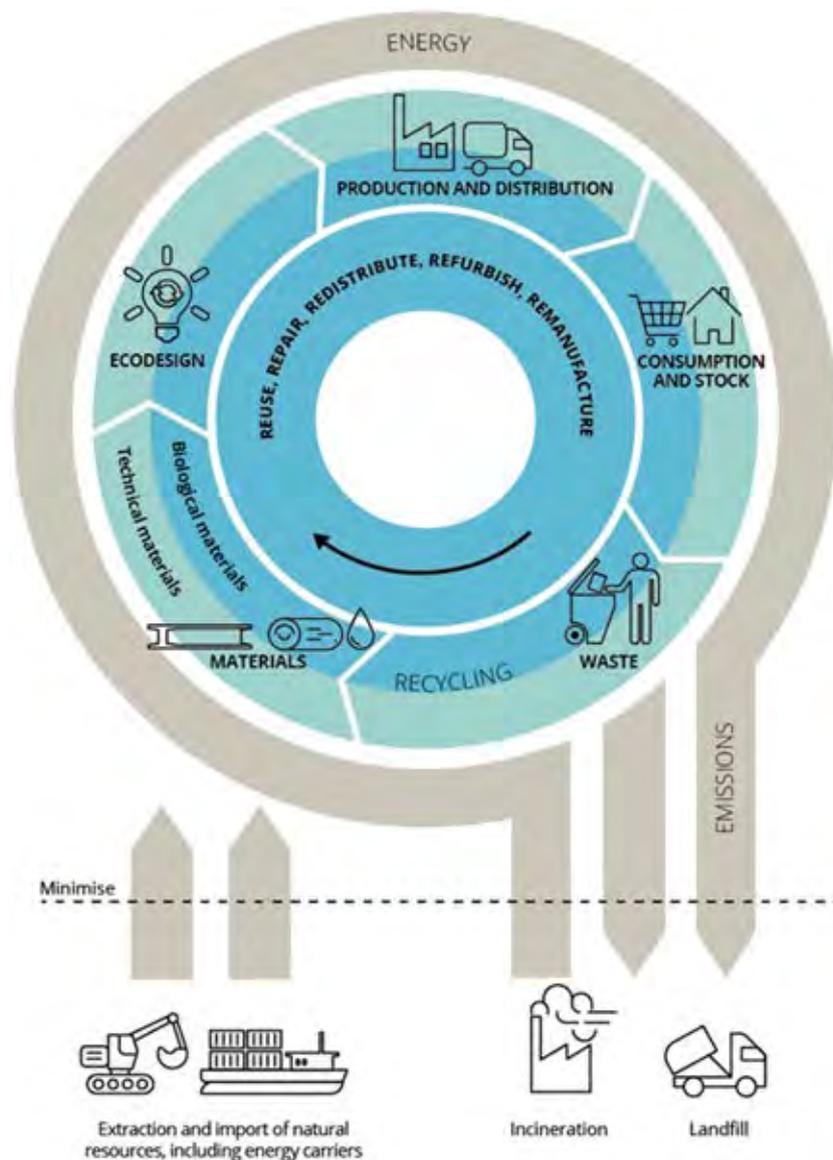


Figure 1. Simplified representation of a circular economy. *Source:* EEA (2021b).

Despite the increasing emphasis placed on circular economy and circular business models, for example in the European Commission's 2020 European Union Circular Economy Action Plan, only a limited number of tools have been developed so far to help navigate the rapidly evolving arena of circular business models and innovations, as well as for assessing circularity (EC 2018). Furthermore, besides addressing how innovations can be built into circular production and consumption patterns, there is a need to analyze how different enablers can support the scaling up of circular business models and increase their viability and market penetration. Collaboration across society by governments, companies, and consumers alike is essential to achieve truly systemic change and to accelerate the implementation of a circular economy by implementing innovations and circular business models.

In this vein, the European Environment Agency (EEA) developed a representation of the circular

economy that focuses on different phases in a product's lifecycle and the flow of materials and energy throughout it (EEA 2016). This representation was further developed in a report of the EEA Topic Center on Waste and Materials in a Green Economy (ETC/WMGE) (EEA 2019a) and in a briefing by the EEA (EEA 2019b). In this Brief Report, we describe a further evolution of this circular economy representation into a framework to describe and analyze circular business models in order to map and advance their implementation and scaling up. As an illustration, we apply the framework to the fashion and textiles sector, with a specific focus on the role of innovation at multiple levels, and on interactions between innovations, policy, and educational and behavioral change enablers. This framework, introduced in the EEA ETC/WMGE report "Business Models in a Circular Economy" (EEA 2021b), constitutes an orienting rather than a restrictive tool to study circular

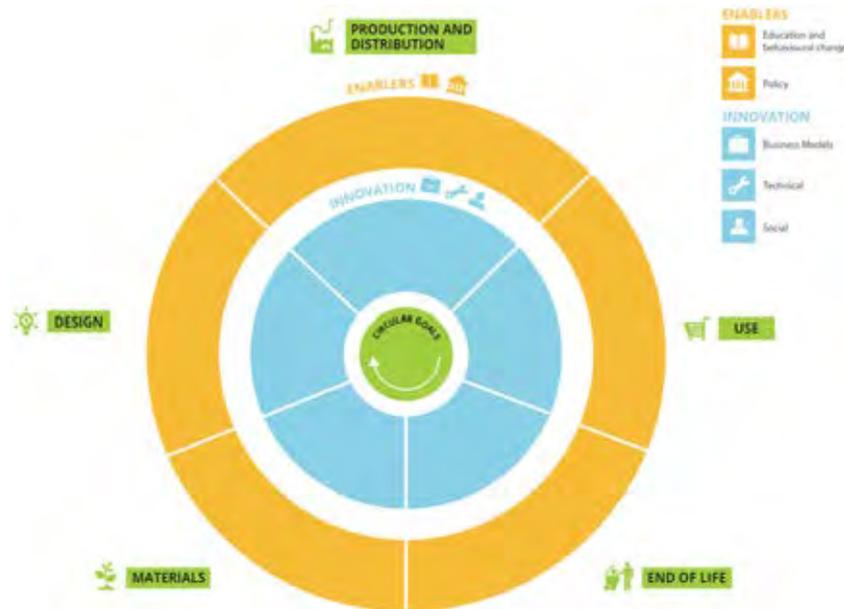


Figure 2. Framework for business models in a circular economy. *Source:* EEA and ETC/WMGE.

business models together with their systemic context. It is applied to explore potential business models for a circular fashion system, including a menu of options and needed transformations. This is useful to navigate the broad range of business models and technological and social innovations emerging in fashion and textiles. The framework can be used to map existing initiatives that aim to create circular business models and to identify which innovation aspects and/or enablers need to be addressed and/or are still missing. This discussion provides a basis for building and implementing coherent strategies for systems transformation: from the development of innovative products and processes to the mitigation of negative impacts.

Business models in a circular economy: a conceptual framework

The circular economy is one fundamental alternative to the linear take-make-consume-dispose economic model. This linear model aims at continuous economic growth and assumes (incorrectly) unlimited abundance of resources with widespread availability and access, as well as unlimited capacity of the environment to absorb waste and emissions. Instead, the circular model aims at minimizing resource inputs to the economy by reducing the use of new materials for production and extending the lifetime of existing products. This is possible through combining technical innovations, such as developing materials with less environmental impact and more efficient production processes, with new forms of consumption, such as longer use or service-based models, or by promoting the

repurposing, reusing, and recycling of products and materials.

A business model broadly describes how a business proposes, creates, delivers, and captures value for its customers and its wider group of stakeholders (Magretta 2002; Richardson 2008). A circular business model can be defined as one that acts within closed material loops (Mentink 2014) or one that combines the creation of economic value with the narrowing, slowing, or closing of resource loops (Bocken et al. 2016; Lewandowski 2016). Overall, circular business models can be seen as the means to realize circular goals such as longer use, reuse, or recycling, supporting the transition to a circular economy (EEA 2021b). Similarly, they can assist in the implementation of the 9R strategies for increasing circularity of the economy introduced by Potting et al. (2017), as they are based on smarter product use and manufacture (refuse, rethink, and reduce), extended lifespans of products (reuse, repair, refurbish, remanufacture, and repurpose), and useful application of materials (recycle and recover).

Among many representations of a circular economy, a simplified one has been developed by the EEA and introduced and discussed first in the 2016 report “Circular Economy in Europe” (EEA 2016) (Figure 1). In this depiction, circular economy goals are at the center of circular flows of materials (middle circle in Figure 1) that circulate throughout subsequent product-life cycles such as material extraction, design, production, distribution, consumption, and waste. Goals and materials are surrounded by another circle, representing circular flows of energy. Elements to be minimized are also represented, and these are emissions, incineration,

landfilling, extraction, and import (in the European context) of natural resources.

This representation has been further developed into a framework in the EEA ETC/WMGE report “Business Models in a Circular Economy” (EEA 2021b) where further levels (or circles) have been added, representing the innovations and enabling conditions that are needed to realize a circular economy (Figure 2). The framework has circular goals at the center (repair, reuse, recycling, and so forth), and it is structured into different life cycle phases (materials, design, production and distribution, use, and end-of-life). Innovations are shown in the first circle around the center (in blue in Figure 2), and are divided into three categories: business models, technical innovations, and social innovations that can contribute to the achievement of a circular goal(s) in a life cycle phase. A second circle is built around enablers (in orange in Figure 2), representing policy making, education, and behavior-change components which support the implementation and uptake of innovations, so they can scale up and foster a system transition.

In this framework, we can refocus business models as a mean for implementing circular goals and placing business-model innovation in the context of two other important innovation dimensions – technical and social. Technical (or technological) innovation can be defined as an iterative process initiated by the perception of a new market and/or service opportunity for a technology-based invention. Technological inventions thus need to be integrated into new markets and adopted by customers and users to be considered as innovations. Furthermore, being iterative, innovations are not static and imply cyclical improvements and reintroduction of inventions, as well as iterative adaptation processes by markets and users (Garcia and Calantone 2002; Griffin and Page 1993; Freeman 1991). Social innovations encompass the emergence and adoption of new solutions and processes that meet a social goal(s), while simultaneously reconfiguring behavior and modes of collaboration, thus leading to new or improved capabilities and relations, better use of assets and resources, and new organization models in addition to the development of new social norms that, once diffused and adopted, can lead to social change (Pue, Vandergeest, and Breznitz 2016; Howaldt, Kopp, and Schwarz 2016; EEA 2021b). Overall, both technical and social innovation are described as processes instead of end-states or linear strategies for business development. In addition to analyzing business models in the context of technical and social innovation, the framework acknowledges and

emphasizes the importance of policy, education, and behavioral change to enable innovation.

We apply the framework to the circular textiles system. The reason for this decision is that textiles have been identified as a key value chain in the EU Circular Economy Action Plan due to their considerable environmental impacts and potential for improved circularity. We analyze the following four approaches of circular business models for textiles, which are based on different principles of circular economy and often highlighted in the literature (e.g., Bocken et al. 2016):

- *Longevity and durability*: This business-model approach is focused on extending the lifetime of garments, thus reducing the need for purchasing new items and allowing for various modes of reuse. It is often combined with design for repair, customized production for promoting emotional product attachment, and offers of repair and maintenance services.
- *Access-based models*: These business models are based on renting, leasing, and sharing of garments. Examples include renting of workwear or hospital or restaurant linen, single-occasion clothing (including wedding or dinner dresses), and baby clothes (including reusable diapers) or leasing everyday-wardrobe sharing. Access-based models aim to lower resource utilization by increasing the use rate of the product stock.
- *Collection and resale*: Business models related to resale focus on extending the useful life of textiles beyond the first user. Textile-collection and resale models include secondhand retail as well as collection and resale to the market for reuse and recycling.
- *Recycling and reuse of materials*: These models emphasize turning textile waste into raw materials to produce new textiles. They involve reusing parts and cuts and producing recycled fibers for re-spinning and use in other products.

While not covering the whole range of possible business models in circular textile systems, the approaches above represent examples that are built around different circular economy principles. Each of them depends on multiple levels of innovation and relies on the design and implementation of enabling policies, as well as on education and behavioral change. Taken together, they contribute in different ways to the achievement of the goals of a circular economy (reuse, repair, redistribute, refurbish, and remanufacture). Via these examples, we aim to showcase how the framework described in this Brief Report can be used to map multiple elements that compose circular business models,

identifying connections between these elements and informing the definition of implementation strategies.

Business approaches toward a circular fashion

Approach I: longevity and durability

Current models of fast fashion imply cheaper garments, rapidly refreshing collections, and decreasing garment quality and durability. Over 70% of the climate impact of the fashion sector is generated by upstream activities, including raw material production, preparation, and processing. The remaining 30% is associated with downstream activities involving transport, packaging, retail, use, and end-of-use (GFA 2020). Furthermore, some impact categories for the fashion sector, including land use and negative social impacts (e.g., exploitation, unhealthy working conditions), are completely related to production. While extending the lifetime of garments involves more washing and drying – which increases energy use, water use, and use of detergents to maintain clothes for longer periods – these impacts can be offset by reduced volumes of production and waste. For example, lengthening the average life of clothing by nine months enables an approximately 30% annual reduction in carbon emissions, water use, and waste generation (WRAP 2017).

Circular business models based on longevity and durability seek to extend both the quality of garments and their lifespan through longer and multiple uses. In other words, these circular business models include strategies to enhance physical attributes (textile quality), as well as emotional durability of garments (how long people stay in love with their clothes and how long clothes stay in fashion) (WRAP 2017). These improvements reduce the need for buying and producing new garments, limiting environmental impacts and the generation of textile waste. Furthermore, enhancement of longevity and durability could potentially lead to higher product quality which in turn could contribute to greater customer satisfaction with garment purchases, increasing brand attachment and business profitability. Improving physical durability of garments is possible by using quality materials; relying on sturdy assembly methods; setting quality standards; choosing dyes, finishes, and processes to suit selected fabrics (instead of more generic ones); testing for quality; using labels with clear instructions for maintenance and care; and educating consumers to recognize and buy good quality garments (WRAP 2017). In addition, brands or third parties could offer repair and maintenance services and product guarantees.

To enable business models based on durability of garments, policies need to target design choices by defining quality requirements and increasing taxation on less durable products. Such policies should be informed by science-based evidence and existing guidelines that include, for example, the Jeans Redesign Guidelines developed by the Ellen MacArthur Foundation that set out minimum requirements to ensure durability, recyclability, and better environmental and social performances in jeans manufacturing (EMF 2021). Many brands are implementing actions for extending longevity and durability of their garments, for instance by using designs that remain fashionable, building attachment of customers to clothes using (e.g., with storytelling linked to support of social initiatives; see GEA Waldviertler 2020), engaging in environmental projects (Tentrée 2020), and creating personal connections with designers or producers. Emotional attachment to garments can also be built through personalized production such as tailor-made clothes or 3D body-scanning apps and other virtual platforms that also reduce returns from online shopping. There is a need for policies to align with these contributions and to facilitate actions for enabling circular business models for durability. This includes also regulating marketing, minimizing returns, and supporting peer-to-peer technologies, among other strategies.

Most of the above-mentioned options for extending longevity and durability depend on design and rethinking of what is valuable in garments: quality and durability versus low prices. The design stage is fundamental for implementing models based on longevity and durability. Design for attachment and trust, design for reliability and durability, design for ease of maintenance and repair, and design for disassembly are only some of the possible approaches to implement these business models (Bocken et al. 2016). The increased costs of more durable products can be justified by making consumers aware of future savings from avoiding frequent buying, by complementing the product with after-sale maintenance or repair services, and by facilitating secondhand markets for the product.

Among the enablers to business models based on longevity and durability, consumer behavior is important, requiring education about the economic and environmental benefits of using clothes longer and buying more durable garments, as well as awareness-raising about repair skills and maintenance practices for durability (such as suitable washing guidelines). Policies need to reinforce these potential changes in consumer behavior by actions such as reduced value-added tax (VAT) on repair services (recently introduced in Sweden; see



Figure 3. Innovations and enablers for circular business models based on longevity and durability. *Source:* EEA and ETC/WMGE.

Ministry of Finance Tax and Customs Department 2015), eco-design measures, and incentives for green public procurement, among others.

Innovation and enablers for circular business models based on longevity and durability can be represented in our framework (Figure 3), highlighting how these models require changes through the implementation of multiple technological, social, and business innovations in addition to specific policy and behavior-change enablers, along all life-cycle stages. The framework assists in defining coherent strategies that connect multiple levels of innovation with enablers. For example, starting from a technical perspective, innovations in materials and design – such as more durable fibers and design for durability and disassembly – can be combined with novel solutions for production and distribution, such as 3D printing. These changes require new skills in the workforce and alterations in the organization of production and retail. Production innovations lend themselves to integrating personalization tools (for example 3D body-scanning technology implemented on a smartphone) and can facilitate after-sales repair services (for example by reprinting worn-out parts from an existing file). Repair services need to be affordable and available, and consumers need to adopt the habit of choosing repair over buying new items. Such behavioral change can be supported by education, nudging, or marketing practices that embed sustainable behavior into new social norms. All of the above can be enabled within coherent strategies by implementing standards for durability, reducing taxes on repair, and taxing textile-waste production.

Approach II: access-based models

Access-based circular business models transform the way we acquire and use clothes, switching modes of consumption from ownership to use and return. While they mostly require changes in the design, production, distribution, and use stages, they also depend on key innovations in materials and end-of-life management (Figure 4). These models imply renting schemes for clothes and textile services including washing and maintenance, as well as more informal models such as wardrobe-sharing and swapping. The former models make products accessible and affordable to a wider market and are increasingly common for expensive garments used on special occasions. In such models, companies charge consumers with a periodic rental or leasing fee or on a pay-per-use basis. While these models can be combined with traditional business models, broadening the customer base of a business, they do entail a refocusing of business strategies toward providing logistics, take-back schemes, quality control, maintenance, replacement (when needed), and repair services.

Access-based models can reduce consumption by increasing garment-use rates and facilitating better maintenance, which in turn reduce the environmental impacts of production of new garments and can offer micro-business opportunities. However, the impacts of logistics and shipping and taking back garments have to be considered along with possible rebound effects as access-based models could lead to increases in the number of used garments.

Technological innovations that can play an important role in further developing and upscaling



Figure 4. Innovations and enablers for access-based circular business models. *Source:* EEA and ETC/WMGGE.

access-based models include more flexible and user-friendly sharing and renting platforms and product-tracking technologies. Development of durable and easy-to-maintain and refurbish materials is also fundamental for offering to customers high-quality products after multiple uses.

To enable access-based models, policies need to reduce taxation on maintenance activities, implement extended producer responsibility (EPR), and provide value-added tax (VAT) exemptions for sharing systems and incentives to startups with a focus on renting or sharing and that promote longer and more efficient use of garments and textiles. A shift to a different set of fashion retail/consumer relations and a change in fashion-buying habits is also needed. While renting provides a reduction in cost for acquiring the garment, it may also involve collateral costs for collecting and returning garments after use and committing to fixed dates for availability and returns (Watson, Gylling, and Thorn 2017).

Innovation and enablers for circular access-based business models can be represented in our framework (Figure 4). The figure highlights how these models require changes throughout all the life-cycle stages, with an emphasis on (and a broader range of options in) the distribution and use phases. In particular, this framework points to the fact that the end-of-life phase is often overlooked in access-based business models. Many access-based models can be rather linear and designed to increase consumption instead of decreasing it (e.g., Levänen et al. 2021). Especially in policy, attention should be paid to not just stimulating access-based models as such, but to make sure that these models live up to their

circularity potential by supporting and achieving the closing of material loops. In order to design coherent and comprehensive strategies for implementing access-based models, it is thus not only necessary to link innovations with suitable social change and viable business models. It is also essential to put in place enabling policies and supporting education, allowing for access-based models that stem from more sustainable materials and have reduced impacts at the end-of-life.

Approach III: collection and resale

Closing material loops is a fundamental principle of the circular economy. It is the one stage that turns linear economic models into circular ones (EEA 2021b). As a consequence, business models that target closing the materials loop are the ones most directly associated with the goals of circular economy to reuse, recycle, and reduce. These business models aim to exploit residual value by collecting waste products and preparing them for reuse and recycling, thus reducing the need for new production and virgin-material extraction (Figure 5). However, the extent to which reuse effectively contributes to reduced consumption of new products, or rather enables consumers to acquire additional products, is still unclear and needs to be further assessed. Studies estimate that on average about 60% of clothing reuse replaces new purchases, contributing to reduced consumption (Farfetch 2020; Farrant, Olsen, and Wangel 2010).

Collection of used textiles can be brand-selective (with companies taking back only garments they



Figure 5. Innovations and enablers for collection- and resale-business models. *Source:* EEA and ETC/WMGE.

have sold in the first place) or unselective (with companies accepting all textiles for collection). Take-back schemes can be operated by the brand itself or by third parties. Collected garments are checked for quality and resold at a lower price. In some cases, customers that provided the used item are compensated with a voucher or part of the resale revenue. Products that are not sold are usually returned to the customer or donated to charities.

Unselective collection of used textiles usually occurs through curbside collection or textile-waste containers operated by waste-management companies or charities. The disposed textiles are sorted, often involving social workers and volunteers, and sold on the global market. Only about 10% of collected items are reused locally (Watson and Palm 2016). In general, a large share of collected textiles is exported for reuse or recycling abroad, mostly in Africa and Asia. Textile-to-textile recycling is negligible (<1%) (EMF 2017) and most recycled textiles are processed into insulation materials (Islam and Bhat 2019).

Similar to what is observed for business models based on renting and leasing, logistics is a major component of business models predicated on collection and resale. Companies aiming to develop such business models typically face considerable costs for collection and sorting while reselling returns relatively low revenues.

Policy enablers for collection- and resale-business models include reducing taxation and providing support to rental services, secondhand retail, collection, and sorting activities, as well as defining and implementing reuse targets. In the EU, for example, the Seventh VAT Directive (2006/112/EC) ruled that

secondhand sales should be taxed on the basis of the difference between the purchase and the resale price rather than the full resale price (EEA 2021b). Innovation through automated sorting could lower logistics costs and lead to faster and more effective selection for reuse and up to double recycling rates per year (Ecotextile News 2019). Regional textile-sorting centers can also facilitate collection and can be designed to operate as wholesalers (HCEAC 2019).

From the customer perspective, acceptance of buying and wearing used clothes is still highly variable across countries. Recent consumer surveys and sales trends, however, indicate the possibility for a much larger switch of purchases to the secondhand market. A recent survey by ThredUp (2019) indicates that over the past four years resale has grown over 20 times faster than the apparel market and that today over 40% of consumers consider the resale value of garments and footwear before buying.

One promising option for enabling the resale market is to selectively locate secondhand stores in central shopping areas, making them more visible and contributing to creation of a mind shift among customers and retailers, while stimulating existing businesses to dedicate some of their space to secondhand sales (Watson et al. 2017). With regard to donations, a clothing tax-donation receipt can be created as documentation of charitable clothing donations and used by the donor to claim tax deductions similar to the provision available in the United States.

The EU has adopted an obligation for the separate collection of textile waste by 2025 (Directive (EU) 2018/851). Additionally, the EU Waste Framework Directive stipulates a combined target



Figure 6. Innovations and enablers for recycling- and upscaling-business models. *Source:* EEA and ETC/WMGE.

for reuse and recycling, and some member states are establishing more specific reuse targets (RREUSE 2016). Schemes based on EPR make producers responsible for bearing the costs of managing garment end-of-life and can increase the collection rate of post-consumer garments (EEA 2019a).

Our framework can assist in defining coherent strategies of collection and resale through the mapping of innovations and enablers in the life-cycle stages from distribution to end-of-life (Figure 5). For example, accessible reuse platforms could allow for enhanced sharing of garments and/or returning end-of-life clothes for resale. All of this can be enabled by increasing awareness about the quality and durability of secondhand clothes, as well as by implementing policies on reuse targets and EPR. However, collection- and resale-business models have to be complemented by recycling and material-reuse models (see the following section) for addressing all of the circular economy goals together.

Approach IV: recycling and material reuse

Textiles account for up to 22% of mixed waste worldwide (Nørup et al. 2019), and 92 million metric tons of textile waste are produced every year (GFA 2017). Fashion consumers today dispose of between 11 and 30 kilograms (kg) of textiles per person each year in European countries, the UK, and the United States (EEA 2019b; Dahlbo et al. 2017; Allwood et al. 2006). One out of every five garments ends up directly as garbage, without ever being sold or used (GFA 2020).

While waste is increasing as a result of fast fashion, textile-recycling rates remain low, partly due to lack of collection and sorting schemes, due to design and manufacturing processes that do not allow for high recyclability (e.g., textile blends) and also due to remaining technical and economic barriers to recycling processes. Globally, the recycling rate of post-consumer textiles was only 15% in 2015, and the share of textiles recycled into similar quality products is below 1%. Over 70% of textiles at their end-of-life are landfilled or incinerated, representing a missed opportunity for enabling circularity and adding value to garment products.

Circular business models based on recycling and reuse turn products that cannot be redeployed for their original purpose into raw materials for (re)manufacturing. This contributes to reductions in resource use in the textile-value chain and the negative impacts associated with the landfilling and incineration of textile waste (Figure 6).

The use of recycled materials can help to highlight value-proposition strategies that can in turn attract a growing, eco-conscious customer base. Some brands even emphasize the recycled content of their garments and make reused fabrics or parts as prominent elements of their product design, labels, product advertising, and marketing.

Looking at reuse of parts and fabrics, the labor-intensive and highly skilled manufacturing process of upcycling is still a barrier for mainstreaming material reuse circular business models (Singh et al. 2019). Training in technical and business-management skills, quality testing, and more effective infrastructure for collecting, sorting, and recycling are some of the areas

where further efforts are needed. Design-knowledge hubs and other physical or virtual platforms to showcase new approaches to design, produce, and market recycled and upcycled garments have the potential to enhance the visibility of innovators for sustainable fashion and amplify learning and sharing of successful approaches and practices for upcycling (e.g., the Closed Loop Fashion Knowledge hub).

Innovation for more effective recycling and design for recycling is also essential. Design for disassembly and using a sustainable material mix can greatly improve garment recyclability. Creative remanufacturing, which uses production leftovers on internal or external sections, to decorate new garments can reduce the use of virgin material by 17% and save about 8,000 kg of CO₂ during the production of 10,000 garments (Runnel et al. 2017). Chemical recycling, which preserves fibers more effectively than mechanical recycling, could increase fiber recycling by over 60%, allowing for the production of 100% recycled garments (Niinimäki et al. 2020).

To enable material reuse and recycling activities, policies need to incentivize the production and retailing of sustainable textile products and, at the same time, disincentive less sustainable ones. Taxes on virgin raw materials and recycled content thresholds need to be implemented to stimulate production modes which take full advantage of the potential of fiber to be recycled (EEA 2019b, 2021b). Taxes and bans on incineration and landfilling of textile waste would support the development of reuse and recycling (EEA 2019a). Clothing labels to encourage recycling of used garments could include a recycling message to a local charity or recycling center.

Innovation and enablers for circular business models based on recycling and material reuse can be represented in our framework (Figure 6). The framework allows for discussing synergies between innovations at different life-cycle stages and across technical, social, and business domains, as well as identifying their enablers, or the lack of them. In the use phase, for example, one enabler that could foster implementation and upscaling is to increase consumer preference for buying recycled garments over virgin-fiber garments. Furthermore, recycling and material reuse business models could be integrated with access-based models and models for increased longevity and durability through, for example, personalization and repairing services.

Conclusion

The development and successful upscaling of circular business models require alignment of different

types of technical, social, and business-model innovation, supported by well-designed policy and consumer behavior-change strategies and initiatives across the life cycle. In this Brief Report, we have proposed a framework that integrates these key components for a system transformation into a tool to analyze circular business models in a systemic context. We discussed possible uses of the framework by means of examples of four business-model approaches for textiles and fashion.

Policies are needed to enable changes in consumer behavior and to incentivize more sustainable design and production modes. Many of the policies identified in the framework complement and reinforce each other as well as other changes across fashion-value chains. These policies include durability and longevity standards and labels, taxes on fast-fashion products with short lifetimes, reduced taxes on repair, EPR schemes, and financial incentives to “slow-fashion” companies. In the absence of these policy enablers, behavioral changes and innovations will not succeed in limiting fast-fashion impacts and achieving a circular economy.

A comprehensive policy strategy for enabling textile and fashion circular business models will have to be designed considering the entire life cycle of products, with a focus on supporting new modes of acquisition of garments, creative remanufacturing, remaking, customization, prosumerism, and other emerging solutions for more sustainable fashion. Policies aimed at specific stages of the fashion life-cycle will have reduced impact if not complemented by initiatives at other stages. Policies should also reinforce education enablers and support the development of skills and consumer behaviors in line with different circular models.

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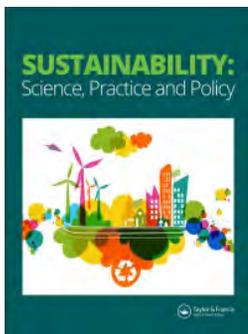
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Circular fashion: evolving practices in a changing industry

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ABSTRACT

Today we are witnessing a change in the production paradigm of the fashion industry. The negative impacts of different processes along the supply chain are evident and consumers have begun to shift to brands seeking effective organizational strategies and supply chain-management models that consider the safeguarding of the planet's resources and demonstrate respect for people. Impelled by these developments, fashion brands are moving from market-driven to purpose-driven strategies. The fashion industry is now recognizing the circular economy (CE) as the leading entrepreneurial model for addressing supply-chain issues related to sustainability. However, there are still gaps in the levels of environmental, economic, social, and cultural sustainability being achieved. Implementation of this model on a large scale is still in the early stages and recent experience indicates a need to rethink the current linear system to enable different actors along the fashion-supply chain to adapt. Further, the fashion system lacks a holistic vision that can support and guide this sustainable transformation toward CE. This article describes how several companies are currently implementing circularity and presents evidence that an emphasis on this concept is relevant for the global fashion industry. It aims to show how emergent design practices are supporting fashion companies to better focus their sustainability agendas, to approach them in a holistic manner, and to consider all business processes with the goal of implementing sustainable development strategies. Analyzing contemporary design-driven best practices, the article introduces a taxonomy highlighting effective ongoing strategies (mini-loops) leading to incremental changes toward CE. Furthermore, it synthesizes possible future trajectories that could lead the fashion system to finally close the loop of circularity.

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Introduction

Sustainability has emerged as a “megatrend” in recent years (Mittelstaedt et al. 2014) and in the international fashion landscape the shift toward a more responsible system has given rise to the prominence of sustainable fashion (Hultberg and Pal 2021; Pal, Shen, and Sandberg 2019). The public's engagement in sustainability is also increasing as consumers, especially in European countries, are calling on fashion companies to act responsibly and to consider the social and environmental effects of their businesses (Riesgo, Lavanga, and Codina 2020; Granskog et al. 2021). The shift in consumer behavior highlights the need to address the issues of fashion sustainability as they are becoming significant determinants in final purchasing decisions (Gazzola et al. 2020).

As Granskog et al. (2021) has reported, despite the deep uncertainty that the fashion industry has

experienced during the COVID-19 pandemic, there may be a silver lining for more sustainable performance. Several scholars have also speculated on whether the crisis might trigger a sustainability transition (Cohen 2020; Bodenheimer and Leidenberger 2020; Goffman 2020; Taylor et al. 2020). Further, as Uddin (2020) has remarked, the situation has been a “perfect storm” that has had extensive impacts on the global fashion system and its constituent networks. Fashion weeks were canceled, retailers closed, workers were laid off, and volumes of unsold stock increased. The direct result was that an expanding share of the fashion industry fell into financial difficulties (Granskog et al. 2021). Additionally, the pandemic further eroded the already precarious social dimensions of the fashion industry. Several global brands were forced to cancel orders and payments for garments that had already been produced and these outcomes had a devastating impact on

manufacturers who faced losses in the billions (Anner 2020).

From the perspective of today, the current stage of the pandemic could be an opportunity for the fashion industry to strengthen its sustainability commitment and to accelerate industrywide changes to business strategies that displace the currently unsustainable linear system and begin to move toward a circular model (Casey 2021). This positive momentum has increased the visibility of the industry's sustainability agenda that has developed over the past four decades and emphasized the need for collaboration among industry, governments, and organizations to implement strategies focused on sustainability-related issues (Thorisdottir and Johannsdottir 2019). The signing of the Fashion Pact, a document presented to world leaders in 2019 at the 45th G7 Summit held in Biarritz, France, was initial evidence of this shift.¹ The pact's signatories—companies in the fashion and textile industries including their suppliers and distributors—pledged that their businesses would follow science-based objectives and operational changes to meet the Paris Agreement. The objectives of the accord center on three major issues: climate, biodiversity, and oceans (Mohr, Fuxman, and Mahmoud 2022; Pastran, Colli, and Nor 2021).

As an industry, fashion has followed the general evolutionary pattern of the world economy which in recent years has been characterized by emergence of competitive and unsustainable linear business models dominated by the globalization of markets and a subsequent overabundance of supply. This situation has led to the rise of new financial scenarios. Over the course of the past ten years, more responsible and market-driven companies have emerged with the goals of ensuring more effective coordination between supply and demand, developing new products, and organizing the physical flows of exchange and communication between companies and their customers (Voola et al. 2022; Beverland, Cankurtaran, and Loussaïef 2022; Wong and Ngaiy 2021; Crittenden et al. 2011). A primary factor motivating these initiatives has been the need to react to market trends (sustainability and transparency) and/or to respond to the evolving behavior of customers (e.g., prosumers, so-called LOHAS consumers).²

More recently, these approaches have given way to purpose-driven companies in which every business decision is consistent with a set of core values. These firms strive to demonstrate strategies that meet their business objectives and to create a suitable environment for their customers and employees. Purpose-driven companies set their objectives beyond mere profit as an end in itself and innovate

continuously to increase their positive effects on people, the territories in which they operate, the environment, and the full range of their stakeholders (Gartenberg 2022). Notable examples of this commitment are brands such as Patagonia, Stella McCartney, and Ecoalf.³ What distinguishes these companies is their voluntary choice to produce in a way that achieves their profit objectives and, at the same time, provides social and environmental benefits. These purpose-driven businesses are motivating others in the fashion industry to begin to formulate reliable strategies to reduce their adverse influences. This new attitude provides incentives for circular behavior—for instance designing and performing according to the 9Rs framework for progressively increasing the circular economy (CE) (Potting et al. 2017)—and calls for a clear focus throughout the entire organization on circularity as well as throughout the whole production process (Enquist and Sebhatu 2021).

This article addresses the role of design in reshaping the fashion supply-chain to enhance circularity. A purpose-driven model is inherently design-driven, as it has a design goal. The process of design is applied to develop strategy, to solve problems, and to create values. In the emergent sustainability transition, the role of design becomes strategic in its technical function in planning the fashion-system circle(s), reinforced by evidence that most sustainability benefits are obtained from procedures and processes implemented at the design stage (Bocken et al. 2016).

In the current context, design-driven strategies refer to those “design thinking practices” that leverage the different internal systems governing a company such as policies combined with procedures created by management (Verganti 2009). These interventions go beyond customers and consider “intermediaries” who understand and profoundly shape the markets in which they work (Rainville 2021; Verganti 2009). A design-driven perspective also enables a comprehensive and purpose-driven approach to circularity that can contribute to the establishment of feasible and common strategies among businesses, stakeholders, and communities (Battistella et al. 2012).

Grounded in this perspective, this article presents the results of an investigation of how fashion companies, particularly firms based in Europe, are addressing the circular transition with the support of design knowledge. The work presented here refers to the circular fashion field which is defined as a regenerative system that utilizes waste and transforms it into new products and useful resources. This system seeks to achieve a supply chain in which disused textiles

are collected, recycled, and remanufactured into new products (Bocken et al. 2016; EMF 2017; Geissdoerfer et al. 2018; Niinimäki 2018; Rathinamoorthy 2019).

We address specifically how circularity has been applied by small- and medium-sized enterprises (SMEs) that represent a majority of businesses in the European fashion sector and are considered key actors in leading change toward a circular fashion system. As reported by Black (2019), the size of these companies and their relative newness compared to the rest of the industry are strategic assets. Of special importance is their flexibility with respect to responses to evolving market conditions and demands (Cernat et al. 2014). As a result, many SMEs in the European fashion sector maintain a dynamic approach that allows them to guide systemic circular transitions. According to the CE framework, this is happening by keeping products in circulation at their highest value, designing and manufacturing them to be used again, and making garments from safe and recycled or renewable inputs (EMF 2020; Black et al. 2019).

The objective of the article is to report on how several firms are performing circularity—all along their supply chains—by focusing separately on two main aspects: (1) raw materials sourcing/production and (2) manufacturing. We discuss how these firms are able to strategically manage a single dimension of sustainability but continue to struggle to combine all facets in ways that will lead to the co-creation of renewed sustainable value to be re-input into the fashion cycle.

The second section presents our framework for defining the meaning of circularity and explaining how it applies to the fashion system. The third section then illustrates the methodology. We describe how design is strategically guiding development of a circular model for the fashion industry. This section also discusses how current circular strategies need to be supported by design to improve productive processes and to enhance associated practices for fashion. The fourth section introduces the results of the investigation and centers on final formulation of a taxonomy to visualize current circular behaviors in the fashion field. What emerges from this section is the identification of current working trajectories to determine the design directions that are driving the fashion industry toward circularity. The taxonomy identifies two main mini-loops related to two macro design-driven approaches to circularity: (1) raw materials and (2) manufacturing practices. The fifth section highlights exemplary best practices of companies that are operating along the two micro-loops by practicing circularity. We then conclude by describing how our model creates

opportunities for further research. This section outlines how design could support the creation of an industrial ecosystem based on sustainable synergies and proposes practical examples of interventions for enabling the fashion industry to close the loop of circularity.

Addressing circular innovation in the fashion system

The current fashion-production model does not consider all stages of a product's life cycle, but only those useful for capitalist purposes (Stahel 2016). It is an approach that produces an enormous amount of waste and has various adverse effects on the environment. Further, viewing such processes through the lens of economics, this mechanism results in a loss of value immediately after its creation, which represents a missed business opportunity. This article reports on changes in the production paradigm of the fashion industry that show a transition toward circularity. According to this shift, designing for circularity is becoming a common goal of a growing number of firms. Therefore, the challenge of creating truly circular products within the fashion- and textile-supply chain appears to be one of the relevant steps to use materials more effectively and to preserve the planet's finite resources.

Yet, what does circularity mean? The concept of circularity derives directly from the domain of economics in which scholars first began to develop theories about the so-called “circular economy” as a response to the impacts of a linear production model based on the triad of “source-make-dispose.” Such a definition highlighted the limits of the prevailing approach based on ecological and social requirements (Stahel and EMF 2019; Stahel 2010, 2016; EMF 2017; Raworth 2022; European Commission 1976).

This linear approach also corresponds to a specific design strategy that focuses exclusively on the product itself (Aho 2016), only considering the resources available, driven by the need that a consumerist market imposes to produce and sell ever-larger volumes of products without considering what happens to them after they break or become obsolete. In contrast, the CE model emphasizes rethinking the concept of growth and introducing a different perspective on the benefits necessary for a society to flourish. Such an approach implies gradually separating economic activity from the consumption of finite resources by reconsidering the design process in ways that avoid the production of waste (EMF 2017). Therefore, the circular model is intended to simultaneously grow economic, natural,

and social capital, and, as stated by the Ellen MacArthur Foundation (EMF) (2017), is based upon three objectives: designing out waste (DoW) and pollution, developing strategies to keep products and materials in use, and regenerating natural systems.⁴

To reach these circularity goals, it is crucial to limit the loss of value embedded in products and materials by keeping them circulating in closed cycles. These cycles aim to extend the life of products and to improve resource use. Once a product has reached the last stage in its cycle, its components, or a given set of materials, are put back into the cycle. This reuse could entail recycling resources, recovering different parts of the product, or reclaiming materials to continue their life through other forms.

In fashion, a circular design structure serves as a sustainable alternative in comparison to the previous generation of products and materials, being able to minimize resource inputs into the system and waste, emissions, and energy leakage out of it (Ostermann et al. 2021). This approach aims to mitigate adverse effects without compromising growth and prosperity (Geissdoerfer et al. 2018) and can be embraced by the fashion industry through specific supply chain-management strategies. These interventions can be implemented to offer opportunities for effective pathways toward a circular change in the system. They are primarily based on companies optimizing resources within their supply chains and working on solutions to solve unsustainability issues and excessive consumption patterns by focusing on decreasing the use of primary raw materials, avoiding waste production, and regenerating the systems involved.

Moreover, as Pal (2017) argues, the circular strategies of fashion companies tend to be structured according to Bocken's eight key sustainable business-model archetypes: maximizing material and energy efficiency, creating value from "waste," substituting with renewables and natural processes, delivering functionality rather than ownership, adopting a stewardship role, encouraging sufficiency, repurposing the business for society/environment, and developing scale-up solutions.

These business-model archetypes are now being tested in the market and can be found in new production and consumption paradigms. For example, they are evinced by the trend of developing efficient and effective solutions to extend the life of clothing: garments are now being rented and leased or, alternatively, brands themselves are increasingly offering free repair services to extend the life of products. These solutions have a dual effect: they satisfy customers emotionally and reinforce business value

(Niinimäki 2018). A pivotal example is offered by Patagonia with its service "Worn Wear" that provides free repair to consumers who bring to one of the company's shops a used (and worn) garment, regardless of its brand.⁵ Anyone can take advantage of free repairs of Gore-Tex garments, zippers, zipper flaps, buttons, punctured or torn fabrics, and more. The "Worn Wear" campaign is designed to encourage people to take care of their garments and to fix them if necessary to ensure that they last as long as possible as well as to educate people on how to care for their clothing to extend its functional performance. This "Worn Wear" initiative is consistent with the goal of the circular economy to adopt a new, more strategic, and future-oriented perspective in all aspects of a company's activities and to highlight how "repair is one of the strategic operations to keep products in use and could be coupled with business models such as rental and re-commerce" (EMF 2020, 6).

Hence, the business-model archetypes that have to date been introduced are inspiring the transformation of industrial systems in the textile and fashion industry and they are instrumental in leading to circular development through timely interventions that companies are incorporating into their approaches. At the same time, these archetypal interventions show the tendency of companies to operate through compartmentalized processes and systems: they still lack an overall vision of the fashion-supply chain and the intrinsic characteristic of holism required for circularity. Both knowledge and circular industrial practices are fragmented and thus require guidelines to make the ongoing and future initiatives more streamlined and effective. Furthermore, the fashion industry is facing severe constraints in implementing a circular system and its inherent strategies.

Considering this scenario, the following section illustrates the current state of circularity implementation in the fashion industry through field studies, aiming to better clarify the key role of design in driving toward a circular transformation. Drawing on the findings of the field studies, we highlight how design is embedded in thinking strategically about the circular model's development and show how current circularity strategies need to be guided by design to improve production processes and to enhance circular visions for fashion.

Methods

The insights for this article are drawn from three field studies that we conducted between 2019 and 2022 (Williams et al. 2019; Black et al. 2019). The

aim of these projects was to collect and incorporate knowledge into an interpretive model of how circular practices are embedded in the current fashion system. The first phase of the research consisted of mapping the sustainability-related practices of nearly 200 fashion companies in 24 European countries. These businesses have distinguished themselves by having reached a mature stage in their sustainability performances which has resulted in operating according to innovative approaches that progressively move away from greenwashing and become effectively viable and strategic (see Figure 1). The companies that we identified are heterogeneous and included fashion and textiles companies that have implemented sustainability not only in design but also in their management and technological practices. Further, consistent with the typical scale of actors in the European industry, most of the firms that we analyzed were SMEs, which means that they keep their revenues, assets, and number of employees below a certain threshold—generally less than 250 employees and €50 million in revenues per year (Black et al. 2019).

Among the 200 companies that we mapped, 45 were selected as case studies due to the advanced level of their sustainability transformation—applying in their practice a reformative approach that fosters how their key personnel think and work with sustainability (Sterling 2010)—and their specific method in implementing circular practices, often adopting a design-thinking approach as a driver. A design-thinking approach means fostering a positive impact of design on competitive advantage through an iterative process that creates sustainable values through the product and includes utilitarian,

emotional, psychological, and sociocultural considerations (Verganti 2009) (Figure 2, Table 1).

The case-study database that we built included numerous sources from desk research involving company reports, scientific papers, specialized press accounts, and government publications. The case studies aimed to narrow down a vast field of research into easily researchable topics and they were chosen according to several criteria: (1) the commitment these companies place on proactively meeting the new sustainability demands of their stakeholders, (2) how they pursue strategic implementation of sustainable practices within their system by adopting a design-driven approach that means generating ideas that are humanly desirable, technologically feasible, and financially viable, (3) their dimension, since the study was intended to be as representative as possible we wanted to have cases from a range of companies (from micro- to medium-sized), and (4) the scalability of their practices which involved selecting companies that were representative of the different methods and technologies for textile-waste recycling so as to enable us to understand the state of the art.

The processing of these resources was based on content analysis (Duriau, Reger, and Pfarrer 2007) to identify recurring patterns and to allow us to find associations between how different circular practices are carried out. We defined the units of meaning—the frequency of individual words and phrases according to the set categories for coding: circular practices, sustainable materials, fashion design sustainable practices, product recovery, and waste collection. The analysis phase allowed us to start to draw the frame of our taxonomy of current circular practices in the fashion-supply chain. We identified



Figure 1. Map of the sustainability-related companies.

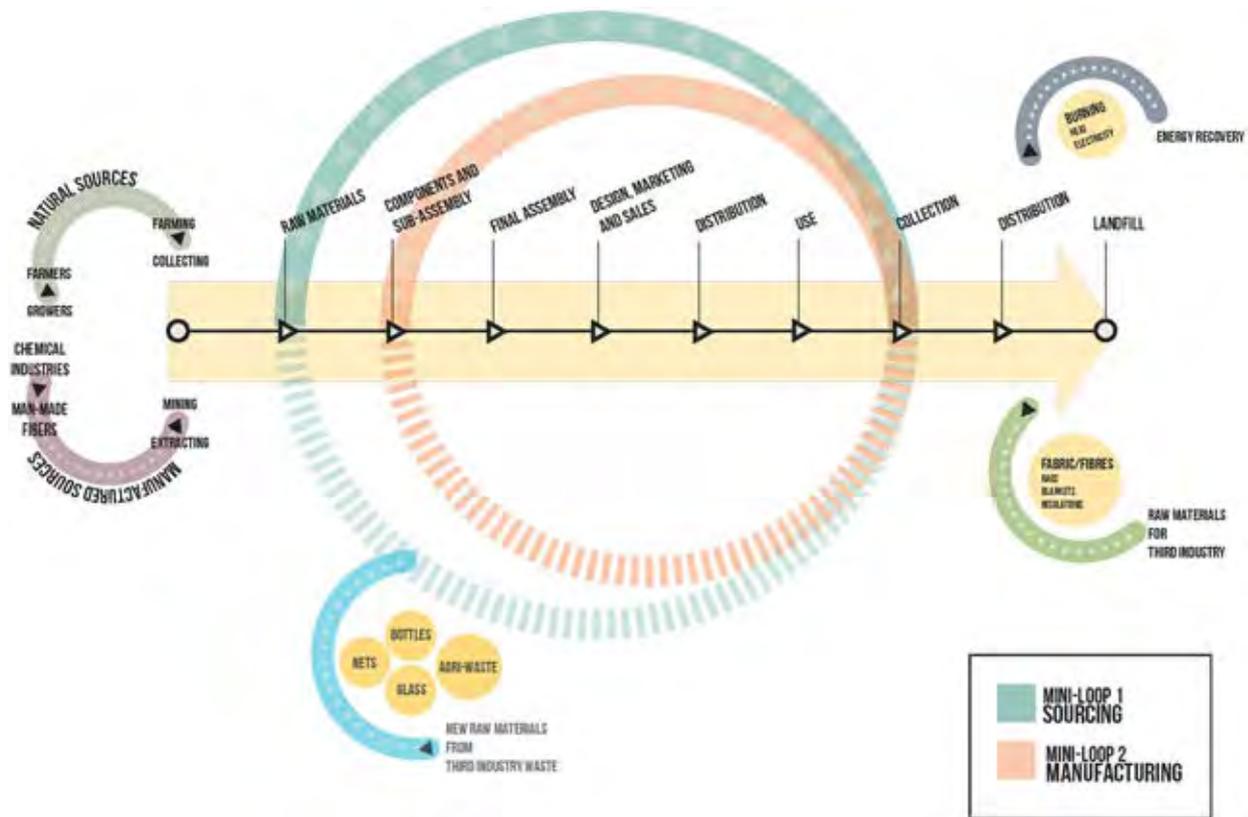


Figure 2. The mini-loops model.

Source: Adapted from D'Itria (2022).

the three steps of the supply chain where the circular practices were performed with the greatest frequency, namely raw materials supply, product manufacturing, and waste collection and management. This further research phase allowed us to better refine the model and to identify the specific design-driven circular fashion approaches that are currently being carried out within the fashion- and textile-supply chain.

We conducted a further qualitative phase after the case-study analysis based on interviews with the selected representatives of the previously identified 45 companies. The interview selection was based on an additional desk-research phase to better profile the companies and to identify the varying degrees to which firms have incorporated circular features into their operations (especially with respect to the optimization of materials and products). We then characterized each of the case studies according to the level of commitment of each company to satisfy the requirements of circularity. More specifically, we focused on how firms were actively seeking to practice sustainable design to reduce the life cycle impacts of their products and to keep the resultant materials in a closed loop. The evidence we collected enabled us to create a taxonomy of current circular production practices in the fashion field. The resultant typology is a first

attempt to understand how specific design-driven approaches can support the transformation toward circular fashion.

Identifying design-driven circular fashion approaches

Based on the qualitative research findings, this section explores the role of design in leading to systemic circular changes in the fashion and textile industry. It is initially crucial to understand the main systemic barriers to implementing circular fashion practices. These obstacles have been discussed extensively in the literature and can be synthesized as follows:

- A lack of awareness on the part of companies and inadequate education of the workforce regarding circularity (Dissanayake and Weerasinghe 2022).
- Firms continue to consider recycled materials to be a new niche market and is thus more expensive, entails lower quality, and is less performative than virgin counterparts (Jia et al. 2020).
- Recycled textiles have no economic benefits and/or market opportunities (Leal Filho

Table 1. List of case studies.

Country	ID Code	Sector	Mini-loop 1 (raw materials)	Mini-loop 2 (components and subassemblies)
Austria	C1	Materials/fibers	x	
Austria	C2	Materials/fibers	x	
Belgium	C3	Materials/fibers	x	
Czech Republic	C4	Production		x
Denmark	C5	Materials/fibers	x	
Denmark	C6	Materials/fibers	x	
Estonia	C7	Clothing		x
Finland	C8	Materials/fibers	x	
Finland	C9	Materials/fibers	x	
Germany	C10	Materials/fibers	x	
Germany	C11	Recycling	x	
Germany	C12	Materials/fibers	x	
Germany	C13	Recycling	x	x
Greece	C14	Materials/fibers	x	
Ireland	C15	Clothing		x
Italy	C16	Materials/fibers	x	
Italy	C17	Materials/fibers	x	
Italy	C18	Materials/fibers	x	
Italy	C19	Clothing		x
Italy	C20	Clothing		x
Italy	C21	Recycling, upcycling		x
Italy	C22	Material innovation, research and development		x
Italy	C23	Material innovation		x
Latvia	C24	Clothing		x
Luxembourg	C25	Clothing		x
Netherlands	C26	Materials/fibers		
Netherlands	C27	Clothing	x	
Netherlands	C28	Materials/fibers		x
Netherlands	C29	Materials/fibers	x	
Netherlands	C30	Materials/fibers		x
Portugal	C31	Materials/fibers	x	
Portugal	C32	Materials/fibers	x	
Portugal	C33	Materials/fibers	x	
Romania	C34	Recycling		x
Slovakia	C35	Clothing		x
Spain	C36	Materials/fibers	x	
Sweden	C37	Materials/fibers	x	
Sweden	C38	Materials/fibers	x	
Sweden	C39	Technology	x	
Sweden	C40	Clothing		x
Sweden	C41	Clothing		x
UK	C42	Clothing		x
UK	C43	Materials	x	
UK	C44	Materials/fibers	x	
UK	C45	Materials/fibers	x	

et al. 2019). Technologies for material detection and sorting are still in the preliminary research and development stages and the industry is still forced to rely on manual sorting operations that require expansive and extensive labor involvement (Sandwick 2019).

- There is a lack of textile-to-textile recycling technology. Modern textiles are made with diverse materials, colors, and finishers and scaling up the recycling process—both chemical or mechanical—is challenging in terms of technical obstacles and economic feasibility (Pedersen, Earley, and Andersen 2019).
- There is a lack of consumer interest and awareness (Kirchherr et al. 2018).
- There is an absence of adequate collection and sorting schemes to guarantee circular processing at the end-of-life stage (Dissanayake and Weerasinghe 2022).

The fashion sector's circular solutions should be centered on building long-lasting products that embed as a feature the possibility of feeding cascading loops through regeneration or recycling to circulate materials and to create value across different supply chains. But, as Theeraworawit, Suriyankietkaew, and Hallinger report (2022), companies today tend to ignore the interconnected nature of supply chains and they resist adopting holistic approaches that acknowledge that actions taken at one stage are passed on to the next. The key goal of this study is to show how the transition to a circular system can be enabled and empowered by intervening at the design stage and highlighting how the most currently successful design strategies are being adopted by the fashion industry. These design strategies were codified from the processing of the data collected and the results of the mapping process, the analysis of case studies, and then validated by a qualitative survey through interviews to

identify and describe the most promising fashion-design practices.

The taxonomy visualizes current circular behaviors in the fashion and textile field and shows two main promising design approaches currently associated with a circular supply-chain model: (1) Design focused on materials with high sustainable performance characteristics and (2) Design focused on enhancing durability through manufacturing strategies such as recyclability, upcyclability, and refurbishment. These circular approaches need to be investigated in today's fashion and textile systems. With this in mind, the most ambitious aim of this article is to present a realistic picture of circular systems. The greatest challenge lies in the fact that to date the fashion and textile industry operates in accordance with a linear paradigm. The two emerging design directions that can promote circular perspectives result in cyclical inputs positioned along a supply chain based on a linear model. They are represented here as two mini-loops related to the two macro areas of intervention for circular practices from a design perspective:

- Sourcing that addresses all the aspects related to strategies that focus on design-driven solutions based on the production and use of materials with high sustainable performance characteristics. This loop starts in the raw materials step and re-enters the system in the collection phase.
- Manufacturing refers to design-driven practices that enhance circularity through production strategies based on reusing and transforming resources and materials. This loop starts in the production phase and re-enters in the collection step.

Figure 2 shows the current linear fashion-supply chain. On this line are positioned the external actors who supply raw materials at the beginning of the system, whether of natural or artificial origin. At the end of the line are actors who recover waste from the sector either to transform it into energy through thermal valorization practices or to reuse it as a secondary raw material in their supply chain through industrial synergies (e.g., the building-materials industry transforms textile waste into carpets or insulation panels). Regarding internal supply-chain phenomena, our research describes how mini-loops are inserted along the production chain to create circular phenomena. From this representation, it is also clear how industrial synergies can occur along these diagrams, on Mini-loop 1, by collecting waste from third industries

as new raw materials (i.e., plastic-industry waste is recovered to produce recycled polyethers).

We discuss in the following sections the two mini-loops to elaborate on how their relative design direction influences the supply chain, generates values throughout, and facilitates circular experiences for the involved companies. A subsequent presentation of best practices further supports these design-driven paths.

Mini-loop 1: Sourcing

Mini-loop 1 represents all design practices which have been enabled by the introduction of several disruptive innovations related to materials such as production practices in recycled fibers and embryonic process technologies related to sorting and recycling (Sandvik and Stubbs 2019). The industries operating in Mini-loop 1 are striving to be more restorative and regenerative in the flow not only of products but also byproducts and waste by narrowing, slowing, and closing resource and energy flows (Bocken et al. 2016).

Companies that operate in this loop are differentiated by their ability to overcome sectoral barriers including technical constraints, institutional inertia, and the scalability of their technologies or circular business models. Generally, these are textile SMEs investing in hyper-sustainable technologies—machinery and equipment developed from the application of scientific knowledge to produce resource-efficient technology and to drive activity that increases investments and growth while substantially reducing sustainability impacts—to produce, recover, and transform raw materials from existing biological or technical cycles. Adapting the notion of upcycling as introduced by McDonough and Braungart (2002), on one hand, the biological cycle includes biologically-based biodegradable raw materials obtained from natural resources. On the other hand, the technical cycle comprises human-made materials, environmentally hazardous materials, and rare metals used, for example, in electronics.

These companies have refined traditional production practices or experimented with new radical processes gaining traction and reaching a higher level of sustainability compared to traditional ones. They have designed or redesigned their products in ways so that they usually require fewer resources and have a reduced impact on the environment, communities where they operate, and people. These firms have enabled important transformations by focusing their circular practices on redesigning materials or creating new ones by focusing on materials design and

related methods to empower the whole design process and to represent the initial step in creating sustainable items.

Mini-loop 2: Manufacturing

Mini-loop 2 represents all design practices in the fashion and textile industry that are aimed at reducing the dependence of firms on natural resources and enhancing manufacturing practices by reclaiming surplus, unexploited materials, or used products. These companies conduct research and develop innovative production practices to achieve performance that is equal or superior to the processing of virgin products and, in turn, minimizes the need for raw resources. These outcomes can be achieved by exploiting the reverse side of the fashion-value chain and specifically focusing on collection, sorting, and processing.

First, the collection phase consists of recovering the products that consumers discard (Paras, Curteza, and Varshneya 2019). Second, the sorting phase involves the selection of disused products according to their condition or type (Geissdoerfer et al. 2018). Finally, the processing phase involves different design-led actions intended to re-establish the function of the products and/or materials and to increase their value (Abraham 2011).

Companies that operate within Mini-loop 2 cope with industry issues such as dealing with inadequate infrastructure available for managing material waste generated by the fashion industry, facing the limitations of current regulations that were designed for a linear system and do not incentivize or enable circular practices, and reconciling consumer misconceptions about extended product life and secondhand materials or garments.

These companies, primarily SMEs, are investing in design-led practices to reduce dependence on natural resources and to enhance the reuse of items by increasing their value. As Murray (2002) stated, these practices are intended to preserve the planet's virgin and limited resources and to leverage the hidden value embedded in the recycled product by exploiting the potential of design knowledge to make this value explicit and to enable recirculation.

In this context, it becomes crucial to consider the waste hierarchy. To fully implement circularity in the textile and fashion industry, it is necessary to engage in upcycling and recycling on an industrial level (Khamisani 2021; Cassidy and Li-Chou Han 2017). Upcycling is a design method that offers the opportunity to circulate leftovers in production through new design processes. In turn, the waste left behind

during upcycling is recycled and returned to the loop of the fashion industry or to third-party sectors.

Best practices for implementing new circular processes in the fashion system

Starting from the mini-loop model, we further explored its potential by conducting several field studies. We initially focus on two emblematic cases of the respective mini-loops: Vegea⁶ (Mini-loop 1) and UPMADÉ⁷ (Mini-loop 2). In addition, we present a third “hybrid” case study involving a firm called Re:newcell which was selected for its ability to exploit the characteristics of the two cycles and to merge them to refine and implement circularity.⁸

The sourcing loop: Vegea®

Vegea is an Italian company that has developed a leather-like coated fabric. The company began by studying the physical and mechanical characteristics of various vegetable fibers and assessing their ability to be transformed into new leather-like materials. This first phase enabled the identification and production of new fibers obtained from grape skins and seeds. These raw materials, which are byproducts of the wine industry, have proven to be optimal for feeding an innovative production process that converts the waste and vegetable oils embedded in the pomace (the pulpy residue that remains after crushing) into a unique material. The technology does not require waiting for the seasonal rhythms associated with the grape harvest. After the pomace is pressed and separated, it is dried to avoid biodegradation. This process ensures that the materials maintain their properties unaltered for at least three years and hence remain readily available to be transformed.

The name Vegea comes from a combination of Veg (Vegan) and Gea (Mother Earth). It refers to the next generation of sustainable materials and capitalizes on renewable resources as an alternative to animal-based materials and nonrenewable fossil resources which are the source of almost all synthetic alternatives to animal skin. Vegea designed its process outside of common sectoral barriers by also embracing a collaborative model involving public and private contributors and allowing for the establishment of synergies and partnerships with local industry and research actors.

After the success of its first prototype, the company continuously invested in research and development to create innovative technologies and processes capable of minimizing the negative effects on the

environment. The aim has been to establish new production chains to valorize biomass and agro-industry residues. This waste is a valuable raw material that can be transformed into new fashionable products. For this reason, the company has established strategic collaborations with Italian wineries to set up a process to recover their production as raw material for the Vegea process.

Vegea is an emblematic example of a company that has promoted innovative industrial ecosystems starting from waste streams. The new production chain provides better valorization of ecosystems, creation of self-reliance, and development of greater circularity in production, distribution, consumption, and recycling methods. In this context, Vegea has responded to the challenge of overcoming barriers in its supply chain to enable systemic learning and to create and produce new fashion solutions with greater eco-efficiency that reduce and utilize food waste as a resource to explore material creation opportunities.

According to the Micro-loop 1 parameters, Vegea has differentiated itself by overcoming its own sectoral barriers such as technical constraints and environmental impacts and experimenting with a radical new process. The company's production practices are much more sustainable than traditional ones, as their products are based on 100% sustainable resources and have a positive impact on the environment and the people involved in their supply chain.

The manufacturing loop: UPMADÉ® system

The UPMADÉ system is designed to introduce the circular economy into the fashion and textile industry. It allows brands and manufacturers to apply the industrial upcycling method and to obtain certification by designing and producing new eco-friendly clothing made from surplus materials. UPMADÉ provides a solution that supports in a real and practical way the goal of circular economy to design and in turn produce zero waste. According to Aus et al (2021), between 24.7% and 39.2% of the textile material sourced for customary clothing production is wasted. The UPMADÉ method closes the loop by applying upcycling on an industrial scale and reducing textile waste, allowing the conversion of otherwise wasted materials into valuable and sellable products (Aus 2011).

Jointly created by the second author of this article in cooperation with the Stockholm Environmental Institute Tallinn, the UPMADÉ system aims to use textile upcycling on an industrial scale by creating garments made entirely from production residues that are 100% upcycled. This maximization of

resources leads to energy, water, and other resource savings by avoiding the production of new materials.

The UPMADÉ system consists of software, design tools, and a certification process. Using production, fabric, and design information from the brand's original order, the UPMADÉ software conducts waste analysis (to determine what kinds of leftover materials are available) and environmental analysis (to determine what resources can be saved because of upcycling). This is a unique kind of gap analysis. Using specific production data, a new upcycled product is created, leading to a physical sample. Each sample is presented with the results of a life cycle assessment. At the end of the process, the UPMADÉ system issues a certification for the manufacturers and validates that recycled products are made from production residues, fabric waste does not contain harmful chemicals, and production operations are socially responsible, meet workplace-safety requirements, and do not use child labor. UPMADÉ certification gives brands and retail companies a choice between manufacturers that are proven to deliver custom-made upcycled products and consequently allows brands to increase transparency with their customers who are increasingly seeking this information.

In 2014, UPMADÉ certified its first garment producer in Bangladesh and saved nearly 175 million liters of water and more than 108,000 kilograms (kg) of carbon dioxide (CO₂) in its first five years. This means that textile waste has been reduced by nearly 13,000 kg and the materials have instead been converted into new clothes (Saarniit and Moora 2019). Such achievements are evidence that the system can help certified factories to reduce textile leftovers and to sell more production services while at the same time enabling the brand to produce more products from fabric that it has bought. UPMADÉ also helps create longer-term cooperation between the brand and the factory which can reinforce the transparency of the supply chain.

Consistent with the features highlighted in Micro-loop 2, UPMADÉ invests in design-led practices enabled by technologies to reduce dependence on natural resources and to enhance the reuse of items by increasing their value.

The crossbreeding loop: Re:newcell

Renewcell is a Swedish company founded in 2012 by a group of innovators from the KTH Royal Institute of Technology in Stockholm. The firm has developed an innovative process that allows for the chemical recycling of cellulosic materials. The process can transform used materials including cotton and rayon

(also known as viscose) into a biodegradable pulp to obtain new fibers and, therefore, new yarns, fabrics, and garments. The revolutionary innovation of its recycling process lies in the fact that the product does not suffer a decrease in fiber quality: when virgin-wood resources are compared to its cellulose fibers, the quality is the same.

In 2014, the company produced a dress made from blue jeans recycled using Re:newcell technology. The resulting yellow dress was the first garment ever made from previously used and chemically recycled textiles and the first fully recyclable garment. Re:newcell soon began producing other garments including tee-shirts, children's pajamas, and scarves. By 2017, Re:newcell had opened a production facility and this development marked the larger-scale viability of the technology, the optimization of its process, and the refinement of its process to increase efficiency, robustness, and quality. In addition, during the same year, the company received a major investment from the Swedish retailer H&M that provided important financial resources and gave the company visibility and credibility in the fashion industry.

Re:newcell is an emblematic case that represents how innovative textile companies can support the fashion industry's transition to a circular supply-chain model. Its key innovation is represented by the company's use of waste produced within the same supply chain as the raw material to create a final fiber that is equivalent to a virgin one. The company's sustainable business model is designed to minimize Re:newcell's impacts on the planet, particularly on water and land because if one kg of clothing is produced from recycled materials instead of from virgin cotton, oil, or wood thousands of liters of water are saved and there are decreased environmental impacts on land (Pensupa, 2020). These objectives are also embedded in other aspects of the company's production practices which entail using only renewable energy, safeguarding wildlife, and requiring no pesticides.

This company bridges the two mini-loops to refine traditional manufacturing techniques with design-led practices. It exploits and repurposes used materials to create new products through also implementing novel production processes and cycles, without affecting the resources available to the planet and restoring the intrinsic quality and value of the recycled material.

As a hybrid company that operates between the two mini-loops, Re:newcell has differentiated itself by overcoming sectoral barriers such as regulatory issues related to the very hybrid nature of the company, which is unique due to the fact that it cuts

across both the wood products and fashion industries. First, the legislation represented an important obstacle because the company did not fall within the regulatory framework of the market system. Such a framework had not been updated at the time and is only now changing according to the new strategic actions promoted by the European Union (EU) to encourage circular business models (i.e., European Clothing Action Plan). Other barriers were related to technological aspects that the company has chosen not to make public for strategic and competitiveness reasons and the lack of investors able to foresee the potential of a disruptive process in the absence of tangible examples or competitors. Furthermore, Re:newcell did not comply with common business standards due to its hybrid and intersectoral commitments (Black et al. 2019).

Through a design-driven approach, Re:newcell developed a process that nurtures a regenerative supply-chain model using a resource that is both accessible and abundant as well as bridges cross-sector barriers and facilitates mutual exchange and collaboration across different industrial ecosystems.

Conclusion

This article addressed the potential role of design in changing the course of fashion-production processes by rethinking and innovating the traditional supply-chain processes to achieve circularity. The taxonomy presented profiles of the design-driven trajectories that are initiating circular change in the fashion and textile industries by introducing circularity into the linear materials and manufacturing dimensions.

The taxonomy presented in this article suggests that the emphasis on circularity is relevant to the global fashion industry and provides a roadmap for companies seeking a systemic approach to their sustainability strategies to reach a point of fully closing the circularity loop. Study of the mini-loops supports the stimulation of a perspective change in the sector guided by design. The effect on the supply chain can occur only through a change at the design stage that considers all of the system's variables and imagines possible new processes. These mini-loops highlight how transitioning to a circular model calls for new infrastructure systems. Such infrastructure should consider the product's entire lifecycle and the possibility of enabling materials to circulate for extended periods of time through an interplay of knowledge and practices in different steps of the supply chain. The overall objective should be to maximize product longevity together with the

optimal use of resources, as well as to avoid the production of waste and to minimize the impacts of industrial activities on the ecosystem (Ferguson 2009). Such synergies along different steps in the supply chain extend beyond organizational boundaries and include interorganizational collaboration and networks in which actors from other sectors (e.g., textile, food, agriculture, chemicals) play a more interactive and relational role (Bourlakis et al. 2014).

Companies that engage in the modes of circularity depicted by the mini-loops are now beginning to overcome one main obstacle: developing new materials and/or innovative production models that must be adopted in what is a still linear context. The linear practices can profoundly influence the circularity potential of the innovation, impairing its ability to effectively return materials to the production system. For example, today's theoretically circular fibers (biodegradable or compostable materials that can be reintegrated into biological cycles) are often blended with other unsustainable materials (synthetic fibers that cannot be repurposed). The result of such blending makes it impossible to recycle and return the original materials to their respective production cycles. Furthermore, the circular innovations are also constrained by limitations imposed by research and development and challenges associated with obtaining grants or other types of funding.

Stemming from the results of this article, research directions toward circular fashion should focus on establishing a clearer picture of how an industrial ecosystem based on positive synergies influences the sector experiences toward closed loops. Furthermore, while this article investigated circular fashion practices in terms of sourcing and manufacturing, additional studies are required to gain more insight into the final part of the supply chain into different patterns of consumption. There is a need to investigate, for instance, whether new green retailing and the phenomenon of digitization in customer interaction can be associated with enhanced beneficial effects on sustainability, connecting the upstream manufacturing green transition with downstream green distribution and behavioral change on the part of consumers.

Regarding the further development of mini-loops, future research should broaden our understanding by investigating the proposed pathways to strategically incorporate design-driven actions to become adoptable guidelines for the growing number of companies working in this field. Their work is promising, but as discussed in this article, these innovations in fashion are still adapting to the prevailing context. Most of the companies we find in today's market are SMEs born during the last two decades. This should not be taken as a constraint.

These smaller but dynamic firms will be able to demonstrate, as they already have done to some extent, that they are best suited for survival. In fact, due to their dynamism, which allows them to adapt flexibly to different events as was the case with the COVID-19 emergency of the past years or the evolving climate crisis.

To conclude, innovation in the fashion-design path toward circularity is a rich field of research. The cases portrayed in this article speak to a process of rapidly unfolding change due in part to recent policy actions such as the EU's Green Deal and the European Clothing Action Plan that focus on supporting a circular transformation of European industry toward a sustainable paradigm. Such a dynamic environment will contribute to the quest to make fashion more sustainable and responsible.

Notes

1. See <https://www.thefashionpact.org>.
2. LOHAS is an acronym meaning Lifestyles of Health and Sustainability.
3. See <https://eu.patagonia.com>, <https://www.stellamccartney.com/sustainability>, and <https://ecoalf.com>.
4. See <https://ellenmacarthurfoundation.org>.
5. See <https://wornwear.patagonia.com>.
6. See <https://www.vegeacompany.com>.
7. See <https://www.upmade.org>.
8. See <https://www.renewcell.com/en>.

Disclosure statement

No potential conflict of interest was reported by the authors.

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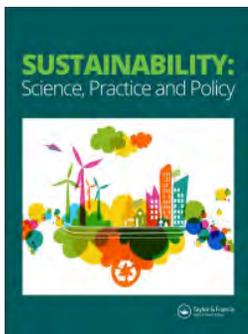
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A value-driven business ecosystem for industrial transformation: the case of the EU's H2020 "Textile and Clothing Business Labs"

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ABSTRACT

This article reports on the experiences and results of the European Union-funded Horizon 2020 project TCBL which has been successful in creating a European network of Textile and Clothing Business Labs aimed at the sustainable transformation of one of the most problematic industries in both social and environmental terms. The approach followed by the project was based on the diffused creation of value by and for all stakeholders, including consumers. This, in turn, implies a systemic transformation of business models, brought about by all players in the sector engaging in the experimentation of new processes and transaction patterns. In this way, all stakeholders were able to reap the benefits of innovation, and the lever of competitive advantage shifted from price to knowledge, collaboration, and shared values. In the meantime, the COVID-19 pandemic has had a devastating effect on the business models of the luxury and fast-fashion brands for which TCBL has aimed to offer an alternative path, also loosely in line with the provisions of the European Green Deal and the United Nations 2030 Agenda. Given the results attained, a two-pronged strategy for the constitution of a sustainable post-project TCBL ecosystem is now being implemented.

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Introduction

Addressing the twin challenges of environmental and social sustainability requires significant changes in the way goods are produced and consumed, and one of the more evident examples of this challenge is in the textile and clothing (T&C) industry. The sector's significant environmental and social impacts have been widely known for several years and visibility has grown as a result of specific episodes such as the discovery of child labor for Nike shoes in 1996 (Schanberg 1996). In addition, Greenpeace raised the environmental issue with its 2011 Detox program¹ to reduce chemicals usage, followed by the 2015 documentary *The True Cost*² which claimed that the fashion industry is the second-most polluting on Earth; more specifically, "the production of [the fabrics used in fast fashion] creates more toxic chemical pollution per item than any other industrial product" (Angelov 2016, x).

Public awareness of these impacts has expanded to include the use of chemicals in dyeing and

finishing and the resulting water pollution (Kant 2012), the impact of pesticides used for growing cotton (Luz 2007), and the sheer quantity of clothing produced amounting to some 80 billion garments per year). It was not until 2017, however, that these claims gained widespread institutional acceptance with the publication of the report *A New Textiles Economy: Redesigning Fashion's Future* by the Ellen MacArthur Foundation in collaboration with the multinational consulting firm McKinsey & Company. To quote from the report's executive summary,

[T]otal greenhouse gas emissions from textiles production, at 1.2 billion tonnes annually, are more than those of all international flights and maritime shipping combined. Hazardous substances affect the health of both textile workers and wearers of clothes, and they escape into the environment. When washed, some garments release plastic microfibres, of which around half a million tonnes every year contribute to ocean pollution – 16 times more than plastic microbeads from cosmetics. (EMF 2017, 3)

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These astonishing figures highlight the scope and scale of the issue which clearly cannot be resolved by one company alone. A broad-reaching structural transformation is required, leading to the main (action) research question posed here: Is it possible to intervene holistically to transform an entire industry toward sustainability, and if so, where to start?

The last ten years have seen the launching of a range of large-scale initiatives worldwide following different approaches. One is to make consumers more aware of what they are buying. Following the collapse of the Rana Plaza garment-production factory in Bangladesh in April 2013, with its death toll of 1,134 mostly women (Reinecke and Donaghey 2015), the Fashion Revolution³ movement was born as an international awareness campaign. By asking the simple question: “Who made my clothes?” the organization highlights the dismal conditions of garment-factory workers making the products of the global fashion brands. Every year on the same date events around the world are held by local chapters in over 100 countries, with a Facebook page followed by more than 100,000 subscribers.⁴ Starting in 2015, Fashion Revolution began to publish a Transparency Index that now rates over 250 brands on different aspects of their supply chains.⁵

With such negative publicity mounting, most of the larger brands have in parallel initiated their own campaigns for creating supply-chain transparency, recycling used clothes, adopting sustainable practices, and so forth. Fashion for Good attempts to bring these efforts together, with an approach that sees the larger brands as the most effective impact path: indeed, the top 20% of sector companies had a 60% share of total profits in 2019 (McKinsey & Company 2021).⁶ In parallel with joint adoption of sustainability targets and similar commitments, Fashion for Good also promotes innovative startups as models for sustainability.

The public sector has also recognized the importance of the issues at hand, starting with the UK’s Sustainable Clothing Action Plan in 2009–10 (DEFRA 2010) through to the European Union’s (EU) listing of textiles as one of the priority sectors in the new Circular Economy Action Plan (European Commission 2020).

Despite these well-publicized programs, however, little has changed. The yearly report “Pulse of the Fashion Industry” by Global Fashion Agenda and the Boston Consulting Group stated in its launch edition of 2017 that if global population and gross domestic product (GDP) grow as expected, “the overall apparel consumption will rise by 63%, from 62 million tons today to 102 million tons in 2030 – an equivalent of more than 500 billion T-shirts”

(Global Fashion Agenda 2017, 8). The most recent update states: “The fashion industry must overcome its roadblocks to achieve more substantial improvements that lead to a systemic change” (Global Fashion Agenda 2019, 15). In addition, a recent report by Business of Fashion, *Measuring Fashion’s Sustainability Gap*, has come out with a new Sustainability Index. Comparing concrete actions against environmental and social targets, the report states that “Pockets of innovation and progress mask significant outstanding challenges that must be resolved over the next decade... The average score [on the Sustainability Index] was just 36 out of a possible 100, with significant disparities in engagement and progress” (Business of Fashion 2021, 8).

The “TCBL: Textile & Clothing Business Labs”⁷ project, started in 2015 and completed in 2019, formulated an alternative approach to address the problem, based not on remedial actions but rather a diffused creation of sustainable value by and for all stakeholders, including consumers. Its stated objective was to “create a transformational ecosystem capable of constantly innovating the business and process models of the European T&C industry” (TCBL 2015, Part B, 4). This, in turn, implies a systemic transformation of business models, brought about by all players in the sector engaging in the experimentation of new processes and transaction patterns. In this way, everyone can reap the benefits of innovation, and the lever of competitive advantage shifts from price to knowledge, collaboration, and shared values.

TCBL argues, in fact, that the economic and social problems of the T&C sector derive from the structural nature of the large brands’ top-down supply chains and business models, designed to reduce costs and increase output. This subsequently imposes specific behaviors on the mostly small companies – over 170,000 textile manufacturers, garment designers and producers, service companies, and so forth employing over 1.7 million workers (Euratex 2018) – who are forced to sacrifice what drive they may have for more sustainable ways to the need to constantly lower prices and reduce delivery times.⁸

Rather than focusing on the large brands, TCBL, therefore, addresses the industry as a whole system, with a specific eye on these smaller, pre-existing European companies. Together with them, TCBL envisions an environment within which production companies can experiment with new materials, processes, and methods together with other businesses sharing the same values and goals, thus reducing the risk of exploring new suppliers, new clients, and new markets. The underlying hypothesis – and this

can only be validated by practice – is that individual businesses, given the right conditions, are best equipped to make the most appropriate innovation choices rather than being asked to adhere to some abstract model of sustainability.

The remainder of this article is structured as follows. The next section overviews the antecedents of the project vision, namely open innovation, living labs/fab labs, and knowledge champions on the methodological side and industrial districts, smart specialization, and the rebuilding of local-global value chains on the policy side. The third section presents the TCBL methodological approach to building a sustainable, value-based innovation ecosystem. This is based on three main pillars: a combined outside-in and inside-out business model-innovation approach; an impact oriented (or focused) collaboration model between TCBL community members (labs and associates); and an emphasis on shared values as the unifying element for a community of like-minded ecosystem members. The fourth section describes the key implementation results of TCBL and the fifth section discusses them, in tight connection with the project's evaluation strategy, which was inspired by three key concepts: Business Ecosystems, Complexity Theory, and Large-scale Change. The final section concludes with an outline of a two-pronged strategy for the post-project phase that is now being implemented by a soon-to-be-established nonprofit association and an already operating commercial small- and medium-sized enterprise (SME).

Background

A cornerstone of the TCBL vision is the application to the T&C sector of a lab concept, leading to structures that openly explore different kinds of innovation in areas ranging from new bio-based materials to social sewing collectives. TCBL Labs collaborate and network with other labs and engage with local T&C enterprises to understand the potentials for developing new business models. Labs are thus the active, physical context in which TCBL's explorations of new sustainable models for the T&C industry take place. To make it easier for businesses to find the services they may be interested in, as well as promoting lab-to-lab collaboration in networked projects, an evolving TCBL Lab model aims to provide a structure that organizes this diversified network in terms of the types of activity carried out.

The initial classification distinguished three types of approach toward addressing a problem or opportunity. *Design Labs* apply a design approach, composing fragments and opportunities in new ways (Dorst 2015) in a “design thinking” (Brown 2008)

mode. This, of course, includes fashion design but also entails, for example, service design for new retail models. *Make Labs* apply the maker-culture approach (Sennet 2009), exploring the potentials of new materials as well as process technologies such as laser cutting. This links to the Makerspaces concept⁹ as well as to model factories for Industry 4.0 (Lasi 2014). *Place Labs* draw inspiration from the regional dimension (Barata et al. 2017) working with locally embedded knowledge and exploring new forms of social and territorial innovation (Marsh 2008) for work and production. Bringing together a network of different labs, each with its own mix of these three approaches, aimed to develop a multi-faceted TCBL lab model capable of overcoming the single-minded championing of specific methodologies and keeping the focus on the common goal of sustainability (Cohen 2017).

Antecedents to this vision are different strands of research relating to how companies can innovate together. The first is open innovation (Chesbrough 2003) whereby firms open up to external ideas, including collaboration in research with competitors, highlighting the value of knowledge flows within a sector. Open innovation is also at the heart of the living lab movement (Niitamo et al. 2006) which engages end users in the co-design of innovation processes both through specific engagement methods and the establishment of a physical hub where stakeholders can come together.¹⁰ The territorial living lab concept (Marsh 2008) further applies the approach to social innovation in regional settings, highlighting the role of culture and creativity in promoting territorial innovation (Barata et al. 2017). Other open, participatory, co-creative models (Troxler 2011) include the *FabLabs*¹¹ network, launched by the Massachusetts Institute of Technology in 2002 where digital fabrication technologies are made openly available to companies, nonprofits, designers, students, and others to develop their own projects.¹²

TCBL applied these concepts in engaging with businesses involved in textile and clothing value chains, from cotton farmers through to dress-sharing startups. So, in parallel with the development of the Labs network, it was essential to build a community of “Associates”: T&C businesses joining the TCBL movement to work together in shaping a new market structure for the industry. While Labs work with both technological and social innovations and explore their possible implications for the Associates, it is the latter that focus on finding ways to incorporate these innovations into their business models. The initial configuration of TCBL partners and labs allowed us to reach out to local business communities in eight regions of six EU member

states, including industrial districts specialized in cotton (northeastern Greece), textiles (Yorkshire, Prato, southern Germany), garment production (Slovenia, northeastern Romania) and fashion design (Paris, Tuscany), to build a first critical mass. The role of the Labs in this process is related to the notion of “knowledge champions”: organizations active both within and outside a certain territory who make a key contribution to a region’s capacity to grasp, to understand, and to process knowledge coming from the outside, in a way that neither entrepreneurship nor policy actions alone have proven capable of attaining (Molinari 2018).

In addition, the project vision drew on understandings of how industrial business systems work and how they innovate. The concept of an industrial district dates back over one hundred years (Marshall 1881) and in fact the T&C industry has historically been a case example of this kind of territorial organization. The question of the impact of industrial districts for regional economic development – the competitiveness of firms within them (Camagni and Capello 2002) – gained particular relevance as the globalization of the T&C sector over the last decades has broken regional value chains and transactional contiguity and drained Europe of important knowledge resources (Dunford 2009).

A related concept to territorial (spatial) development is the EU’s so-called Regional Innovation and Smart Specialization Strategy (RIS3) (Foray 2015), an effort to coordinate¹³ the planning exercises for innovation policies in Europe’s 236 regions for the European Regional Development Fund’s 2000–2014 programming period.¹⁴ In this context, the idea of “place-based innovation” was revitalized, with a case-study analysis (Rissola and Haberleithner 2020) published by the EU’s Joint Research Center (JRC) identifying as key elements of success: multi-stakeholder partnership, effective leadership and orchestration, talent attraction, presence of research infrastructures, and internationalization. The concept of *related variety* is also part of the RIS3 and further elaborates the advantages of knowledge spillovers from different sectors (Asheim, Oughton, and Smith 2011) and the recombination of knowledge, ideas, and practices among heterogeneous industries (Frenken, Van Oort, and Verburg 2007). In this context, TCBL placed specific importance on rebuilding local-global value chains not only to improve environmental and social performance but, above all, to restore the territorial dimension of value and knowledge flows (Huiling and Dan 2020). Ongoing engagement is shaped by another concept emerging from the smart specialization experience, namely *entrepreneurial discovery*. This idea refers to an inclusive and interactive bottom-up process in

which participants from different environments (e.g., policy, business, academia) discover and produce information about potential new activities, identifying opportunities that emerge through this interaction (Smart Specialisation Platform 2017). This approach allowed us to identify areas of common interest in which to engage Labs and Associates in collaborative projects.

Methodology

Over the project lifespan, TCBL dealt with the theme of business-model innovation by means of two distinct, yet complementary, approaches: outside-in and inside-out. In the exploratory phase of the first two years, the *outside-in* approach carried out an analysis and classification of exemplary cases. We selected a set of innovative companies and related service offers on the basis of their innovative contribution toward one or more of three dimensions – sustainability, openness, and use of data – and from there a set of archetypal business models were defined to highlight the possibilities within each dimension.¹⁵ Not by chance, a number of business-model archetypes discovered in the outside-in phase triggered initiatives subsequently activated by the TCBL project. For instance, the Second-Life business model archetype¹⁶ inspired the TCBL journey into circular fashion, resulting in services meant to maximize the value of end-of-life garments (e.g., Second Life)¹⁷ as well as partnerships with TCBL Service Providers such as Circular Fashion¹⁸ and Reverse Resources.¹⁹ The Do It Yourself²⁰ business model-archetype spawned a wave of interest in digital fabrication, with the involvement of FabTextiles²¹ and activation of new services as well as proximity production, for example, the “Short Runs” project, combined with the enrollment of Sqetch²² and SourceBook²³ as TCBL Service Providers. As far as the data-driven archetypes are concerned, the Predictive Offering business model²⁴ raised awareness of the potential in leveraging data intelligence to reframe the customer experience, leading to TCBL initiatives such as My Yorkshire Wardrobe, proposing a radically new online clothing-rental concept that offers customized clothing and accessories selections for men.²⁵

As the TCBL innovation projects took shape, outside-in thinking was gradually replaced by *inside-out* thinking, where project developments were modeled to identify new business models representing the TCBL vision. Along these lines, the six TCBL innovation projects launched in project year 2 – named Business Cases – were generalized as three Business Model Practices that are seen to form the key strategic intervention axes through which to promote

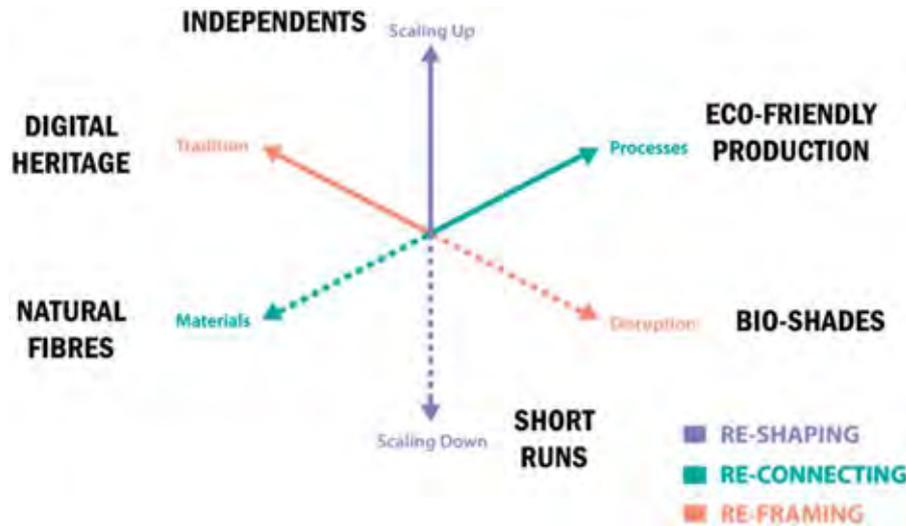


Figure 1. The TCBL Business Model Practices.

Table 1. TCBL Business Model Practices.

	Re-connecting	Re-shaping	Re-framing
Business opportunity	Embrace integrity across the supply chain to deliver high-quality and environmentally friendly products.	Transition toward collaborative production processes within a trusted community of like-minded businesses.	Reimagine the consumer experience by exploring new markets and creative possibilities.
Innovation drivers	Radical transparency, sustainable materials and processes, certified supply chain.	Agility, responsiveness, resource sharing, rediscovery of local sourcing.	Product as experience, radical new product meanings, disruption/tradition mix.
Target audience	T&C companies, especially SMEs situated along a specific value chain (e.g., cotton, silk).	Small workshops and ateliers aiming to scale up by networking, manufacturers aiming to scale down.	General public, consumers, fashion designers, fashion brands.
Business focus	Value chain	Value network	Value proposition
Alignment with TCBL vision	Environmental sustainability	Revitalization of manufacturing	Customer-driven experience

the systemic transformation we are looking for (Figure 1).

The three Business Model Practices are as follows:

- *Re-connecting value chains*: This involves innovation across value chains and is derived from the Natural Fibres (material flows) and Eco-Friendly Production (process flows) Business Cases.
- *Re-shaping production*: This involves innovation within production units and is derived from the Independents (scaling up) and Short Runs (scaling down) Business Cases.
- *Re-framing consumer markets*: This involves innovation in the shared understanding of what fashion is and is for and is derived from the Digital Heritage (reinterpreting tradition) and Bio-Shades (radical disruption) Business Cases.

Table 1 below further develops the Business Model Practices in the context of key insights gained in the course of project implementation as well as the desired impacts.

This strategic framework leads to a synthesis of the outside-in and inside-out approaches, bringing to the fore business-model destinations – for which we have coined the term *Business Model Magnets* –

capable of attracting T&C companies into an alternative, value-based market space.

Business Model Magnets aim to define key spaces within the landscape of roles, transaction patterns, and value chains of the kind of sustainable T&C ecosystem that is expressed in the TCBL vision. As exemplary models, they aim to have a lighthouse effect for existing businesses tracing their own transition path toward an alternative market space where their own practices of sustainability, inclusion, and transparency can contribute to the broader picture in a coherent way.²⁶

The final phase of the TCBL project identified a first list of five non-exclusive Business Model Magnets, capable of engendering sustainable value chains in the T&C sector.

1. The first is *Circular Materials*.²⁷ By considering the environment as an opportunity rather than a constraint, this business model keeps textile materials at their highest value at all times, through reverse logistics, restorative and regenerative practices (e.g., upcycling), and broader commitment to materials and processes whose life cycle has a lower environmental impact (e.g., bio and natural fibers, renewable energy)

- and sustainable business practices (e.g., local production, traceability).
2. The second “magnet” refers to *Design Co-Workings*.²⁸ These provide independent designers with shared spaces within which to collaboratively develop a culture of sustainable design, where fashion designers can meet, share ideas, and exchange practices inspired by contemporary visions, daily cross-fertilization, and original (perhaps provocative) ideas.
 3. On the supply side, an important role is played by *Short-Run Production*.²⁹ Short-run textile producers deliver and sell smaller quantities at a competitive price by combining sustainable nearshoring, small-batch production, and short lead times. The business model represents a diversification avenue for artisan fabric makers and processing houses (e.g., dyeing, printing) as well as a one-of-a-kind downscaling opportunity for large mills adopting flexible production technologies, delivering short-runs during intermittent or structural overcapacities, wishing to broaden their offer, and/or having leftover fabric to sell.
 4. Complementary to this are *Local Cut, Make & Trim (CMT) Hubs*³⁰ which bring short-run thinking from textile to garment production, spanning the gamut from home sewers to larger manufacturers needing to downscale. Following increasingly digital and distributed pre-production processes (e.g., product design, pattern making, pattern grading), Local CMT Hubs can form networks to supply established fashion brands in search of responsiveness, excellence in execution, local sourcing, and adaptability of production capacity.
 5. Finally, we have new *Retail Experiences*.³¹ These place personalized, sustainable, and circular fashion at the core of the value proposition by tapping into a new breed of digital technologies and organizational models to reinvent the consumer journey.

While such Business Model Magnets aim to constitute emergent archetypes, their viability under certain conditions is proven by market-success stories coming from T&C value chains, including the identification of “champions” in the TCBL community that are implementing them.³²

Alongside the outside-in and inside-out thinking, a third pillar of the TCBL methodology was the emphasis on *shared values* as the unifying element for a community made up of like-minded ecosystem members laying the foundation for a novel way of working in line with the TCBL vision (Jonker, O’Riordan, and Marsh 2015). We invited Labs and

Associates to join TCBL more as a movement than a business network, on the basis of their match with seven principles that the TCBL partnership identified as important for its mission, not – as is convention – on the basis of company profiles or specific project proposals.³³ The TCBL values, further refined and developed over the course of the project, are as follows:

- **Curiosity:** creative exploration of new paths, roles, social constructs, and business models.
- **Viability:** equally increasing the prosperity of businesses and the well-being of communities.
- **Durability:** commitment to the environment, moving toward circular economy and zero kilometer, reducing waste, and designing for durable relationships.
- **Multiplicity:** highlighting the value of different cultures, traditions, and opinions, and designing for diversity of needs and tastes.
- **Openness:** sharing resources and information, and working toward interoperability through common processes, platforms, and standards as well as transparency in business practice.
- **Respect:** of privacy, authorship, and intellectual property as well as the dignity of individual workers and consumers, the power of social knowledge, and the value of place and territories.
- **Responsibility:** committing to reliable, trustworthy, and professional behavior as well as responsible design, production, selling, and consumption.

This value-based approach proved highly successful, with 41% of Associates responding to an evaluation-outcome survey (see the Discussion section below) reporting they were attracted to joining TCBL because of this upfront declaration of principles. To consolidate this result, different forms of peer-based accreditation or Participatory Guarantee Systems³⁴ were studied in similar value-based networks. Two examples are the distributed approach adopted by IFOAM – Organics International (for organic agriculture)³⁵ and the coordinated accreditation system developed by the World Fair Trade Organization (WFTO).³⁶ Applying these models, the TCBL Protocol³⁷ was defined to ensure adherence to the shared principles over time and thus the long-term brand value for the community.

Implementation

The TCBL Labs network was launched with an initial set of fifteen Labs, five of each type, and expanded through an open process of registration and accreditation that continues today, with the network currently counting some sixty Labs worldwide. Some examples of TCBL Labs³⁸ include:

- **Centexbel (Belgium)**, a textiles and plastics research center offering research and innovation, testing, and consultancy; currently working with biofibers.
- **Performance Augmentation Lab (UK)**, a university-research lab experimenting with augmented reality for on-the-job learning at the sewing machine.
- **TextileLab Amsterdam (Netherlands)**, a FabLab exploring new textiles, new materials, and new techniques of digital fabrication.
- **Lanificio Paoletti (Italy)**, a woolen mill operating since 1795 offering experimental weaves, on-demand production, and experimentations with local Alpage wools.
- **Makesense (France)**, a co-working and incubation space identifying market opportunities through participatory signature *Créathon* events.
- **SOFFA – Social Fashion Factory (Greece)**, a cooperative of fashion professionals providing work opportunities for refugees, victims of human trafficking, and unemployed persons living at risk of survival.



Figure 2. BioShades distributed TCBL workshop @Waa held on March 15, 2018.

- **REDU (Romania)**, a community lab that has collected, reused, repaired, and reconditioned over five tons of textile waste.

During the TCBL project lifespan, Labs held over 200 workshops and seminars, mostly with local communities and businesses but also including several networked events involving different locations contemporaneously (Figure 2).

Most importantly, the Labs identified a series of over fifteen innovation projects³⁹ to explore together with the TCBL business community which have been and continue to be carried out by several Labs (often of different types) collaborating from their different perspectives. Examples of such projects include: Bioshades, researching bacterial dyes as an alternative through creative experimentation and the exploration of scalability and impact; Workplace of the Future, experimenting with team-production approaches in garment manufacturing, including island redesign of sewing-workstation layouts; and the already mentioned My Yorkshire Wardrobe.

Midway through the project lifetime, service-modeling exercises⁴⁰ consolidated and structured these activities, further developing the original model of Design, Make and Place Labs to provide a multidimensional representation of each Lab according to a common set of criteria,⁴¹ some of which are shown in Figure 3.

The community of TCBL Associates⁴² also represents a wide mix of company types and sizes, covering the entire T&C value chain.⁴³ Some examples include:

- Thrakika Ekkokistiria, cotton-ginning mills in northeastern Greece.
- AW Hainsworths, a centuries old woolen mill in Yorkshire (UK).
- Beste, fabrics dyeing and finishing in the Prato (Italy) district.
- Feltros Portugueses, a felt factory in northern Portugal.

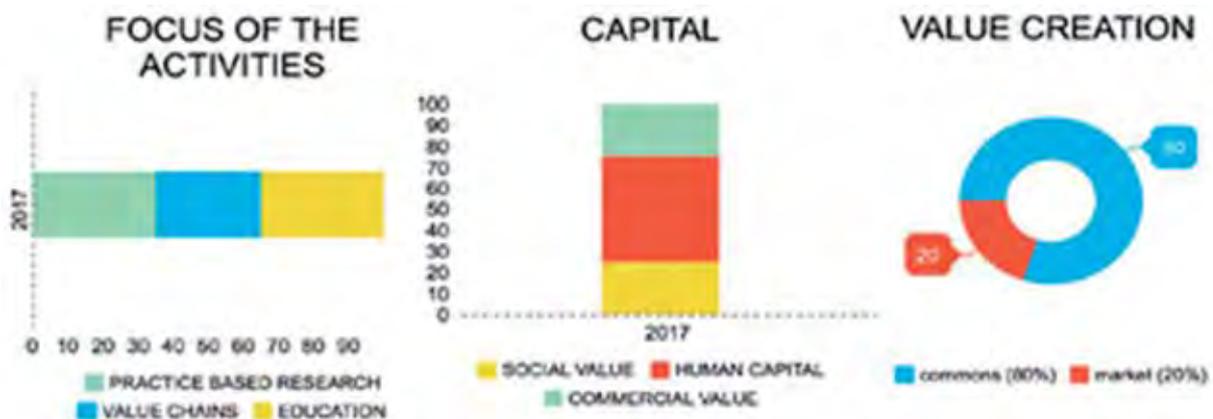


Figure 3. A typical TCBL lab service profile.



Figure 4. The group production island layout tested at Coco&Rico production facilities.

- Gorfoo, promoting and using hemp fabrics in western France.
- Doljesi Modni Gumbi, a button producer in Slovenia.
- Hall Couture, a haute couture prototype co-working facility in Paris.
- Bivolino, an online made-to-measure men's shirt maker in Belgium.
- Ioanna Kourbela, fashion design and clothing production in central Athens.
- Coco&Rico, a sustainable, small-lot fashion atelier in Paris.
- Rifó, apparel producer using recycled denim and cashmere in Prato (Italy).
- Katty Fashion, a large-scale garment producer in the Iași (Romania) district (Figure 4).

Bringing this business ecosystem alive involved igniting collaboration between Associates and Labs. To this end, Labs engaged with Associates to identify the themes of reciprocal interest for the joint experimental actions built around the six Business Cases upon which the Business Practices discussed previously are based. The first of these addressed *Natural Fibers* and was launched with the reconnection of different companies along the natural cotton-value chain – from ginning through to design and manufacturing – in Greece, Europe's main remaining cotton producer. This case now covers a range of natural fibers such as silk, wool, and hemp, extending throughout the European TCBL network. The *Eco-friendly production* case was launched in the Prato (Italy) textile district, where chemical usage in textile production and finishing is an important concern. The driving idea is to track and certify chemicals across the value chain rather than to focus on individual companies. *Short Runs* looks at the issues and barriers involved in both scaling down – the shift from mass production to smaller lots – as well as scaling up – supporting business development for small-scale producers. In parallel, the *Independents* Business Case addresses the needs

and potentials of independent designer-producers, supporting networking, technology adoption, and zero-waste production. Another, *BioShades*, originated from research in the Amsterdam Bio-FabLab, experimenting with growing bacteria to dye textiles. The “open to citizens” approach and the disruptive sustainability potential – near-total elimination of the use of water and chemicals for a near-zero environmental impact – help spread awareness and learning across the TCBL network of Labs. Finally, *Digital Heritage* was inspired by the Design Lab at the Textile Museum in Prato; this initiative explores the brand value of digitized textile archives together with their potential as a source for the creation of new designs.

As these Business Cases developed and the community of Associates grew – 78 in 2016, 136 in 2017, 227 in 2018 and 249 at project end – a series of yearly two-day conferences provided important moments of information exchange and identity building.⁴⁴ Each edition was hosted by a TCBL Lab at the heart of one of the textile districts – Huddersfield in Yorkshire (UK), Athens (Greece), Prato (Italy), and Iași (Romania). These events provided the opportunity to mix local businesses, schools, and innovators with members of the European network through different interaction formats: keynote talks, TEDx style sessions, a PechaKucha series, factory visits, workshops, textile-art exhibits, and evening receptions (Figure 5).

The different types of engagement of Associates with the collaborative Business Case projects and yearly events supported by a wide-reaching communication strategy ranging from the production of guidebooks (over 80) and videos (over 175) to active social media campaigns, led to growing recognition of TCBL as a brand signifying active membership of a value-based innovation community.

Discussion

The unifying element of collaboration within the TCBL community has been the collective goal of making progress toward four ambitious objectives as set forth in the Horizon 2020 call topic to which the project responded, “Business models with new supply chains for sustainable customer-driven small series production,”⁴⁵ in terms of the expected impacts to be attained within five years after the end of the project. These are:

- A return of previously off-shored manufacturing to Europe, on the order of at least 5% of the total manufacturing capacity.
- A reduction in the environmental footprint compared to products produced in the traditional



Figure 5. The natural cotton collection from the Greek experiment at the 2017 Athens conference.

value chains by 20% through less stock, less waste, and less transportation.

- The creation of a novel supply network involving at least 1,000 organizations and individuals.
- The creation of new embedded services supporting the customer-driven supply chain.

To assess the degree to which progress was made toward the project's ambitious objectives, a multifaceted evaluation strategy identified specific tools capable of assessing impact in such a complex intervention as TCBL.⁴⁶ The evaluation methodology was shaped by three key concepts: Business Ecosystems, Complexity Theory, and Large-scale Change.

First, the literature on *Business Ecosystems* explores the relationship between business entities and business models and how these interrelate to form business networks. In this context, a business, or service, ecosystem is defined as “a value-coproduction configuration of people, technology, other internal and external service systems, and shared information” (Spohrer Maglio and Gruhl 2007, 7). TCBL, in fact, seeks to promote new kinds of networks, and hence new kinds of value chains within the textile and clothing sector by stimulating the production, diffusion, and replication of business innovations in its Labs and Associates.

Second, understanding how these ecosystems work is supported by *Complexity Theory* which focuses on understanding and better describing dynamics and processes of change in interventions such as TCBL that are not predictable, involving emergent and responsive interventions and causal processes that cannot be completely controlled or predicted in advance (Ramalingam et al. 2008).

Finally, this endeavor requires (1) an adaptive development mode that supports reflective practice and organizational learning (Ling 2012), inclusion, and sense-making with multiple competing explanations of why and how change happens and (2) an

understanding of the project's *Theory of Change* (Sullivan and Stewart 2006) to identify the key dependencies upon systems and subsystems which lie outside the formal structures of the intervention.

On a broader level, the TCBL's systemic vision raises questions of governance and transferability of the experience. What features of the methodology were instrumental in reaching these results, and what relevance might they have for the continuation of these efforts or for their application to other industrial sectors? The evaluation-planning activity addressed these issues, looking at processes and outcomes as they unfolded so as to constantly feed into shaping the system's configuration.

Considering TCBL as a complex intervention (Rogers 2008), the evaluation team identified a number of key characteristics that are embedded in the project design and that have been critical for its success.

- *Emergence:* The project was designed to be implemented in phases, with transition periods allowing for the shaping/designing of each phase and the taking on board of learning from the preceding phase. This allowed the TCBL ecosystem to shape itself as a function of the kind of organizations joining and the innovative transition paths they brought.
- *Open system:* TCBL was from the outset designed as a “living and breathing” organism in which the different components grow and interact, both with each other and the wider social and ecological environment, to change the textiles and clothing industry. TCBL was thus an innovative, if not experimental, initiative,⁴⁷ aggregating shared knowledge, innovation, creativity, and business innovations to attain a systemic impact on the T&C sector; technology is used as a tool for this change, rather than imposing itself as a driver of change.
- *Diversity of experience and expertise:* TCBL could draw on significant diversity of experience and expertise including partners from within and without the textiles sector. This diversity contributes to produce innovation itself, as well as to offer a valuable backdrop to the implementation of the project.

In this context, *Large-scale Change* can be defined as

[T]he emergent process of mobilising a large collection of individuals, groups and organisations towards a vision of a fundamentally new future state, by means of: high leverage of key themes; a shift in power and a more distributed leadership; massive and active engagement of stakeholders; and mutually reinforcing changes in multiple systems and processes. Done properly, this leads to such

deep changes in attitudes, beliefs and behaviours that sustainability becomes largely inherent. (NHSIII 2018, 12)

The main lessons learned from the TCBL experience are in terms of the *mechanisms* identified to be successful. In the Theory of Change, the journey from activities to impacts is assumed to be determined by these mechanisms, defined as “underlying entities, processes, or structures which operate in particular contexts to generate outcomes of interest” (Astbury and Leeuw 2010, 368). They explain the combinations of “resources” (for example access to TCBL Labs) and “reasoning” (changes in knowledge, skills, and behavior associated with the use of these resources) that lead to outcomes. For TCBL, seven such mechanisms were initially developed in a co-creation workshop with TCBL partners and subsequently refined to eliminate duplication between individual mechanisms and to remove unclarity. The wording of the mechanisms was finalized on the basis of the evaluation evidence.

1. *Alternative vision mechanism*: TCBL offers an alternative scenario that includes and liberates and leads to innovation. This includes opening up opportunities for international working to transcend local competitive attitudes and behaviors. The alternative vision has been central to making TCBL a “movement” in the context of Large-scale Change.
2. *Mobilizing untapped resources mechanism*: By participating in TCBL, Associates recognize untapped abilities and resources in themselves and their businesses and the broader potential of what they are doing. This has been an essential element of the value added, allowing participants to “discover” their own worth.
3. *Engagement, relationship, and human relations/networks mechanism*: Change/collaboration in TCBL happens by promoting interpersonal relationships directly, at workshops and conferences, and digitally. This element is an essential ingredient for enabling knowledge flows and lowering the risk of innovation.
4. *The Lab as an ecological bridge*: TCBL Labs serve as bridges that connect systems and practices with the external environment and thus play a pivotal role in changing ecological systems and practices. TCBL Labs thus directly have an impact on reducing the T&C sector’s carbon footprint and indirectly lead to more widespread eco-friendly consumer behaviors downstream.
5. *Value and mentality change mechanism*: TCBL provides the stories that are in line with TCBL values. Change of attitudes leads to a change in behavior which in turn fosters the creation of services and products with higher ethical values.
6. *Networking mechanism*: Successful networking between TCBL stakeholders through matching for business outcomes provides concrete examples of best practices and evidence of added value of services.
7. *Knowledge generation mechanism*: Through Labs and the experimentations within them, knowledge is generated in terms of processes and practices, technologies, and materials that TCBL Associates can then turn into products and services.

The specific methodological tools used for the evaluation of project impacts can be summarized as follows.

- *Contribution analysis* (Mayne 2012) essentially involves constructing a plausible explanation of the contribution of different causal factors to a project’s identified outcomes and impacts. “It assesses causal chains from beginning to end, reports on whether the intended changes occurred or not, and identifies the main contributions to such changes, including the intervention under evaluation” (Delahais and Toulemonde 2012, 281). In parallel, the *counterfactual* describes the situation that would have arisen had the intervention not taken place (Ferraro 2009). While in complex interventions it is often much harder to identify the counterfactual, nevertheless it is crucial to pose the core question in an evaluation which is “did it make a difference?” as well as “compared with what?”
- The *social return on investment* (SROI) methodology is a framework for measuring and accounting for the value of an intervention by measuring change from the perspective of the people and organizations involved: “SROI tells the story of how change is being created by measuring social, environmental and economic outcomes and uses monetary values to represent them” (Nichols et al. 2012, 8).
- And finally, *cost-consequence analysis* is “a form of cost-effectiveness analysis comparing alternative interventions or programs in which the components of incremental costs are computed and listed, without aggregating these results (e.g., into a cost-effectiveness ratio).”⁴⁸ Like SROI, this method considers a broader range of outcomes and measurements beyond financial ones, including “humanistic” measures such as value attributed by stakeholders to collaborative business partnerships, provision of more sustainable choices for consumers, contribution to promoting social inclusion, and so forth. These tools were implemented through a series of questionnaires, surveys, case studies, and

workshops involving project partners and Labs and Associates involved in the innovation activities.

Combining and synthesizing evaluation results, it is possible to assess the contribution the project made toward its key impacts.⁴⁹

- As concerns *increased manufacturing capacity*, 24% of survey responses said that TCBL helped them to create new business lines, with an average value of €258,000. A total of 37% of TCBL businesses experimented with new sustainable business models, contributing €62,500 average value to business as a result. The economic analysis suggests that organizations in the TCBL ecosystem gained an aggregate of €2,331,000 in benefits from business-model experiments.
- For *reduction of environmental footprint*, the economic analysis suggests that organizations in the TCBL ecosystem saved €319,000 from implementing TCBL waste-reduction strategies, €100,000 through TCBL energy-saving strategies, and €120,000 by reducing raw material consumption. Twenty TCBL Associates witnessed increased orders based on waste-reduction measures, with an estimated €60,000 average value from compliance with the waste-reduction protocol.
- In the creation of *novel supply networks*, 71% of survey respondents extended their network of business contacts, while the majority of Business Cases involved new supply-chain relationships in real business transactions.
- And, finally, for *embedded services*, we have the TCBL Open Platform that aggregates third party online Business Services with 1,055 registered users.
- Overall, the cost-contribution analysis estimates a total value generated for TCBL Associates of over €16 million in the life of the project, with an SROI of 0.716 (significant for a research project).⁵⁰

Despite the positive evidence attained through these evaluation exercises and the sophistication of the methods employed, some important limitations emerge that can set the stage for further research. The main issue is related to the known gap between the time frame of implementation and that of impacts. The desired impacts listed in the Commission's call text were already situated five years after the project's end, while the broader TCBL vision is perhaps realizable over a still longer period. This makes it difficult to measure progress toward results and feed those insights into the process as it is developing. Evaluation in TCBL experimented with the concept of mechanisms to address

this issue, but it would be useful to follow up over time on the hypotheses discussed above to refine the method.

Related to this matter is the specific issue of measuring environmental benefits, particularly within the systemic approach adopted by TCBL. Work in the project began to attempt assessment of the impacts of chemical-use reduction, material-waste reduction, and so forth beyond the confines of a single company or product – looking for instance across value chains or within an industrial district, but further work is needed to address this level of complexity. A dedicated effort in this sense – including building forecasts of systemic environmental impacts into design and production systems – will be a priority for further research, including within the TCBL network itself.

Conclusion

Given the results attained, the TCBL business ecosystem represents a shared outcome that the participants – TCBL project partners as well as Labs and Associates – wish to keep alive. To fulfill this aim, a two-pronged strategy for the constitution of a sustainable post-project TCBL ecosystem is now being implemented. The commitment of a group of TCBL participants is leading to the creation of the TCBL Association, a nonprofit entity whose main purpose is to maintain the value-based community through the TCBL Protocol, to coordinate the search for funding of future activities with Association members, and to organize communication and knowledge-sharing, including the annual events (post-COVID-19). In parallel, an existing company with a track record of innovation services to the T&C sector was transformed into CEDECS-TCBL Sas,⁵¹ which among other possible business lines holds the license for commercial exploitation of the TCBL brand and services developed during the project and afterwards, on condition of supplying essential services to the TCBL Association and its members.

In the meantime, the COVID-19 crisis has had a devastating effect on the business models of the luxury and fast-fashion brands for which TCBL aims to offer an alternative path. Debenhams and Topshop's Arcadia Group collapsed (Nelson and Paton 2020), Zara announced the closure of up to 1,200 stores in June 2020 (Jolly 2020), and H&M reported a 21% drop in sales in the three months to February 2021 resulting in the closure of "as many as 1800 stores" (Barnes 2021). In response to the impact on demand, large brands abruptly canceled over \$16.2 billion of orders (Dean 2020), including garments already produced and ready to ship, resulting in over one million garment workers laid off or

furloughed in Bangladesh alone (McNamara 2020). Online retailers fared better, although with little regard to working conditions in fulfillment warehouses (Butler 2020).

Some of the larger brands have experienced recovery following the initial impact of the COVID-19 pandemic: already in Spring 2020, as China was the first to emerge from lockdown, LMVH claimed that “Chinese shoppers have flocked back to its boutiques in mainland China” (Dalton 2020) while Inditex, owner of Zara and other brands, saw revenue hit record levels a year later (Q2 2021), 7% above pre-pandemic figures (Bottomly 2021).

Nonetheless, recovery is “uneven” in the words of the Business of Fashion/McKinsey report for 2022, as supply chain issues – “logistical bottlenecks, manufacturing delays, high shipping costs and materials shortages” – plague the large brands’ clockwork organizations (McKinsey & Company 2022, 11). Most interestingly, consumer trends toward more ethical and sustainable purchases have continued to grow throughout the pandemic, such that, “following supply chain disruptions, the second most prominent challenge on executives’ minds is the sustainability gap” (McKinsey & Company 2022, 16). It remains unclear, however, whether this renewed concern will lead to any better performance in meeting the highly touted sustainability goals discussed at the outset.

In the meantime, the EU is aiming to give a clear direction to recovery of the bloc’s economy through the European Green Deal, described on the Commission website as “a new growth strategy that will transform the Union into a modern, resource-efficient and competitive economy, where there are no net emissions of greenhouse gases by 2050, economic growth is decoupled from resource use and no person and no place is left behind.”⁵² This policy will certainly have an impact on the T&C as well as other industries, but the ultimate prospects for a sustainable transformation of the sector will also depend on other, broader forces already at play even before the onset of the COVID-19 pandemic. Rapidly increasing awareness of the climate crisis is accelerating a change of mindset that was having a concrete effect on both policy (new legislation under the Registration, Evaluation, Authorisation, and Restriction of Chemicals (REACH) regulation, Circular Economy funding) and consumer behaviors even before the European Green Deal. While not initially the focus of attention, the T&C sector is now fully in the spotlight both in European policy (e.g., the European initiative on Textile Innovation)⁵³ and in consumer perceptions (e.g., “fast-fashion shaming”) (Hoikkala 2019). This trend strongly reinforces the mission of the TCBL

ecosystem and could lead to a greater than expected increase of its role in accompanying industrial transformation toward sustainability.

In parallel, there is the trend toward digital society and, more specifically, Industry 4.0. These technologies can bring important benefits to supporting business models coherent with TCBL’s goals, digitizing supply chains and making sustainable fashion economically viable, but will also have to address serious concerns about privacy, job losses, and the tendency to only further contribute to overproduction. The TCBL project showed that innovative technologies are alone not sufficient to bring about structural change, but once mindsets have shifted, they can play an important role in making change viable. This approach is fully in line with the EU’s new approach branded “Industry 5.0”: “a vision of industry that aims beyond efficiency and productivity as the sole goals, and reinforces the role and the contribution of industry to society ... putting research and innovation at the service of the transition to a sustainable, human-centric and resilient European industry.”⁵⁴ Here the opportunities for the TCBL ecosystem are to demonstrate how technology can support knowledge and interaction rather than replacing them, in a model of “human digital fashion.”

All these trends will be influenced by the strategic choices of the big brands in both the fast-fashion and luxury markets. While many continue to claim headline actions toward sustainability, their business models are likely to face difficulty in escaping from their current ways as they emerge from the COVID-19 crisis: fast fashion trapped into overproduction and luxury into exploitation, with overconsumption as the main driver of profit in both cases. Those willing to undergo a real transformation, shifting their significant organizational and infrastructural assets to support alternative business models, could potentially be powerful allies for TCBL, although this is not seen as a necessary condition for the ecosystem’s continuing development.

The real key to keeping the momentum built up to date is to maintain support for the innovative business ecosystem post-COVID-19, in line with the methodologies, principles, tools, and initiatives developed during the TCBL project’s four years. With the significant challenges being faced by the existing brands’ business models, ever-increasing public awareness, and opportunities offered by the EU’s new policy directions, the time is ripe to tip the balance in favor of a finally sustainable fashion system.

Notes

1. <https://www.greenpeace.org/international/act/detox/>
2. <https://truecostmovie.com/>

3. <https://www.fashionrevolution.org/>
4. <https://www.facebook.com/fashionrevolution.org>
5. <https://www.fashionrevolution.org/about/transparency/>
6. <https://fashionforgood.com/>
7. <https://tcbl.eu/>
8. The Lead Partner of the TCBL Project was the City of Prato (Italy), at the heart of Europe's largest textile district. These insights are the result of private conversations with several of the area's leading textile companies, but they remain confidential so as to not jeopardize existing business relations.
9. <https://www.makerspaces.com/what-is-a-makerspace>
10. <https://enoll.org/>
11. <https://www.fablabs.io/>
12. https://issuu.com/tcbl/docs/what_is_a_lab
13. <https://s3platform.jrc.ec.europa.eu/>
14. <https://ec.europa.eu/jrc/en/research-topic/smart-specialisation>
15. https://issuu.com/tcbl/docs/business_model_dynamics_for_tcbl
16. The second-life business model is predicated on establishment of an online or offline marketplace enabling the exchange of T&C goods that are not new, either transferred hand-me-down, or sold for a fraction of their original value.
17. For more information on this and other projects in TCBL, see <https://tcbl.eu/projects>.
18. <https://circular.fashion>
19. <https://reverseresources.net>
20. The do-it-yourself business model consists of the publication of digital clothing that is made available by independent designers for proximity production performed directly by customers using 3D printers, either at home or in next-door digital fabrication workshops ("fab labs").
21. <https://fabtextiles.org>
22. <https://www.sqetch.co>
23. <https://sourcebook.eu>
24. The predictive offering business model combines art (i.e., on-trend clothes) and science (i.e., algorithm deciphering personal styles and tastes) in order to surprise and delight customers through a recommendation engine while saving time.
25. See a presentation video at <https://youtu.be/RkOysvc7XE0>.
26. https://issuu.com/tcbl/docs/tcbl_trifold_final-2019
27. Championed by Rifó and Anneka Textile.
28. Championed by Hall Couture and CO-Factory.
29. Championed by Trafi Creatività Tessile and Lanificio Paoletti.
30. Championed by Coco&Rico and Katty Fashion.
31. Championed by My Yorkshire Wardrobe and Bivolino.
32. https://issuu.com/tcbl/docs/tcbl_business_model_magnets. For further information on individual "champions" (TCBL Associates) see <https://tcbl.eu/directory>
33. <https://tcbl.eu/tcbl-ecosystem/values>
34. <https://fairworldproject.org/alternative-paths-for-consumers-assurance/>
35. <https://www.ifoam.bio/pgs>
36. <https://wfto.com/what-we-do#our-guarantee-system>
37. https://issuu.com/tcbl/docs/the_tcbl_protocol
38. Further information on TCBL Labs can be found at <https://www.tcbl.eu/labs>
39. See <https://www.tcbl.eu/projects>
40. https://issuu.com/tcbl/docs/tcbl_lab_service_portfolio
41. https://issuu.com/tcbl/docs/t_cbusinesslabsportfolio2018
42. Further information on TCBL Associates is at <https://www.tcbl.eu/directory>
43. See <https://www.tcbl.eu/directory>
44. <https://tcbl.eu/tcbl2019>
45. https://cordis.europa.eu/programme/id/H2020_NMP-35-2014
46. Evaluation of TCBL was entrusted to The Tavistock Institute of Human Relations in London. The relevant evaluation reports describing the methodological framework, evaluation plan, and evaluation results are listed as confidential.
47. Source: TCBL partner interviews, November 2015.
48. United States Department of Health and Human Services, Office of the Assistant Secretary for Planning and Evaluation.
49. The final sample size for the survey analysis was 66. This sample size includes cases that did not complete the outcome questions.
50. Social return on investment (SROI) was used to calculate a financial return for TCBL. This process used data drawn from a survey of TCBL businesses and combined their estimates of the tangible financial gains from being involved in TCBL – for example increase in turnover – with the financial gains on "intangibles" – for example, business benefits from experimentation. The SROI ratio of 0.716 measures the social impact value set against the initial investment amount. For a research project, this ratio would normally be expected to be negative. The figure of €16 million in total value generated extrapolates the estimated total value to all members of the TCBL ecosystem on the basis of the data derived from the survey.
51. <https://www.cedecs-tcbl.com/en-gb>
52. https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en
53. <https://s3platform.jrc.ec.europa.eu/sdgs-textile-innovation>
54. https://ec.europa.eu/info/research-and-innovation/research-area/industrial-research-and-innovation/industry-50_en

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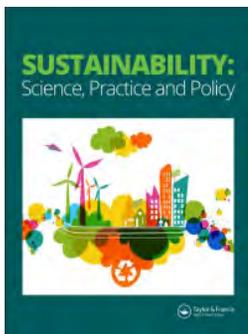
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The role of networks in supporting micro- and small-sized sustainable fashion businesses

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ABSTRACT

Micro- and small-sized sustainable fashion businesses benefit greatly from their formal and informal networks which provide a wide variety of support and services. This exploratory study reports on the findings of a UK-based research project that investigated 27 firms in this category. We focus on four case studies comprising two designers running their own labels and two product developers who support other designers. Our analysis maps the networks of these micro- and small-sized sustainable fashion businesses. Taking an approach informed by actor-network theory (ANT), we describe human, organizational, and social media actors in formal and informal networks. We show how networks are formed and extended through supply-chain relationships, professional networks, and the serendipity of personal and online contacts. Focusing on informal networks, the article also discusses the models of working and the role that geographical (or physical) and cognitive proximity plays. The networks of sustainable businesses particularly depend on trust and shared values and help designers to understand and increase their sustainable practices.

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Sustainable fashion businesses; networks; collaboration

Introduction

While the fashion industry overall is still dominated by large corporations, there are many micro- and small-sized designer-led businesses that espouse a more sustainable way of creating and using fashion and clothing. Establishing any business involves challenges such as finding finance, premises, and suitable suppliers, and many small businesses fail within the first few years. Running a business with a focus on sustainability can be even harder, as material costs are often higher and tracing supply chains and engaging with suppliers and customers about sustainability takes time. In many cases, such businesses are run by an individual designer or a very small team who rely on support networks to thrive. This article is informed by an actor-network theory (ANT) approach and analyzes such formal and informal networks. We focus on four case studies of UK-based designer-led fashion enterprises out of the 27 sustainable businesses that we studied as part of a larger project “Rethinking Fashion Design Entrepreneurship: Fostering Sustainable Practices (FSP).” We investigated the following questions: (1) How are these informal networks created and

maintained? (2) What is shared within the network? (3) What is particular to sustainable businesses?

The UK’s designer-fashion sector, with an estimated £32.3 billion gross value added (GVA) before the pandemic, is largely made up of micro- and small-sized enterprises (MSEs) which are widely acknowledged for their creative influence (BFC 2018). This article highlights particularly micro-fashion enterprises with 0–9 employees, including innovative startup businesses and sole traders, where much creativity is found. Many designer-led MSEs pioneer alternative visions of prosperity in business and can provide a key focus for the sector’s transition to sustainability. The research project informing this article interpreted sustainability holistically across four key dimensions: environmental, social, cultural, and economic. We focused on MSE designers and founders who aimed to reconcile all of the sustainability dimensions while maintaining a viable business. This is a journey of constant learning and improvement. It often started with material choices and minimizing waste but extends across all aspects of running a business including interactions with employees, suppliers, clients, and customers. Sustainable fashion businesses seek to transform

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current practices of fashion, encourage sufficiency, and create long-lasting products, while creatively educating their customers and clients about sustainability values and behavior.¹

As explained in the following sections, networks play a hugely important role in the success of businesses and this is well recognized in the fashion industry. We then outline the FSP project and its methodology in the next section. In the following section, we discuss four case studies – two designers with their own labels and two designers supporting other design businesses – to illustrate patterns of behavior observed across the FSP project. The presentation of the results starts with a section on networks of designers. This discussion features a map of the formal and informal networks that the designers in the FSP project were part of and describes the fluidity of membership and dynamic changes in category membership of the actors. The subsequent section discusses how networks are formed or enlarged and highlights the serendipity of collaboration and then moves on to outline the modes of working in the networks, the role that geographical (or physical) and cognitive proximity play in the working of the networks, and their role of proximity in enabling businesses to be sustainable. The penultimate section brings out insights into the conflation of human and non-human actors (in fashion), before we draw several conclusions in the final section of this article.

Networks of fashion businesses

Networks have been studied from multiple theoretical positions and practical questions. Rather than comprehensively review this literature, we select here several aspects that are relevant to our analysis of the networks of sustainable micro- and small-sized businesses. In particular, see García-Lillo et al. (2018) for a comprehensive overview of the literature on clusters and industrial districts.

Collaboration in networks

Collaborations among all agents in a network, such as suppliers, distributors, customers (often involved in co-creation initiatives), and even competitors, can be drivers of innovative and sustainable business models in fashion. More specifically, collaboration allows the creation of a supporting ecosystem (Todeschini et al. 2017). Collaborative design is a knowledge-sharing and knowledge-integration process (Kleinsmann, Buijs, and Valkenburg 2010) and it occurs in conversational turns in which everyone contributes their own expertise (McDonnell 2009). Collaborations across the supply-chain benefit from

an alignment of business priorities (Macchion et al. 2015) and can contribute positively to income (Wenting, Atzema, and Frenken 2011), for example, through co-branding (Oeppen and Jamal 2014).

An important element of many networks is proximity, which has two dimensions: cognitive proximity and geographical (or physical) proximity (Balland, Belso-Martínez, and Morrison 2016). The notion of cognitive proximity indicates “that people sharing the same knowledge base and expertise may learn from each other” (Boschma and Ter Wal 2007). Knowledge is transferred between businesses in a highly dynamic process according to a study of Italian industrial districts by Camuffo and Grandinetti (2011, 820):

1. The facilitation of inter-organizational and interpersonal relations.
2. The observation, aimed at imitation, of the artifacts and actions of other firms in the district.
3. The mobility of human resources from an existing firm to another existing firm.
4. The creation of new ventures through spin-offs (i.e., the mobility of human resources from one existing firm to a newly born firm).

Industrial districts foster mutual and reciprocal cooperation which increases trust, constitutes a form of collective capital (Dei Ottati 1994, 531), and creates a balance between competition and collaboration. Relations between actors are socially embedded when they involve trust based on friendship, kinship, and proximity (Boschma and Ter Wal 2007). Co-working occurs in localized spaces where independent professionals share resources and are open to imparting their knowledge to the community. Under such circumstances, small businesses can get involved in collective innovation processes (Capdevila 2019).

Historically, networks were often based on geographical (or physical) proximity. Piore and Sabel's (1984) seminal work proposed that industrial districts with flexible specializations could take advantage of the latest technological advances and provide an alternative to mass production by being more adaptable in responding to demand for a variety of customized items. Their analysis focused on industrial districts with many examples drawn from the garment industry where flexibility and specialization have long been based on strong community ties and cooperation through networks of small- and medium-sized enterprises (SMEs). A critique of Piore and Sabel's (1984) research found that flexible specializations within these industrial districts have been disrupted by globalization and affected by the

destabilization of institutions (Marangoni and Solari 2006). Many businesses have thrived in the context of globalization because cognitive proximity enables businesses to become agents of change combining global and local knowledge (Camuffo and Grandinetti 2011). In addition, Guercini and Ranfagni (2016) argue that conviviality both forms and maintains entrepreneurial communities. It preserves individual identities, creates social capital, and promotes greater knowledge and trust. Interactions with other firms can lead to the implementation of innovative strategies such as the development of new products or the development of better-performing business models (Guercini and Runfola 2012).

Collaborative networks furthermore provide for flexibility and cooperation and allowing SMEs to compete in niche markets for high-value, high-quality fashion products (Courault and Doeringer 2007). For the creation of new value, actors need to both learn and interact with others in their local community and to benefit from investment aimed at building communication channels beyond the local context (Bathelt, Malmberg, and Maskell 2004). Training and organizational support can be more fruitful if enterprise development is treated as a collective activity (Mills 2011).

Much of the literature on industrial districts and clusters has focused on textiles centers in Italy. While a detailed analysis of the cultural differences between Italian and UK assemblages is beyond the scope of this article, it merits noting that London has long been recognized as a creative cluster with rich ecosystems of knowledge and resources (Rieple et al. 2018). Innovation in the British capital is enabled by scale, diversity of demand, and cultural dynamics. The city also offers urban markets, good transport systems, and supporting institutions (Athey et al. 2008). London is the home of multiple national and regional fashion organizations (Virani and Banks 2014) and supports numerous networks that include funding bodies and universities that foster design collaboration through philanthropy, education, and consultancy (Azuma and Fernie 2003; Ashton 2006). It further is home to the recently created East London Fashion Cluster.² These formal networks can help SMEs grow in terms of their net assets and net value (Schoonjans, Van Cauwenberge, and Vander Bauwhede 2013).

Collaboration in networks of sustainable fashion businesses

Sustainable clothing businesses face multiple challenges: maintaining product value, quality, and aesthetics; meeting the needs of suppliers; and coping

with higher material and labor costs (Curwen, Park, and Sarkar 2013). Personal (informal) and formal industry networks and professional connections play key roles in helping startups meet the challenges they face (Mills 2018; Aakko and Niinimäki 2018) as SMEs often lack sufficient resources and knowledge for business operations (Schoonjans, Van Cauwenberge, and Vander Bauwhede 2013). In particular, building relationships with manufacturers is important (Malem 2008). Many designers use networks of friends to source staff and produce small production runs (Athey et al. 2008) as the dominance of global supply chains requiring large throughput is not suitable to their needs and values (Ashton 2006).

Ashton (2006) proposes that we think of networks as based on social relationships and common values in which knowledge and products are shared among a wide range of participants. The businesses sit in a range of nested or overlapping networks which may be clustered geographically, with access to immediate networks as well as to conduits to other networks of suppliers, customers, and collaborators – sometimes with a global reach (Athey et al. 2008; Ashton 2006). The uncertainty associated with creative businesses leads to designers developing bonds based on personality, style, or shared background rather than economic reciprocity (Gu 2014). Accordingly, personal relationships and shared cultural understanding play an important role.

Methodology

This article draws on actor network theory (ANT) to analyze the findings of the subsequent case studies that were carried out as part of the project “Rethinking Fashion Design Entrepreneurship: Fostering Sustainable Practices (FSP).”

Actor network theory as an approach to analyze design processes

We utilized an ANT framework to support our analysis as “it does not limit itself to human individual actors but extends the word actor – or actant – to non-human, nonindividual entities” (Latour 1996) and does not have preconceptions about the distance between actors, the direction of their influence, or the size of the network. This makes ANT a valuable framework for the empirical analysis of organizations (Whittle and Spicer 2008) as it assumes that if any actor – human, technological, or organizational – is added to or removed from the network the network will change (Doolin and Lowe 2002). This is an important aspect of ANT for

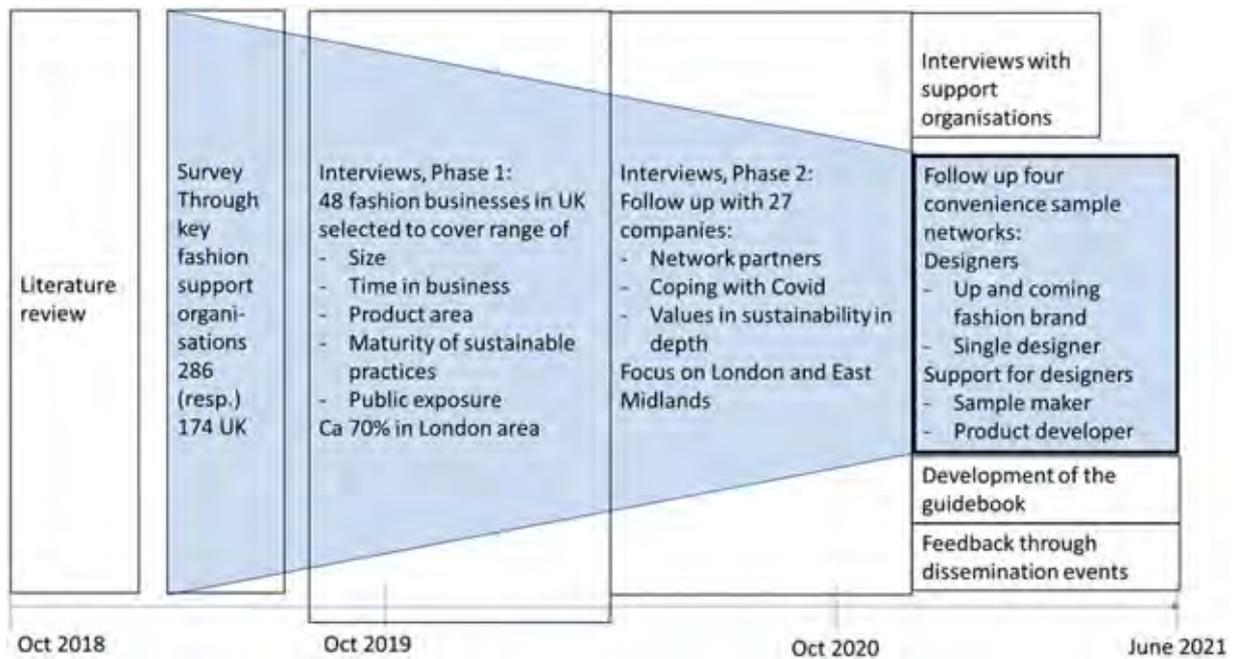


Figure 1. Timeline and methodological steps of the FSB project.

understanding the dynamic nature of the designers' networks.

Actor-network accounts of design tend to focus on the role of the designed object. "Expanding the project of ANT to the field of design requires mobilizing this method's persistent ambition to account for and understand (not to replace) the objects of design, its institutions and different cultures" (Yaneva 2009, 280). ANT accounts also enrich the discussion of co-design, because they highlight that in a collaborative process not only the invited participant, but also unintentionally included or unexpected actors, can play an important role (Andersen et al. 2015). Studies of emergency situations have shown how different actors – human and technical – come together to share critical information (Potts 2009). "Participants in such systems engage in networked communication; they forage for information and then assemble that information in an ad-hoc, but still coordinated, manner" (Potts 2013, 48) moving flexibly through different media to obtain information as required.

Entwistle (2016) advocates that ANT is a useful tool to examine the everyday routines and practices of fashion – how people do fashion. It entails "following the actors" (human and non-human) through observation (ethnomethodology) of the rules, practices, habits, and routines of daily life. She observed models and fashion shows, the role of the photograph, and the fashion cycle (fashion weeks, fashion buyers, and merchandizing in Selfridges department store). ANT gives equal agency to humans and devices, tools or objects, where the non-human actors support the human ones, for example websites facilitating sales.

The research project

As noted above, the research reported in this article was part of a UK-based project entitled "Rethinking Fashion Design Entrepreneurship: Fostering Sustainable Practices (FSP)" (see Figure 1). Our aim was to investigate creative and business practices in design-led fashion MSEs to evidence their potential to exemplify transformation toward a more sustainable fashion industry. The research team examined the fashion-design entrepreneurs' visions, values and capabilities, designs and operations, business models, working practices, and networks. While many of the fashion companies were centered in and around London, the authors also studied designers in the Midlands to diversify the sample outside of the capital area and to extend the project to an important region in the UK fashion (manufacturing) industry.

Micro- and small-sized fashion-designer firms are heterogenous with different attitudes toward their markets, peers, and use of external resources (Rieple et al. 2018). To capture this rich diversity, the project went through several phases of data gathering, as illustrated in Figure 1. After an initial survey of the networks of several key support organizations (including the British Fashion Council, Center for Fashion Enterprise, and UK Fashion and Textiles Association (UKFT)), we selected 48 fashion MSEs (predominantly in London, with a few in the South East, South West, and East Midlands) for first-stage interviews between September 2019 and March 2020. Each interview was conducted by two of the researchers from the project to provide a cross-disciplinary perspective of different businesses.



Figure 2. Positioning of case studies (bold, larger font) in the context of other examples in the FSP project. *Note:* Companies in smaller bold font are mentioned in the article to illustrate additional points

The project interviewed a total of 27 fashion businesses a second time 9–12 months later, four of which were selected for this article to compare businesses in the East Midlands (that did not have the support of fashion organizations) with businesses in London. The interview period overlapped with the COVID-19 outbreak. While the original intentions of the research could not anticipate the pandemic, inevitably all businesses were affected in some way by the crisis, such as a loss of clients or needing to pivot to online retailing. The authors interviewed each of the designers in the four selected case-study companies at least three times. In addition, for the case study of Love White Rabbit (LWR), in February 2021 we interviewed collaborator Claire Shell from Pin Curls Vintage (PCV), and two managers of Maker's Yard, the Leicester design hub where PCV and LWR are located.

We transcribed all interviews and manually carried out a thematic analysis that focused on networks. The qualitative data analysis followed the three flows of actions identified by Miles and Huberman (1994): data reduction, data display, and conclusion drawing. For this article, we also analyzed the data from an ANT perspective. The interviews are referenced in the discussion below by the initials of the designer and the number of the interview.

The case-study companies

This article focuses on four case studies: one firm based in London and three others in the Midlands representing typical categories of MSEs encountered in the project at varying scales – designer/founders managing their own production and service businesses supporting designers (see Figure 2).

Designer-led businesses do not always support their own brands but may also work for other

designer-led businesses as service providers. As Figure 2 illustrates, there also is a middle ground where some designers produce both their own designs and work for others as a sample maker, product developer, or producer of small runs. All four case-study companies (bold, large font in Figure 2) are led by trained fashion designers who have positioned themselves differently in the market. The following case studies showcase the spectrum of business activities. We selected for each scenario a larger business with multiple employees and a sole trader. Each is trying to be sustainable in its own way. The article also refers to the companies shown in bold, (smaller font), to show the range of different firms and to illustrate salient points that did not come from the four case studies alone.

The designers

The two designers who have set up their own fashion labels oversee the entire process from design to production. Throughout the article, we will refer to the case study by the name of the business or the person, depending on whether we are making a point about the respective firm or the individual

The designer brand

Sabinna Rachimova (Sabinna) came from Vienna to London to study fashion and worked for fashion labels in Paris and London before setting up her own label in London. Sabinna is a lifestyle brand that offers sustainable products and services beyond garments. The brand has a workspace and shop in London where the firm makes and sells some of its clothing. The garments are produced in small batches from natural fibers and designs aim to make use of deadstock. Packaging is compostable as far as possible. The brand is committed to fair wages

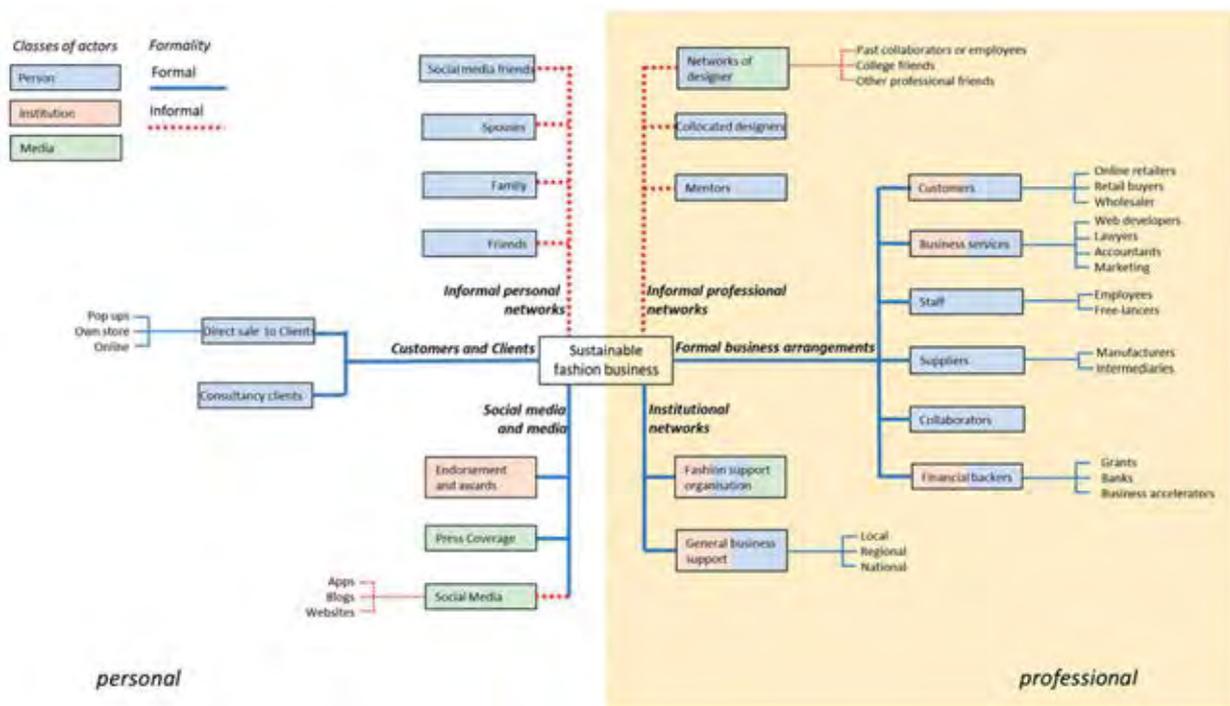


Figure 3. The networks of designers in the FSP research project exemplified by the four case studies.

across the supply chain and offers a free repair service for its garments. Rachimova has a close relationship with her customers through her studio/shop, pop-up shows and, increasingly, communication through her website and social media. The business is situated close to other small garment brands and creative businesses in East London's Fashion District development,³ creating an informal network of co-location in an East London cluster. She is also part of several formal design networks in the city.

The FSP project also interviewed a number of other businesses that are in geographical proximity, located across East London, an area with a long history of garment manufacturing and now being redeveloped as the Fashion District (some are shown in Figure 2). These include Black Horse Lane Atelier that produces a denim-jeans range that can be tailored to customer measurements and manufactures for other fashion brands such as Raeburn. Phoebe English is a womenswear brand showing at London Fashion Week that has been instrumental in building a local London network of designers to share knowledge and resources.

The lone designer

Ismay Mummy is the founder and owner of Boy Wonder (BW). As a former designer for High-Street brands, she spotted a gap in the market for boys' ethical clothing that is colorful and does not use stereotypical boys wear motifs. The brand was set up to follow environmental best practice in all aspects of the business. Following circular principles,

her business model includes a buy-back scheme for outgrown clothes. The garments are made of organic materials using environmentally friendly dyes and are ultimately recyclable. Patterned fabric is digitally printed to easily adjust production volumes. BW is based in a small town in the Midlands with very little textile industry so there is no local network of companies with which to collaborate. As a result, Mummy has largely relied on online connections. She is committed to local production but has experienced difficulties finding suitable suppliers in nearby Leicester that are willing to supply small-order volumes reliably at reasonable cost. She has set up a widely read blog about sustainability and the fashion industry. Unable to access funding, she crowdfunded her 2019 collection and has continued trading and initiating and running online sustainable fashion events and workshops.

Designers supporting other businesses

These two designers offer services to other businesses starting with ideas or developed designs and facilitate product development and production.

Product developer

Fazane Fox trained as a fashion designer and worked as a senior account manager for an established fashion brand for several years. When setting up her business in rural Derbyshire, she was advised by her business mentor to establish a clothing development and production company instead of setting up her own clothing label. Starting with design

briefs or rough ideas from clients, who often have no background in fashion, she oversees the entire process from the original designs to product completion. Fox has built up a network of suppliers that she works with on behalf of her clients. She largely collaborates with a network of manufacturers in Portugal because the Portuguese government enforces ethical work practices. Sustainability is becoming increasingly important to her business and her clients ask for more sustainable products. She has strong ethical principles about the treatment of people and works hard on being a responsible and flexible employer by providing secure employment for both her part-time and full-time employees. Fox comes from a family of entrepreneurs and various relatives provide business advice and office space, as well as childcare.

Sample maker

Florie Struthers from LWR took a Contour Fashion BA at De Montfort University and set up a business offering pattern-cutting, small production runs, apparel sampling, and conceptual and bespoke designs. Prior to the pandemic, Struthers worked mainly for two small swimwear businesses and other small designer firms that she had met online. She had also planned to take on an apprentice with investment by her family, but she experienced a dramatic fall in orders during the COVID-19 crisis. During this period, she became involved in making scrubs for the National Health Service (NHS) in the UK. LWR is based in Makers Yard in Leicester, a historic factory building run by the Leicester City Council for creative businesses but there is little support tailored to fashion businesses.

The networks of designers

All of the respondents are part of numerous networks where they receive support and contribute to the support of peers. The following discussion focuses on networks that support designers over long periods of time rather than actant networks that are formed around a specific issue. The map in [Figure 3](#) originated from summaries of the networks of the case-study designers and we supplemented it with the practices of other designers who were part of the FSP project. Not all areas are necessarily applicable in every case. For example, none of the case-study firms in this article sell through wholesale buyers which has until relatively recently been the norm in the designer-fashion sector. Most of the case-study companies excel at developing personal relationships with the people that they interact professionally. This situation makes it difficult to discern a clear distinction between personal and professional networks as a friend can become a

collaborator or business services can be bartered with friends. Client and customer relationships are on the informal side of the map (indirect sales are covered under formal relationships with retail buyers) because several designers have built up personal relationships with their clients. For example, before COVID-19, Rachimova brought clothes from London to Vienna to sell to groups of regular clients in informal get-togethers (where she also received immediate feedback). Rachimova also encourages online clients to provide comments on her designs and thereby influence her design and color direction.

Fluid classes of actors in networks

[Figure 3](#) illustrates that the designers' networks contain a combination of human actors, institutions, and media. As the distinction between the categories can become blurred, several boxes are marked to indicate multiple classifications. For example, the interviewees reported on getting grants from a bank as institutions but also spoke of bank managers as people. Some had individuals as backers, for example family friends. There is also a degree of overlap between media and people. For example, in the case of the fashion-support organization *Make it British*, the participants conflated the person running the organization, its website, and network into one actor rather than three. We nonetheless classify *Make it British* as an institution in the mapping in [Figure 3](#). In particular, during the COVID-19 crisis the designers interacted with colleagues in their informal networks through social media. For example, *Fazane Fox* joined a network of entrepreneurs in her region through a WhatsApp group and talked of them as the "WhatsApp group" as she had not yet met any of them in person. There is also, as noted above, a lot of overlap between personal and professional networks. In formal networks the designers act within the boundaries of contractual arrangements or become the recipients of other actors' formal offerings or services, such as receiving a grant or business support from a regional council. In informal networks the actors have casual, but often long-term, relationships.

Formal networks

All four designers are part of formal business arrangements where contractual relationships determine the level of support that is provided. Both Rachimova and Fox have permanent staff who work for them as well as freelancers that they bring in for specific tasks or to ease the workload. Both have commented that their team is their greatest support but also a huge responsibility. As the quote below

from Fazane Fox illustrates, this is particularly an issue for sustainable businesses that are committed to ethical treatment of staff.

If I want to grow my business, I'm going to have to take staff on which is scary ... [It is] very important to me ... making sure people are happy at work, well supported and paid properly ... [also in] all the factories. Because the human cost is ... sometimes worse than the environmental cost. A lot of time people forget that. (F1)

Struthers from LWR and Mummery from BW work on their own and commented that the step of taking on a permanent employee or an apprentice is a big one. All of the case-study businesses draw on business services, such as accounting or website development, either as a one-off service or on retainers, as well as banks. Many designers see their manufacturers or suppliers as very important actors in their networks. The suppliers understand the products and support the development process of specific garments. They also introduce designers to other suppliers if they do not have the capacity or experience to help. The fashion businesses also depend on general business support that they describe as either personal or institutional in nature.

Most of the businesses in our project have joined formal institutional networks and these networks exist in various parts of the UK. Makers Yard, where LWR is based, is a space for creative industries set up by the Leicester City Council. Fashion designers also have access to local and regional business support, which is funded through job-creation initiatives with the aim that the resident businesses will grow over time. However, as several of our respondents commented, they did not always find these services to be especially helpful as they did not want to expand but rather wanted to maintain their businesses in a steady state. For example, Struthers of LWR enjoys making clothes herself and does not wish to manage others doing the sewing.

In London, several design spaces and designers' networks dedicated to fashion designers exist. For example, Rachimova is part of several networks including the Lone Design Club (sales support), the Trampery (studio spaces), and the Fashion Innovation Agency at London College of Fashion (special projects). These networks are also a means of accessing business support as well as for meeting other designers. Several national networks, like UKFT and Make it British have been set up in the UK and operate both online and through face-to-face events; they also lobby on behalf of the overall fashion sector. These networks are led by committed individuals who customarily built up a personal relationship with the members but proved very agile in offering their services online. In particular,

during the pandemic, the designers interacted with their websites and spoke of these fashion-support organizations as websites.

Informal networks

Informal networks are often, but not exclusively, based on personal relationships. For many designers, their customers and clients are an important part of their network. Customers can provide feedback, encouragement, and inspiration. This assistance is particularly important for sustainable businesses that are usually committed to reducing waste and increasing longevity of garments. They want their customers to wear their clothing for a long time, but also to come back and buy new ones. Consequently, Sabinna, for example, has set up a repair service for her clothing. Both Sabinna and Black Horse Lane Atelier (mentioned above) run making workshops to get to know customers personally. Small businesses encounter their customers directly either online or physically if they run their own shops. Pop-up shops can be very successful, as customers often look online but like to buy in stores where they can see and feel the physical object. These retail facilities can also be a way to get quick feedback on specific garments, as customers comment on what they like and what alternatives they would have preferred, in particular around colors. Mummery writes, as mentioned above, a well-read blog but found that while she receives encouragement and press coverage through the online site, this network of readers did not translate into a significant number of orders. However, Mummery did use the blog to successfully crowdfund her collection in 2019.

For small fashion businesses, friends and particularly family members are an important part of their support network. Some of this assistance was highly practical, such as looking after children, while other relatives supported businesses financially, as the case of Fazane Fox illustrates. While BW, had recruited funders through the blog, an old friend of Mummery's also become her lead customer.

In summary, these four fashion designers have built their own informal networks of designers and contacts throughout their careers including former university classmates, previous work associates, colleagues sharing workspaces, or people they meet through others. We discuss the significance of these relationships in further detail in the following section.

The dynamic formation of networks

While the categories of actors persist, the actual membership of the network is highly dynamic. Designers are constantly searching for and finding

new collaborators and becoming part of other actors' networks. As this section explains in more detail, actors help each other find other actors.

The supply chain as an enabler of networks

While the supply chain can become a very important network for designers, this can involve many false starts. Prospective clients frequently contacted both LWR and Fazane Fox about developing samples for them. Many of these contacts lead nowhere, as many potential clients do not think through what it means to set up a fashion business and the costs and expertise involved in doing so. Both respondents invested time in explaining basic business aspects and nurturing their clients by formulating an understanding and specifying what they want to achieve. Consequently, both Struthers and Fox have developed detailed explanations for different types of requests that they send out before engaging in a personal dialogue. Nevertheless, they have developed long-standing collaborations with client companies. Equally, finding suitable suppliers or manufacturers can be challenging for small sustainable fashion businesses, as the example of BW illustrates. However, once Mummery found her organic fabric supplier he was instrumental in introducing her to a local garment manufacturer.

Product developers like Fazane Fox find factories for their clients and Fox has many manufacturers on her books. She works with companies in Portugal that are well connected among themselves, and they pass work on to businesses they know if they do not have the technical knowhow, capability, or capacity to do the work themselves. Due to the effort involved in researching sustainable credentials, all sustainable businesses included in this project have a fairly stable manufacturing base and value relationships built up with suppliers. Sabinna has developed a small range of suppliers that pay fair wages to all of their staff including interns and produce locally (in Austria and the UK). In addition, she has hired seamstresses who sew directly for her. Small sustainable businesses also work for each other to help each other out.

The peer group of designers

University friends and former colleagues often provide practical support for designers. For example, Struthers stayed in touch with a former tutor who gave her access to production machines that he personally owned. Old friends also act as sounding boards and advisors. Rachimova is still in touch with many of her university colleagues in London and has also become a part-time lecturer which has

enabled her to build up connections with other full-time and temporary staff. She brings them in for specific tasks as collaborators on one-off projects. In particular, the physical proximity to the peer group of other designers plays a crucial role in fostering collaboration for the designer brands. Fox also teaches on a part-time basis at Derby University and has benefited from both the personal connections and the professional acknowledgement associated with this role. Giving recommendations and making introductions to businesses services, staff, manufacturers, or suppliers is also an important function of these informal networks.

Unfortunately, these collaborations can take a long time to set up. Rachimova, who is considering working with a business located next door, commented in February 2021:

With collaborations you need to be a way ahead. So, we definitely have it planned out I think until almost August now and we are now starting to contact people for Christmas collaborations. (S3)

Time is required for ideas to develop as well as to negotiate the commercial aspects of a collaboration. This situation illustrates that many networks grow organically over time and are based on shared values. The relationship is markedly different when designers like Rachimova are hired as consultants by other brands. These potentially very lucrative arrangements, where the designer is in the role of a service provider, have clear deliverables.

The serendipity of collaboration

Many business arrangements are dynamic, informal, and serendipitous and networks tend to form through personal contacts. The resulting connections are a response to fluid opportunities and needs. LWR shares an office space with several lone designers, including Claire Shell from Pin Curls Vintage (PCV), who offer a range of vintage-inspired activities, including selling mid-twentieth century clothing. During the COVID-19 crisis, both Struthers and Shell struggled to maintain their businesses. When Struthers' business was further hit by import and export complications from Brexit, she changed her business model and commissioned LWR to make replica-1940s garments using period fabric and haberdashery. Struthers' pattern-cutting and sampling skills enabled her to adapt historic styles to larger contemporary bodies; she and Shell viewed the use of historic fabric and well-fitting clothes as a pathway to sustainability. Shell had a business background and saw the advantage of Struthers' complementary expertise but also wanted to provide employment to her friend. She introduced LWR to a previous client who sells burlesque

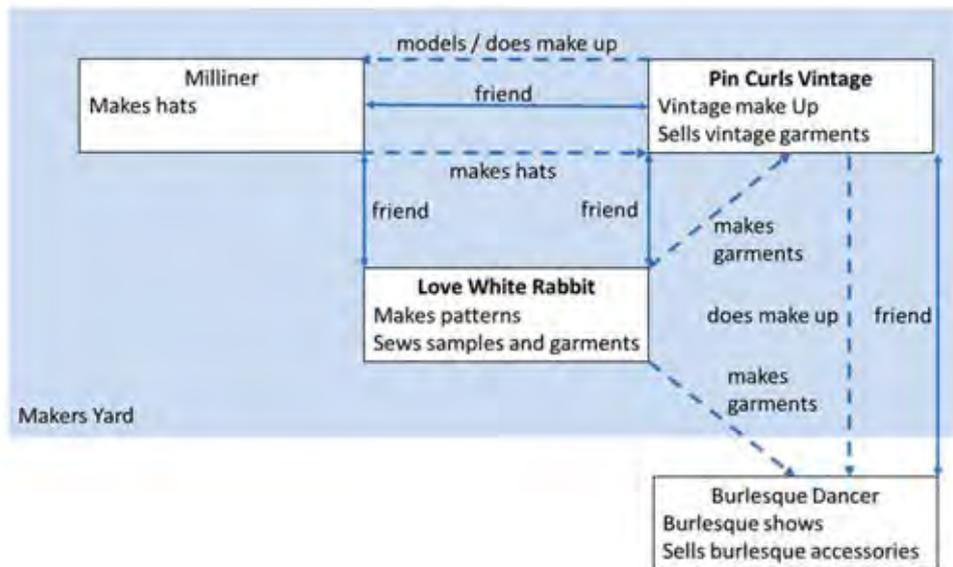


Figure 4. LWR's Collaborators.

equipment. Physical proximity played an important role in developing their ideas as well as their businesses.

I mean we're all really good... between us we have like a little fashion community going... I mean what we really push towards is sort of the quality of the design and the outcome. So, we have the same aesthetics in that group, so we find it very easy to tell each other what to do in their businesses and how to deal with customers and clients. (LWR1)

LWR, PCV, and a milliner are located in the same space and this proximity enables them to advise and support each other with ideas and practical suggestions. They also exchange services. Rather than having a formal contractual arrangement, they swap small services. For example, Shell did make-up for the milliner's photoshoot and received a hat in exchange. Figure 4 illustrates the network that supported Struthers and LWR during the pandemic. This network is based on friendship, trust, and complementary expertise and it has enabled them to open up to each other and to bounce ideas around. Acquaintances or friends-of-friends can become collaborators when opportunity arises, and necessity demands it.

The case of BW made apparent how difficult it can be to set up collaboration without personal networks. The business is geographically isolated and for personal reasons Mummery could not easily join non-local networks. While she contacted similar businesses online for advice, she did not have the opportunity to develop the personal relationships and to gestate shared ideas. Especially for designers, serendipity is important for finding new projects and business opportunities. The situation is quite different for product developers like Fazane Fox

who are often sought out by clients on the basis of personal recommendations.

Working in informal networks

Formal contractual relationships define specific interactions or create a framework for various types of services which are set up indefinitely until the aligned business run into problems, stop trading, or change their values or policies. Informal networks with often stable long-term relationships give rise to different modes of support between the members. While much of the assistance provided by informal networks can take place remotely, physical co-location plays an important part in how easily some of these relationships work.

Modes of working

Informal personal networks operate on different levels of engagement and commitment ranging from simple encouragement and advice to working together or working for each other, as discussed below, and illustrated across the four case studies.

Encouragement

For fashion designers, success and failure are very personal and this unavoidable feature makes direct encouragement very important. BW's collection proved challenging to sell even though it had received very positive media coverage. The situation was emotionally challenging for the designer as she lives far from other designers, and this limits her ability to be in close contact with a wider community. In contrast, in a shared workspace like Maker's Yard designers can support each other and consult on small-scale design decisions such as color

combinations. Others act as sounding boards and proxies for customers. For example, Struthers of LWR and Shell of PCV realized that they were onto a good thing when they sold all their palazzo trousers to work colleagues before listing them in PCV's online Etsy store. Conversely, if designers are not complimented on their creations, they can take this silence as a signal that the item may need improvement. This informal support takes very little time or commitment by any of the actors but it serves an important purpose in reinforcing relationships.

Recommendations

Designers who have trusted networks give each other recommendations, for example, for suitable suppliers, manufacturers, or service providers. Designers often gain business through these personal referrals and may also share information regarding poor experiences such as with particular wholesale customers.

Swapping services

As many relationships in the design field are based on personal friendships, designers try to help each other out. For example, when deadlines are looming, they might assist each other with packing. Rachimova commented on designers aiding each other with the customs declarations required since Brexit and Phoebe English initiated the pooling of surplus fabrics among a group of London designers. There is moreover a degree of expectation of mutuality. In some cases, there is a direct bartering of services or products, which gives designers access to high-quality products and services that they could not otherwise afford. This also applies to business-support services. For example, LWR commented that within her shared workspace she offered web design to other businesses while another business helped her with social media.

Working for other designers

Designers often have rather fluid working relationship with each other. This can start with a favor or informal hourly assignment and then turn into a contractual relationship, as illustrated in the section above on the serendipity of collaboration.

Collaborations

Designers also engage in joint projects with their counterparts where they operate as equal partners. For example, Rachimova was at the time of our interview engaging in a collaboration with a jewelry designer. This relationship enabled both parties to increase their exposure, to try out new ideas, and to be inspired by others. These can be one-off partnerships or long-term arrangements. For example, via

the Fashion Innovation Agency at the London College of Fashion, Rachimova collaborated with digital designers RYOT studio on a project that interpreted her design concepts for an immersive digital presentation as a virtual event that was part of London Fashion Week during the pandemic.⁴

A significant instance of designer collaboration took place in 2020 during the COVID-19 crisis using networks for a wider purpose. Three London-based fashion designers (Holly Fulton, Phoebe English, and Bethany Williams) formed the Emergency Designer Network to create and deliver personal protective equipment – coveralls known as “scrubs” – for NHS hospitals. Using their own trusted networks, they put together teams and raised funds through crowdsourcing and donations to provide materials and to pay workers. With the assistance of industry-support organizations, both makers and factories went into production of scrubs locally and across the UK.

The importance of physical proximity

The pandemic has highlighted the importance of physical proximity. For example, the collaboration described in [Figure 4](#), has come out of a shared space, in particular a coffee area where people meet and chat. Capdevila (2019) describes three different types of co-working spaces: (1) sharing a space and assets to reduce costs for individual businesses without collaboration, (2) limited and focused collaboration, and (3) the emergence of a highly innovative community that engages in collaborative practices to create new knowledge and gain new resources. During the lockdown, the designers particularly missed the shared access to machinery as well as the ability to come up with new ideas together and to bounce ideas off each other. The second point – limited and focused collaboration – was easier to achieve. While designers can be successful in working remotely and moving their consumer interactions online, the tactile nature of fashion makes some activities (such as assessing fabric properties or fit), difficult to do remotely.

Support organizations facilitate the networking of designers. Local agencies can encourage access to new networks and mobility of labor, thus having interchanges to transfer knowledge (Ashton 2006). Some of these associations also provide the physical space to collaborate. The case studies illustrate a stark difference between, on one hand, the highly active and well-supported shared workspaces and networks in London (where Sabinna and most of our respondents in the FSP project are based) and, on the other hand, the Midlands (where the other three case-study companies are located). London is

recognized as a creative cluster with resources, knowledge, and strong local networks (Rieple et al. 2018, Azuma and Fernie 2003; Ashton 2006). For Rachimova, her local networks have been a hugely useful opportunity to meet other designers and to gain visibility herself, for example, to become part of the research project reported in this article. Her London networks really understand the needs of sustainable fashion designers and have been able to offer her specific support. Her studio/shop is also physically located next to those of other sustainable fashion businesses and near others in the neighborhood.

By contrast, the Midlands companies had to rely on more general networks. Maker's Yard is a creative industry space but does not seem to offer the level of support experienced by other case studies in London. The City of Leicester, where Maker's Yard is located, has been an industrial district for fashion production since the early decades of the nineteenth century, but more recently it has become known for fast fashion and exploitative work practices. LWR and her network deliberately distanced themselves from these practices and had to actively fight the reputation of Leicester.

Fazane Fox received general regional business support and managed to find a network of local young entrepreneurs with whom she talked about general business challenges. BW largely relied on national online resources. Physical proximity also played a part during the pandemic-induced lockdown when both Fazane Fox and Sabina Rachimova obtained assistance from their staff while Ismay Mummery of BW became further isolated.

None of the case-study designers utilized or attended traditional business-networking events intended to introduce businesspeople to each other and to exchange experiences. Instead, they tend to receive business advice through digital networks as the following quote by Fazane Fox illustrates:

I'm not a massive fan of networking in its traditional sense where you go to all these events. I used to do that a lot with my brand and hated it but that was necessary because I needed to meet the businesswomen that were going to wear my clothes. I don't do any of that anymore. We get business and meet contacts through the website, social media, so Instagram and Facebook. (F1)

As Gu (2014) also identified in his study of creative entrepreneurs, the four case studies discussed here formed their business networks based on bonds of trust and social relationships rather than the more traditional approach based on business advantage. For our respondent companies, shared values were an important selection factor for any actors in

their networks. Regarding some activities, such as collaboration, they prioritized cognitive proximity over physical proximity. However, they also enjoyed the benefits of personal interactions and belonging to a community that comes from physical proximity.

Networks enabling sustainability

The sustainable fashion businesses in the FSP project were driven by strong moral values. All were extremely disillusioned with the fashion industry in general and wanted to earn a living in a more ethical manner. Ethical working was particularly important to these sustainable businesses and the owners strived to be good employers themselves and did not want to be associated with suppliers that exploited their workers. They discussed ways of being sustainable within their informal networks and learned from each other how to increase the sustainability of their performance.

The categories of network actors in Figure 3 cover all of the small fashion businesses studied in the FSP project and exemplified by the four case-study businesses. However, the number and relative importance of the actors under each category are strongly influenced by the sustainable values of the business owners. All of our respondent businesses are highly committed to sustainability across the entire supply chain and the life cycle of the product.

- *Supply chain*: The designers wanted transparency across their supply chain and to be able to trace their production processes and materials as far back as possible. All worked with a small set of carefully selected suppliers which had been able to provide information to demonstrate their ethical credentials. For example, the designers wanted to ensure that their suppliers paid fair wages or used organic materials, if possible. They also wanted to source locally, or in the case of Fazane Fox, to purchase from one location to minimize transportation. Their suppliers typically were also small businesses committed to sustainability and this led to strong and persistent personal relationships. Often, they spoke directly to the owner of their supplier company and received business advice from them.
- *Personal interaction with customers*: The four cases and others in the FSP project looked to personal contact with their customers or clients to understand what customers wanted and how they used the garments. Based on this feedback the businesses took active steps to prolong the

life of their garments by offering repair services or resale options.

The case-study designers were passionate about their businesses and business success was very personal for them. This combination of enthusiasm and vulnerability also drew in a lot of personal support from friends and family. All the parents of the case-study designers seemed highly committed to supporting their daughters through emotional, practical, or financial help.

Perhaps not inevitably, but often, striving for sustainability pushes up the cost of products, but working together by sharing knowledge and resources and/or exchanging services enabled the businesses to stay competitive. Using up each other's spare resources also minimizes waste. Bartering services was another important way of making sustainable fashion affordable for more customers. Forming networks and collaborating also generates opportunities for small sustainable fashion MSEs businesses, for example, by running joint pop-up shops or workshops.

Conflation of human and nonhuman actors

ANT gives equal agency to human and non-human actors, such as websites, institutions, and garments. These non-human actors promote and enable activities by human actors and facilitate the creation of networks. However, distinguishing between, on one hand, human actors and, on the other hand, business and institutions can be ambiguous in the case of the networks of small sustainable fashion businesses. For example, institutions, such as Make it British are run by a person, who also runs an online platform, to help fashion businesses to find human suppliers. In pre-pandemic times the individual small businesses would also connect physically in face-to-face events and trade fairs and talk to the online platform's owner directly. The distinction between person and online platform can thus become blurred and the two can be conflated.

The case-study companies also referred to the members of their networks both as the businesses and as the people. For example, the customers and suppliers of Fazane Fox interacted with the business – Fox and her employees – while some had only personal relationships with Fox. In talking about other businesses, the interviewees switched between the name of people and the name of businesses (e.g., Struthers talked about working for “Claire” or for Pin Curl Vintage depending on the context). This conflation of business and person is highly prevalent in the designer-fashion sector where the

business and brand name are very often the personal name of the designer. The merging also masks the contribution of design and production teams behind the culture of the “genius designer.” In contrast, within the case-study businesses, both Fox and Rachimova were deeply concerned about the well-being of their employees, especially during the pandemic and listed them among their most important network members.

Conflation between the person and the role is an important element of relationships within formal networks both in employer-employee relationships and in collaborations. The blurring between the personal and the professional was also evident in the bartering of services, as illustrated by PCV receiving a hat as payment. It was not clear whether this was a friend helping out and receiving a gift or an in-kind business exchange.

The businesses constructed strong personal relationships with their suppliers which tended to blur the boundary between the person and the organization. For most of the designers that we studied in the FSB project, it was important to trace the supply chain of their materials back to their sources to ensure that they had been produced sustainably. Some designers depended on the word of their immediate supplier while others traced the materials further back, but all had to take some assertions on trust. This trust was built through knowing the suppliers personally, even though not all were local, and enabled the case-study businesses to establish a small base of trusted suppliers. To cope with the ebbs and flows of business, the companies also depended on their employees and suppliers to work overtime, if necessary.

Conclusion

This article describes the networks of micro- and small-sized businesses in the fashion-design industry. While the map in [Figure 3](#) is based on the 27 companies that we studied in the FSB project, most of our insights are drawn from four main case-study companies. However, many of the observations could apply to fashion micro- and small-sized businesses in general. The high standards for sustainability added a burden that increased the need for support from the designers' networks. Taking an ANT-informed approach, we analyzed support by other designers, businesses, and organizations, but also websites and social media, which were offered by the businesses as part of their support networks. We show how even small businesses depend on large and heterogeneous networks. While some of these relationships are formal, many of them are

between network partners and are deeply personal to the extent that the person and the business or organization of which they are part become conflated.

Physical proximity is important for the designers to get to know each other and to gestate ideas over time. Co-location in shared studio spaces and physical neighborhoods is an important enabler of collaboration. This particularly applies in London which has a high concentration of creative clusters centered around universities and their fashion alumni as well as specialized support organizations that understand the needs of fashion businesses and can advise and publicize the designers. In the absence of connections provided by a local fashion cluster, the designers in the Midlands tend to depend on personal informal networks or contacts they make online. Regardless of specific geographic location, networks provide important sources of both emotional and practical support.

The dynamic nature of networks is an important enabler of success and resilience for the designers. The people the case-study designers chose to interact with were those they aligned with cognitively and with whom they shared an outlook and values. In times of change or difficulty, such as during the pandemic, new collaborations could thrive based on recent physical proximity and pre-existing personal networks, irrespective of size. Regardless of the circumstances, networks, formal and informal, provide vital support for micro- and small-sized business without which few businesses could thrive. In particular knowledge about sustainability and ways to operate sustainably are shared through such networks.

Notes

1. See case studies at Fostering Sustainable Practices (<http://www.sustainable-fashion.com>).
2. See <https://www.fashion-district.co.uk/wp-content/uploads/2018/09/East-London-Fashion-Cluster-Draft-and-Strategy-Plan.pdf>.
3. This initiative was founded in 2017 to support the regeneration of the creative fashion industry in East London and supported by the London College of Fashion (University of the Arts London) and five London boroughs. See <https://www.fashion-district.co.uk>.
4. See <https://www.sabinna.com/ryot-studio-x-fia-x-sabinna>.

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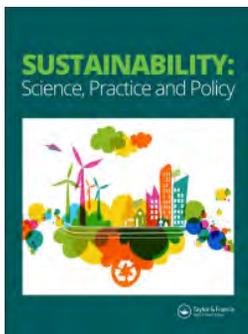
Claudia Eckert  <http://orcid.org/0000-0002-2201-3828>

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Fashion in turmoil: impact of the COVID-19 pandemic on Finland's textile and fashion industry

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ABSTRACT

With continuing climate change, consumers are reconsidering their fashion-consumption habits and clothing and apparel businesses are critically examining their industrial practices. The coronavirus pandemic can be considered a turning point as it has significantly affected the textile and fashion industry. By applying path-dependence theory to analyze developments in the textile and fashion industry in Finland, this study investigates prior pivotal moments to better understand how crises can provide possibilities for transformation. We first provide a historical review that aims to identify external shocks as major transitional events and examines their implications for short- and long-term trends. The study then analyzes the changes triggered by COVID-19 in the textile and fashion industry using empirical data collected from Finnish companies. The study reveals that the pandemic forced some firms to introduce several changes into their practices as part of efforts to survive, including innovations at all levels of design and manufacturing as well as new ways of managing sales and marketing. In addition, the crisis has been an opportunity to take steps toward societal and environmental transformation through more open and responsible business models involving a shift to local or close-by production to reduce environmental impact, to secure decent factory-working conditions, and to engage customers to reduce their consumption. The article concludes by considering issues relevant to the future of this industry during the post-pandemic period.

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Introduction

The climate crisis has forced consumers to reconsider their consumption habits, prompting fashion businesses to critically examine their industrial practices (Niinimäki et al. 2020). The international outbreak of COVID-19 in early 2020 created a new sense of urgency and could prove to be a turning point for many economic activities, especially the textile and fashion industry (Brydges et al. 2020; Cohen 2020) which has been grounded strongly on a fast-fashion business model and cheap and effective mass manufacturing in lower-cost countries in the global South during the past 25 years (Niinimäki et al. 2020). The health emergency hit this industry hard but at the same time pointed to instructive ways to survive.

The pandemic triggered numerous restrictions, uncertainties, and difficulties regarding production and transportation and influenced the behavior of consumers, increasing pressure on the industry to

become more sustainable and transparent (e.g., Black 2020; Brydges et al. 2020; D'Adamo and Lupi 2021; Iran et al. 2022). COVID-19 affected the entire textile and fashion field and revealed its hidden backstage, exposing many of its negative aspects and increasing the need for innovation and greater responsibility throughout the supply chain (see also Brydges and Hanlon 2020). For example, the pandemic revealed power imbalances in the production system while the global brands did not pay their suppliers for orders commissioned in the global South when fashion consumption diminished especially during the spring and autumn of 2020 (Clean Clothes Campaign 2021). In January 2021, we could read news about garment-factory workers who were facing hard times due to wage cuts and forced resignations. The situation was particularly severe in Bangladesh where textile and fashion production has a high societal impact and crises can even

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prompt political unrest (Anguelov 2015; Niinimäki 2023).

The effects of COVID-19 on the production and consumption system has drawn the attention of several scholars who have investigated, for instance, how the pandemic could support sustainability transitions toward system-level change, including consumption transitions (Cohen 2020; Seibel et al. 2021; Iran et al. 2022), “glocalization” (Goffman 2020), and evolution toward a more sustainable industry (Brydges et al. 2020). Recent studies have also focused on corporate social responsibility (CSR) issues (e.g., Pelikánová et al. 2021) demonstrating the significance that consumers attach to these practices (Vățămănescu et al. 2021) and how the pandemic has affected CSR trends and attitudes of front-line employees and customers (Cvik and Pelikánová 2021, 120). Furthermore, Wischer (2020) studied how the pandemic has affected sustainability movements in the textile and fashion industry, revealing the precarious ways that employees are often treated. Brydges et al. (2021) examined the evolution of the Australian fashion industry and the external shock triggered by COVID-19. Impacts on firm-level dynamics, garment production, and fashion retail were the three key spaces where the pandemic affected the path-dependent evolution of the Australian fashion industry. Moreover, alongside local production, Brydges and colleagues anticipated that sustainability would be a growing priority during and following the pandemic. However, contrary to many studies, Cvik and Pelikánová (2021, 120) revealed “discrepancies and lack of readiness to embrace COVID-19 as an opportunity to move to sustainable entrepreneurship” and showed that crises have not brought new opportunities but instead have “magnified the prior difference.”

Given the historical evidence that crises of various kinds can open windows of opportunity to change regional industrial trajectories (Rantisi 2004, 104), the use of path-dependence theory can provide a fruitful point of departure for examining the role of disruption in the evolution of the textile and fashion industry. To extend recent studies, we set out to examine the evolution of the Finnish textile and fashion industry and the immediate impacts of COVID-19. We apply this approach to understand how the industry has evolved over time and discuss the impacts of the pandemic to date. Finland offers an empirical context where the total amount of money spent on clothing during 1994–2019 more than doubled (STJM 2021) and global players came to dominate the market. While there are national characteristics of the domestic textile and fashion industry—such as high-quality products, creative design, and emphasis on research and

development—Finland is part of the European Union and thus follows the bloc’s regulations to increase industrial sustainability. Even if the country is located in the “second tier” from the viewpoint of the major European and global fashion centers (Rantisi 2011), it can provide useful evidence of more geographically extensive developments.

The article is structured as follows. The second section introduces path dependence as the theoretical underpinning and provides a historical review of both the Finnish textile and fashion industry and the various crises that have shaped it. The third section explains the empirical data and methods used in our study. The fourth section presents an analysis of the immediate impact that COVID-19 has had on the country’s textile and fashion industry, businesses, and consumption in 2020. The fifth section draws on this history of the turning points in textile and fashion and we interpret this knowledge in light of the pandemic. We conclude the study by anticipating future themes for the industry as well as its activities, responsibilities, and esthetics.

Theoretical and historical underpinnings

Path dependence

Path dependence emerged in evolutionary economics to describe how and why certain technologies gain dominance, sometimes owing to a minor advantage or random event (Arthur 1989; David 1985). The concept implies that current and future states, actions, or decisions depend on the path of previous states, actions, or decisions (Page 2006). The assertion that “history matters” is the basis of path-dependence theory. “[W]hat happened at an earlier point in time will affect the possible outcomes of a sequence of events occurring at a later point in time” (Sewell 1996, 262–263).

Path dependence is often coupled with the concept of lock-in (Arthur 1989; Unruh 2000) which refers to how decisions made in the past hinder new developments and create structural and systemic logics that resist efforts to encourage change. Path dependence concerns not only individual technologies but also technological systems or regimes (Unruh 2000). These dependencies can be defined as “large-scale historical patterns caused by lock-ins in specific sectors, or technological pathways that become self-reinforcing” (Aalto et al. 2021, 15).

Path dependence has been used to study a wide range of phenomena. Applications of the general approach have expanded from technologies to institutions and organizations and path-dependence theory has also been applied to analyses of local and regional economic development to show how historical events can drive certain regions to specialize in

specific industries (e.g., Cooke and Morgan 1998; Maskell and Malmberg 1999). The application of the path-dependence concept to local and regional economic development emphasizes the role of history in forming the practices and relationships of firms and industries in particular places (Rantisi 2004). Brydges et al. (2021) identified several existing historical industrial strengths (e.g., developing capacity for domestic manufacturing, investing in quality, and emphasizing design over production costs) that supported the Australian fashion industry's response to COVID-19. The authors further found that many of the country's fashion-design brands were innovative and adaptive in their responses to the pandemic, finding new ways to connect with consumers and buyers, making investments in digital retailing and promotions, and retraining staff. These innovations have not been radical but rather were immediate responses that were consistent with the previously established pathway. According to Brydges et al. (2021), the pandemic has also reinforced the importance of having strong brand aesthetics and identities that resonate with consumers, an opportunity that has particularly concerned brands that embrace and promote a sustainability mandate.

Historical context: path dependence in the Finnish textile and fashion industry

The textile and fashion industry has changed over the years, not least due to external shocks to the system. We examine some events in the history of this industry in Finland that served as either external perturbations or turning points with respect to production (see Figure 1). These events have also placed the industry on a new trajectory or at least made it adapt to the situation within the confines of

the same pathway, as it is often easier to continue on the same path. As Beyer (2020) points out, changes are in most cases gradual but “innovations or crises can lead to a situation where old key conceptions are called into question and replaced with new ones.” By “shocks” we mean a sudden upsetting or surprising event or experience, and we use the term “turning point” for occasions when a decisive change occurs in a situation, most probably resulting from a shock. The events are analyzed using the path-dependence theory.

Phase I: favoring domestic production and industrialization, and the rise of social responsibility, 1700s–1910s

The Finnish textile industry emerged in the middle of the eighteenth century. In 1738, the Wechter wool factory was established in Turku following enactment of a statute to ensure that the equipment and materials provided for military use would be domestically produced (TIM 2006). The development of industrial machinery in England, such as the Spinning Jenny in 1767, as well as weaving and printing machines, steam- and water-powered machinery, and fabrication of strong cotton yarn for machine weaving also helped pave the way for the rise of industrialization and especially cotton and linen factories in Finland in the next century (Niinimäki and Saloniemi 2008, 17).

The Russian markets opened up to Finland when Russia obtained suzerainty over Finland beginning in 1809. Before this time, Finland was part of Swedish territory. Linen fabric and cotton became popular in St. Petersburg and this was a market opportunity for Finnish textile factories (TIM 2006). A new era began when James Finlayson, a Scottish immigrant, founded a factory in Tampere in 1820. The location was desirable because of its proximity

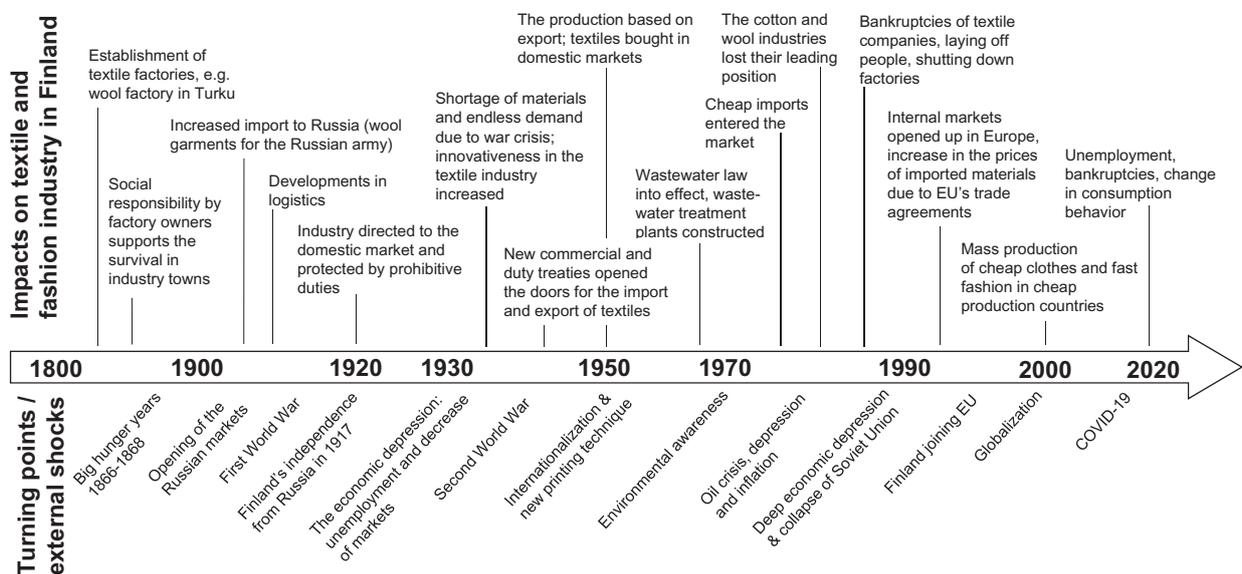


Figure 1. Turning points and their impact on the textile and fashion industry in Finland.

to ample hydropower created by a rapid river flowing through the city. Finlayson started by producing textile machines, but in 1828 switched to manufacturing cotton yarn for the Russian market. Ten years later, the first weaving machines began to produce cotton fabrics (Tanninen 2014, 8; TIM 2006). By the middle of the nineteenth century, 75% of the cotton fabric manufactured in Finland was being exported to Russia. The development of infrastructure—for example the Riihimäki-St. Petersburg railway in 1870—further accelerated textile exports. However, domestic textile demand in Finland did not begin to increase until a period of economic expansion starting in the 1870s (Niinimäki and Saloniemi 2008, 21).

As was the case more generally during the nineteenth century, child labor was common in Finnish textile factories. Children (and women as well) received lower remuneration than men and textile-factory owners were important actors in the social development of cities and towns. They established schools for children working in the factories, provided health care for workers, and built retirement homes for former workers. For instance, Finlayson established an orphanage in Tampere in 1821 and a school for children in 1840. In 1890, children younger than the age of twelve were prohibited from working in factories (Niinimäki and Saloniemi 2008).

At the beginning of the twentieth century, the textile industry in Finland achieved further success and its position was further strengthened by World War I. Imports to Russia continued to increase as the wool industry in particular produced garments for use by the Russian army and cotton production was also exported due to shortages of the commodity in Russia (TIM 2006).

In summary, the combination of technical developments (machinery and energy) and fiber advancements made large-scale industrialization possible. Industrialization also contributed to societal modernization. The industrialists who took an interest in the welfare and well-being of their workers established the foundations for contemporary interest in CSR. The favoring of domestic production, as well as developments in logistics (for example the train line to Russia), helped the Finnish industry to grow. The first implication that we draw of the turning points in Phase I is that favoring domestic production may lead to a growing domestic textile industry (during crises) and reduce risks in business activities.

Phase II: the early decades of independence—war-time and economic depression, 1910s–1940s

The year 1917 became a true turning point in the history of the Finnish textile industry when Finland

declared independence from Russia. Domestic textile manufacturers lost access to former Russian markets and needed to reorient themselves to the smaller domestic market which was protected from imports by prohibitive duties (TIM 2006). During the 1920s and 1930s, the industry grew in size as the Finnish population became more affluent and could afford to buy clothes from retail shops (Tanninen 2014, 10). However, the economic depression in 1929 and the early years of the following decade led to unemployment and a decline in markets (TIM 2006).

World War II then triggered a shortage of materials and endless demand. Men and even women were called to war and there were no longer enough industrial workers and women were recruited in large numbers to join the industrial labor force (TIM 2006). In the 1940s, the shortage of materials limited textile production and innovative approaches were needed to find substitute materials. Several factories manufactured viscose-type fabrics and Tampella (a manufacturer of heavy industrial machinery) even produced paper textiles to replace linen. The Finnish army needed a great deal of gauze which was manufactured in overtime shifts. The war crisis and the lack of traditional materials strengthened the textile industry's capacity for innovation. Old bed sheets were printed to make new window curtains and dress fabrics and beautiful patterns were designed to cover the uneven and cheap bottom fabric. Design was used to improve morale and to promote a positive and uplifting outlook (Niinimäki and Saloniemi 2008).

Overall, during Phase II, the declaration of independence and the subsequent war changed the situation in the Finnish textile industry and ended the long period of relying on export to Russia. Production remained domestic but the output was directed to a much smaller market. This situation highlighted the vulnerability of bilateral trade and economic crisis and war meant difficult times for the industry, but creativity flourished. Accordingly, the second implication of the crises is that scarcity of materials leads to increased innovation and creativity. The rise of independence also turned the industry's attention to finding its own "style" in printed textiles. Most designs were previously imported from other countries (e.g., the UK and France), and now the public discussion in applied arts circles favored more modern textile design and many Finnish companies began to hire domestic designers. The public discussion highlighted the importance of supporting domestic production from the country's cotton factories (e.g., the new floral textile type "cretonne"). Industrial facilities began to invest in new machinery such as new printing and

dyeing machines which enabled the production of new types of textiles (Niinimäki and Saloniemi 2008, 38).

Phase III: the era of internationalization and the rise of environmental awareness, 1950–1970s

Textile production in Finland during the period following World War II focused on internationalization and is sometimes referred to as “the golden age of Finnish design” (Korhonen 2016, 16). The distinctiveness of this era was established in the 1950s, especially through multinational competitions and new commercial and duty treaties opened the doors for international trade of textiles. New factories in the country started to produce printed fabrics in the 1960s and fast-rotation printing technology and new reactive dye types accelerated this development. Non-wrinkle nylon shirts and easy-care polyester fabric partly substituted for cotton. In 1979, half of the textiles and 80% of the clothes purchased in Finland were domestically manufactured (Niinimäki and Saloniemi 2008; TIM 2006). Moreover, the bilateral trade (clearance trade) with the Soviet Union during 1970s and 1980s provided a stable and safe income for the textile industry, yet it prevented development of other important export markets.

The 1970s also saw growing environmental consciousness on the part of textile producers. The increase of textile factories during the 1960s led to visible waste problems in close proximity to factories, for example dye-treated wastewater released into a nearby river colored the river red, blue, and other hues (Niinimäki and Saloniemi 2008). A new wastewater law came into effect in 1961, but it was not until the 1970s that towns and factories began to construct wastewater-treatment plants. The oil crisis in 1973–1974 had a global impact and affected the Finnish textile industry as “stagflation” led to bankruptcies and an increase in imported garments. The country’s cotton and wool industries lost their leading positions and cheap clothing started to enter the market during the decade (TIM 2006).

To conclude, Phase III, or the golden age of the Finnish textile industry, was a critical period of development for domestic manufacturers with companies such as *Marimekko* gaining prominence. This phase was also characterized by bilateral trade with the Soviet Union which was profitable for the Finnish textile and fashion industry in the 1970s and 1980s. During this phase, both internationalization and bilateral trade created new opportunities for domestic production to be exported abroad. However, in tandem with the growth of the Finnish textile industry, environmental concerns gained in

prominence and industry itself begin to implement interventions to address these problems.

Phase IV: the modern era: from deep economic depression to globalization and climate change, 1990s–present

The third implication of the crises had its roots in Phase III and became increasingly visible in Phase IV. It is characterized by the globalization of markets that led to inexpensive imports taking over at the expense of domestic production. Finland was doomed to lose the competition to cheap sources of foreign production. A decline in clothing manufacturing in the country had already begun at the end of the 1980s (Korhonen 2016, 19) and was further exacerbated by both the deep economic depression of the 1990s and the collapse of the Soviet Union in 1991, leading to a widespread pattern of bankruptcy of Finnish textile producers. Finlayson, for instance, had to lay off workers and shut down its weaving factory in Tampere in the 1990s. The only redeeming feature of this situation was the increasing domestic and international demand for specialty textiles for use in restaurants and by hospitals and construction companies that began in 1993. In the case of these markets, the higher level of technical knowledge embedded in the garments prevented low-cost alternatives from gaining a dominant market position (TIM 2006).

With establishment of the European Economic Area in 1992, information on the origin of products disappeared. When Finland joined the European Union (EU) in 1995, internal markets opened up in Europe and international businesses were guided by the EU’s trade agreements, leading to an increase in the prices of imported materials. Given the challenges of robust business competition, the only way for domestic textile producers to survive was to out-source manufacturing to lower-cost countries (Niinimäki and Saloniemi 2008).

To sum up Phase IV, since the beginning of the 21st century, globalization of the textile and fashion industry has accelerated and the notion of infinite growth has become predominant. Especially notable has been the role of fast fashion which constantly produces new and cheap garments. This mode of production has become mainstream and has led the fashion industry to become the second most polluting economic activity in the world (UNCTAD 2019). Clothing is manufactured in low-income countries under oftentimes poor working conditions, and this strategy leads to the production of cheap, low-quality clothes that are highly profitable (Buchel et al. 2018, 11), but with significant social and environmental impacts that are invisible to end consumers (Niinimäki et al. 2020). Finland is no exception

to this global situation and most of the textiles and garments produced by Finnish companies are manufactured in accordance with this business model.

The textile and fashion industry in both Finland and the rest of the world now faces a new problem. The restrictions caused by COVID-19 resulted in governments closing manufacturing plants, stores shutting down, events being canceled, and consumer demand decreasing due to remote work and the rise of homebound lifestyles. In the meantime, the wider base of consumers had already started to become more aware of the effects of fast fashion in terms of climate change before the pandemic period (e.g., Niinimäki et al. 2020; Accenture 2020) but has more recently—at least in some parts of the world—become cognizant of the sufficiency challenges associated with material production (e.g., impossible to achieve increases in cotton cultivation, need to decrease the scale of the fashion system and aggregate consumption) (e.g., Niinimäki et al. 2020; Niinimäki 2021; Iran et al. 2022; Coscieme et al. 2022; Vladimirova et al. 2022). Another implication of the crises in the textile and fashion industry is that these events have exposed the backstage that had previously been hidden from the public, revealing many negative aspects of contemporary production and raising the need for a new kind of openness and greater responsibility throughout the supply chain.

Methods

Data collection

The empirical data for this study were derived from two sources: online ethnographic observation and a survey. First, the online ethnographic observations were carried out between March 2020 and June 2021 from sources including Twitter discussions, websites, and the Facebook pages of fashion companies in Finland. We also reviewed the national media, including articles in the *Fashion Finland* online journal and national newspapers.

The online ethnographic data collection focused on changes in business practices, design, and production in small Finnish fashion companies, and thus we identified and mapped the emerging discussions on fashion in connection with the COVID-19 crisis. The data were collected in an unstructured manner which is a qualitative, flexible, and loose method of gathering data (e.g., Turunen and Henninger 2022). Utilizing an unstructured approach, it was possible to follow the emerging phenomena and avoid a predefined focus which would have limited the scope of the findings (Eskola and Suoranta 1998). Such a technique has been found to be valuable in situations where

circumstances are changing rapidly and the unfolding of ensuing developments is hard to predict (Hirsjärvi et al. 2004). In ethnography, the aim is to understand the situation as a whole and not as different or separated variables (Eskola and Suoranta 1998), and in our case we applied the method to follow the changes triggered by the pandemic on business practices as well as on design and manufacturing. Additional data from Twitter focused especially on issues pertaining to social responsibility in global supply chains and we reviewed newspaper and online articles more generally about the COVID-19 crisis and its effects on Finnish companies. Online ethnographic data collection served two purposes—it informed primary survey-data preparation and provided supplementary data.

Second, we sent a qualitative survey with open-ended questions to 140 small Finnish fashion companies belonging to the sustainable fashion research consortium FINIX's e-mail distribution list. The list comprises all Finnish companies that have expressed an interest in following news related to the FINIX project.¹ We contacted companies using this list and included a link to the online survey. This particular survey was part of a larger research project conducted by the consortium that included five questions related to COVID-19 out of a larger instrument consisting of 26 items (see Appendix 1). The survey questions analyzed in this article focused on the immediate effects of the pandemic on the Finnish fashion industry including open-ended questions on the perceived impacts of the health emergency. Forty respondents from different companies replied to the survey, representing a response rate of 29%. A majority ($n = 34$) of them reported manufacturing and sales as their main business, followed by secondhand and resale ($n = 6$). The survey was open for 17 days between November and December 2020.

Data analysis

Data collection and analysis formed a cumulative process—we mapped the immediate effects of COVID-19 based on the online ethnographic observations. The aim was to focus on the role of crisis and change and to identify pivotal moments or elements for the textile and fashion industry. It became evident from the ethnographic observations that respondents discussed the pandemic especially in terms of adjustments in product design, production, customer relations, and sales. We then constructed the survey questions based on these observational findings. The survey expanded, validated, and redirected the online ethnographic observational data

collection which we continued for six more months after survey-data collection or until June 2021.

The process of analyzing the observational and qualitative survey data followed the same procedure. First, we mapped the immediate impacts and reactions of the textile and fashion companies. Second, we categorized the reactions and changes based on the themes that frequently emerged in the data. Third, we condensed the themes after the survey following the procedures employed by Buchel et al. (2018). Finally, we compared the immediate impacts and reactions in these themes to the previous literature and historical turning points to determine whether there were similarities in terms of the future paths of the market and industry. The longevity of the online ethnographic observations enabled us to follow the changes and to develop an understanding of how the companies evolved over time.

Results

Five themes emerged from the actions and behaviors of the respondent firms during the COVID-19 crisis and we condensed them to the following: (1) technology, fibers, and production, (2) business models and customer relations, (3) value-chain models and partnerships, (4) design, and (5) CSR and discuss them in turn in the following sections.

Impact on technology, fibers, and production

The technology and fibers niche is related to different types of innovations. Over one-third (35%, $n = 40$) of the small fashion companies answering the survey had to reorganize their production processes by, for example, creating new digital systems for manufacturing or other business activities. Ethnographic observations supported this finding, as many of the firms reported implementing and using digital online presentation tools and virtual environments, enabling remote meetings with their business clients instead of traveling to face-to-face appointments while travel restrictions were in effect.

COVID-19 affected brick-and-mortar stores by limiting the hours that they could be open and this situation pushed companies to move their actions toward online selling. The questionnaire revealed that some Finnish fashion brands without an online store presence before the pandemic started online sales to complement offline sales. Moreover, many companies that already had online store processes further improved them. For example, *R-Collection* is a family-owned firm started in 1978 and located in a small town in northern Finland. The company focuses on functional leisurewear and its iconic

garment is an anorak coat (*R-Collection* 2022). The firm increased its total sales by 40% in 2020 even though it had to close its physical stores for 2½ months during the spring of 2020 (Pölkki 2021). This achievement resulted from the company's giant leap into a digital culture which increased its online sales from €1.4 million in 2019 to €2.5 million in 2020 (Pölkki 2021).

Many respondent firms seemed to be in survival mode during the pandemic and numerous developments originated from actions undertaken to avoid bankruptcy (STJM 2020). In terms of fibers, it is notable that some companies focusing on redesign had to stop production for some time due to a lack of available recycled material when consumption froze. Furthermore, a huge global need for face-masks emerged in the spring of 2020. The vulnerability of global production and the availability of products posed a problem when manufacturing plants in China shut down due to the pandemic, triggering a shortage of protective garments for European hospitals. Many manufacturers in Finland were able to hire new workers and start domestic production and several of them succeeded in transforming their product lines very quickly to face-masks or other protective garments. For example, *Lifa Air* established a factory in Finland to produce respirators and surgical masks in the spring of 2020 (Lassila 2021) while others such as *Filterpak* and *Lumi Dental/Lumi Medical* also started manufacturing surgical masks (Hyttinen 2021), and still others like *Ahlström-Munksjö* developed new facemask materials (Fab 2020). In May 2020, many Finnish textile and fashion companies were involved in protective clothing production or material production for health-care purposes (STJM 2020). However, a year later, production dropped off due to a lack of demand as they could not compete with lower priced Chinese-manufactured surgical masks (Hyttinen 2021).

Impact on business models and customer relations

As many as 75% of the companies needed to create new ways to reach their customers. Under the "business model and customer relations" theme, most of the short-term changes related to development of deeper customer relationships with new ways of marketing such as increasing visibility on social media, enhancing direct communications through e-mails, and developing individual customer services (e.g., home fittings). For instance, the menswear company *Frenn* started home fittings in the Helsinki area and tightened their connection to its customers by sending them more e-mails (Frenn

2021). Some Finnish small fashion brands created “friend-brand sales” (#*yhdessäkauppaa* campaign) in which the purchase of a garment from one brand triggered an extra gift to the customer from another brand (STT 2020). The idea was to raise interest among consumers to buy local Finnish fashion during the COVID-19 crisis. Organizers canceled the annual Helsinki Design Market, but the event was instead held in several small shops in the city as networking activities where customers could pre-book a visiting slot in a shop, for example, to attend the fashion brand *Samuji*’s secondhand sale.

Although the survey showed that overall sales decreased, nearly 50% of businesses reported an increase in online sales. To stabilize revenue, respondents reported implementation of innovative approaches to engage customers. At the end of 2020 and in early 2021, the rise of secondhand fashion became not only a notable phenomenon in Finland but a global trend as well (see, for example, ThredUp 2022). Several fashion brands in the country posted on social media that they were offering secondhand services for their own brand garments. *Emmy*, an online business platform in Finland for consumer-to-consumer transactions of secondhand fashion increased its turnover throughout the pandemic and reached record sales in May 2022 of over €500,000.² Even the iconic Finnish design house *Marimekko* partnered with Archive Resale and launched a customized secondhand and vintage marketplace in 2022 (*Marimekko Pre-loved* 2022).

Impact on value-chain models and partnerships

In terms of the “value-chain model,” the survey revealed that two companies had to renegotiate their contract details with manufacturers and five companies were forced to find new production premises. As mentioned above, some companies even reverted their production to Finland and started their own manufacturing (mainly sewing). Some smaller companies (approximately 35%) that had tight and trustworthy connections with manufacturers were able to renegotiate production timetables and even cancel preordered and yet-to-be-produced garments when it became obvious that consumption would freeze in the spring of 2020. In general, the smaller the company, the more flexible it was in negotiations as well as in cultivating new modes of business (e.g., adding home fittings as *Frenn* did).

Some interesting findings are conspicuous in the ethnographic observations. *FinnLea* highlighted that during the pandemic it was important to have its own production in Finland (close by), to maintain production at a moderate level to create capacity for greater flexibility in all company processes, to keep

inventory low (no extra production), and to focus on producing only products with strong sales potential (strengthening risk management). This was enabled by tight customer relationships, as the company knew their clients’ preferences. Accordingly, they created a more stable business and better control, even during COVID-19 (*Sinervo* 2021). Furthermore, in early 2021, *Lapuan Kankurit* began an initiative to start yarn production from Finnish wool in a new type of collaboration with sheep farmers, bringing in the aspect of super-local and transparent production. Currently, as much as half of Finnish wool remains unused due to high processing costs. Against the backdrop of sustainability, this approach returns lost resources, currently seen as waste, to industry (*Lapuan Kankurit* 2021).

Moreover, in addition to the collaborations of textile companies to boost the production of protective garments for hospitals (*Voglia* 2020), ethnographic observations showed some evidence of partnerships across industry boundaries and firms sought to address peak demand for safety clothing in innovative ways. For example, printing houses opened their facilities and machinery to support the production of “paper-like” disposable protective garments.

Impact on design

The ethnographic observations made it clear that facemasks in particular had been integrated into fashion collections as part of design esthetics through the use of bright colors and prints and even luxury materials such as silk (e.g., A. Ruohonen [personal communication, May 15, 2020]). Several companies started producing textile facemasks which proved to be a lifesaver for them. When shops were closed, *R-Collection* was able to shift quickly to textile-facemask production (the first manufactured batch was 22,000 pieces). For many consumers, facemasks became the entry product into *R-Collection*’s online shop and they were tempted to buy other items. There was even a time when the company only manufactured facemasks, with production reaching 60,000 pieces a day (*Pölkki* 2021). *Aim by Mia*, a sock company, also started producing facemasks, a totally new product for them. *Anna Ruohonen* designed an elegant summer collection of dresses with matching facemasks made from linen and silk material (A. Ruohonen [personal communication, May 15, 2020]).

Some companies reported reducing their collection size and adopting a better design focus (clearer design style) as a business strategy. *REMAKE* designed and manufactured a limited-edition home-clothing fashion collection named *CO*ID*: only a

limited number of each garment was produced, but they could be pre-reserved and ordered according to one's own measurements. Some fashion companies avoided designing new collections and focused on manufacturing "safer" older products. *R-Collection* increased its sales of sweatpants by 5% in 2020 and for *Prisma* (a leading retailer), men's sweatpants sales rose by 19% (Frilander 2021).

Impact on CSR

Before COVID-19, the textile and fashion industry had been struggling with sustainability issues, be it the environmental consequences of its activities and the climate crisis or its social impact and unethical production practices. Fast fashion, in particular, had a poor reputation prior to the pandemic not only for its environmental implications (Freudenreich and Schaltegger 2020; Niinimäki et al. 2020; Thorisdottir and Johannsdottir 2020), but also for its negative social and ethical effects (Lohmeyer and Schüßler 2017; Williamson and Lutz 2019). The general atmosphere seemed to indicate that consumers' climate anxiety was replaced by coronavirus anxiety, at least temporarily. Nevertheless, 2020 witnessed a considerable amount of social media attention on the backstage of the fashion business and the social problems of countries engaged in work at the early stages of fashion-supply chains. As major international fashion brands refused to pay manufacturers for their orders, factories were unable to pay workers' salaries, causing a social crisis in several developing countries (Frayer 2020; ILO 2020). In Finland, discussions about local production and environmental responsibility have been in the headlines and Finnish fashion has managed to garner a relatively good reputation on this matter. A transition toward local production and sustainability had already started before the COVID-19 outbreak, and many small companies have been highlighting these features of their business models (e.g., *Vimma*, *Uhana*, *Billebeino*) as well as measures to reduce their carbon footprint (e.g., *Frenn*) and this discussion intensified during the pandemic.

In the second section of this article, we outlined three implications that crises might hold from a historical context. As the textile and fashion industry was severely affected by COVID-19, with a decrease in consumption leading to the closure of factories and shops, in combination with movements in this sector to find a more sustainable balance in manufacturing (avoiding overproduction and overconsumption), we can identify the following pandemic-related implications for the textile and fashion industry:

- Reduced consumption driven by economic crises.

- Risk management as a significant issue (environmental, social, reputational).
- Shifts in worldviews may lead to transformation at the system level.

Discussion

Our study aimed at investigating the immediate impacts of the COVID-19 crisis on the Finnish textile and fashion industry. Applying a path-dependence framework enabled us also to draw on patterns of historical evolution and to identify seven possible implications of crises: (1) favoring domestic production, (2) increased innovation and creativity due to scarcity, (3) internationalization driving market changes, (4) rise of sustainability and social responsibility issues, (5) reduced consumption caused by economic crises, (6) importance of risk management, and 7) transformation at the system level owing to shifts in worldviews. Each implication contains and is supported by a combination of themes that emerge from the data which are: (1) technology, fibers, and production, (2) business models and customer relations, (3) value-chain models and partnerships, (4) design, and (5) CSR. We now consider these seven implications together with the emerging themes and ground the discussion in the historical path dependencies.

First, both *favoring domestic production* and *the scarcity of materials* enabled the domestic textile industry in Finland to establish factories or to change partly their in-house production to manufacture protective fabrics. This was an unconditional change while garment consumption dropped drastically. Some companies even hired new sewers and started their own production while others established factories to produce nonwoven material for facemasks. Finland has a long tradition of cellulose (paper) production and therefore the knowledge of nonwoven technology exists in the country. These issues appeared in the data especially in the beginning of the crisis when firms were reconsidering their value-chain models and partnerships. However, the profitability of the protective fabrics was not as high as expected because once Chinese manufacturing and imports were back on track, domestic production could not compete with the low prices of these alternatives. Consumers seemed unwilling to pay more for domestic products. To some extent, this contradicts Finns' previous tendency to favor domestic production and is simultaneously the result of the effect of globalization and a sign of lock-in. More specifically, globalization leads to lower manufacturing costs in the textile and fashion industry and over the course of the past 25 years the focus has been largely on less expensive retail

prices and the loss of local production. Accordingly, Finland (and other countries of the global North) have become locked into a mindset that emphasizes low cost and cheapness.

Increased innovation and creativity were visible in many of the emerging themes in our data. Findings indicated that the COVID-19 crisis forced some companies to significantly change their practices to find ways to survive 2020. Companies were forced to take a huge leap into the use of novel technologies and new ways of doing business (e.g., online shopping, home fittings). Furthermore, flexibility in production, changes in product lines and designs, and new kinds of collaboration between companies have provided inventive approaches to existing business practices. Local sourcing, tight customer relationships, and own production can provide greater stability and more control over a range of business functions and this strategy offers a means for managing turbulence and brand reputation during crises which is also an indication of the importance of *risk management*. It was soon evident that smaller company size provided for flexibility; supported better relationships with suppliers, manufacturers, and customers; and built trust and a stronger basis for negotiating and reorganizing activities in times of turbulence.

Nevertheless, the COVID-19 crisis also opened windows for new niches. Renewing practices in design, manufacture, sales, and marketing were essential while the textile and fashion industry was transforming throughout this period. The innovation and creativity that emerged during the crisis have similarities to developments in the industry during World War II when there was *a lack of traditional materials*, and inventive approaches to substitute textile materials included new viscose-type fabrics and paper textiles (Niinimäki and Saloniemi 2008). The pandemic did the same for the facemask and protective garments. During the 1940s, designers developed attractive patterns to cover the uneven, cheap bottom fabric and design was used to cheer people (Niinimäki and Saloniemi 2008), just as during the COVID-19 crisis when bright and joyful facemasks became part of street fashion.³

During such a crisis, *consumption fell* as consumers did not need fashionable clothes when working remotely or having to stay at home due to unemployment, and this led to a temporary closure of shops and redundancies, as in the case of Finlayson in the spring of 2021 (Törnudd 2021). The survivors of the crisis within the Finnish textile and fashion industry have thus been, first, those who were able to move their activities and sales online and, second, those who had—or were able to develop—close relationships with their customers,

and, third, companies that have successfully transformed, reconsidered, and extended their offerings.

Risk management is emerging as a key element in the fashion sector and an even more important aspect of sustainability. As Zhao and Kim (2021, 157) note, the COVID-19 “period represents an extraordinary market situation with almost no prior research on how an industry can recover from such a crisis and reshape its value chain.” Global supply chains have encountered unpredictable risks at the economic and reputational levels. Previously well-functioning material ordering might stop entirely if the exporting country closes its borders, industrial production ceases, or subcontracting causes social problems when orders are not paid. The tendency to find manufacturing locations closer to end markets is increasing globally. Current discussions of the need for better CSR in connecting to the treatment of factory workers are reminiscent of the era of industrialists in the Finnish textile industry and their care for employees. The social responsibility of factory owners helped the country to survive the so-called hunger years (1866–1868). Social responsibility is likely to come to play an even greater part in sustainable fashion. As Brydges et al. (2021) observed, the importance of having strong brand esthetics and identities that resonate with customers, in particular sustainability and value-driven brands, has increased. Our findings are also consistent with recent studies (Casey 2021; Pelikánová et al. 2021; Vătămănescu et al. 2021) of the growing importance of sustainability, not only for consumers but also for local production, which became more important in Finland during COVID-19. Brydges et al. (2020, 299, italics in original) argue that “any transition toward a sustainable fashion industry that does not address structural inequalities will not be *just*.”

Conclusion

In this study, we have examined the impacts caused by recent and historical crises in the textile and fashion industry in Finland and reflected on emerging themes and their implications on the system level. To conclude, we emphasize the context of sustainability and related issues. Brydges et al. (2020) highlighted that sustainability had been neglected in terms of the production and end-of-life stages, as well as negative development (e.g., heavy discounts) in the retail sector. Concurrently, consumers’ preferences, finances, and lifestyles have shifted toward greater environmental awareness and sustainability, including criticism of fast fashion (Casey 2021, 31; Wischer 2020, 15; Iran et al. 2022). COVID-19 seems to be a crisis that has given rise to novel, yet temporary, behaviors of companies and consumers,

but we do not know whether they will in the end prove to be transient or more durable. Therefore, the future of sustainable fashion is challenging to predict, but there are clear action points that could support a transition that moves in this direction. Even the trends among large fashion houses (such as *Gucci*, *Balenciaga*, *Yves Saint Laurent*, *Dior*, *Fendi*, and *Prada*) of developing policies that encourage sustainability have accelerated significantly during the pandemic (D'Adamo and Lupi 2021).

A megatrend affecting the current system is climate change, and now COVID-19 has imposed a significant shock on the system. However, these disruptions have also served as drivers. They have revealed the need to produce clothes locally: climate change has given rise to the need to reduce greenhouse gases and the pandemic has shown the vulnerability of long-distance transportation. These two factors have also made customers more aware of the circumstances under which garments are produced and, in a complementary way, risk management at different levels has been shown to have a significant role to play for business and industry. These forces will exert new pressures on companies to become more transparent in their supply chains. A recent trend shows that consumers may also be ready to pay extra for a “circular premium” (D'Adamo and Lupi 2021). Based on our study, we observe that COVID-19 has led on the part of firms in the Finnish textile and fashion industry to enhanced responsibility, meaning the management of environmental impacts, the management of relationships with supply chains and customers, the management of social responsibility issues with factory workers on the other side of the globe, and the management of brand reputation.

In line with Brydges et al. (2020), we can see this crisis as an opportunity to build societal and environmental transformation through more open and responsible fashion. Our findings also identified paths for the future. First, there are some signs that the foundations of the current textile and fashion system are increasingly being questioned and business models that just focus on cheap consumer prices are not enough. Moreover, future trajectories include elements not only of localization but also of globalization in the form of online stores. Moreover, localization does not necessarily mean that all garments are produced proximately, but rather that firms source production with greater attention to geographic distance and by extending “local” to mean “close by” (e.g., within Europe has the potential to afford better control due to a shorter supply chain). Second, we find, consistent with, for example, Casey (2021, 31), fast fashion will more

likely become slower fashion and production scale will be downsized. Third, digitalization will mean more than online stores. Digital planning and prototypes are increasing and virtual fashion (as discussed elsewhere in this special issue) is a potential development path. Finally, legislation may prompt further changes in the near future. For example, the European Union (EU 2022) is creating new guidelines for textiles as part of its Green New Deal that emphasize lower environmental impacts, high quality, longevity of garments, emphasis on circular economy at the system level, and development of new tools for CSR.

Even if our study focuses on the context of Finland, we argue that our findings point to larger trends. The textile and fashion sector forms a global system, where development paths tie each player to the others, creating a network of dependence.

Notes

1. See <https://finix.aalto.fi>.
2. See <https://store.emmy.fi>.
3. Facemasks can also be seen as a new accessory for self-expression, making a fashion statement or a political statement, as was seen, for instance, in Brazil as a sign of being for or against former President Jair Bolsonaro. Even antibacterial fabric became popular in some parts of the world (Zhao and Kim 2021).

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Appendix 1. Survey questions

How do you perceive the impacts of COVID crisis on your business? Choose the relevant options.

Product design

- *Design and products have stayed the same*
- *Product design has changed*
- *Old products were left out of production*
- *New products were designed*

- *Something else? What?*

Production

- *We were not forced to implement new arrangements in manufacturing*
- *We were forced to implement new arrangements in manufacturing*
- *We were forced to renegotiate the terms of agreements*
- *We were forced to negotiate new agreements*
- *Something else? What?*

Customer relations

- *Customer relations and ways to encounter customer have stayed the same as before COVID-19*
- *We were forced to find new ways to reach our customer*
- *Other change in customer relations? What?*

Sales

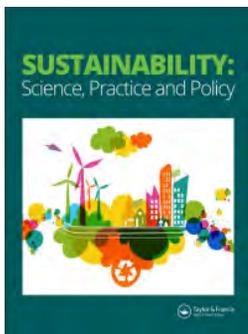
- *Our sales have remained the same*
- *Our sales have changed*
- *Our e-commerce has increased*
- *We started e-commerce*
- *Something else? What?*

Since COVID-19, has something else changes in the way you do business. What?

Please specify your answers by describing the situation (what, how, why, and when). Describe also the starting situation and how the situation has changed since spring 2020.

Are there other impacts COVID-19 has had for your company?

Do you think the changes are permanent? (Yes/No/I don't know)



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Navigating sustainability in the fashion industry: insights from entrepreneurial perspectives on collaborative approaches

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ABSTRACT

Sustainability is an urgent topic for the global fashion system's full evolution, although coping with it is not a simple task because of the extensive attention, discussions, and media coverage that sustainability in the fashion industry has received in recent years. This article uncovers common themes, provides a holistic perspective, and offers insights into sustainability from an entrepreneurial standpoint, by investigating the collaborative approaches implemented by five cultural and creative industry (CCI) players that are recognized globally for their strong proactivity in developing sustainable practices. Through semi-structured interviews with these experts, this contribution takes advantage of the knowledge, first-hand experience, and lessons learned from frontrunners in the field, a privileged perspective to observe sustainability's multifaceted and heterogeneous nature. The insights presented in this article illustrate the interviewees' perceptions and understanding of the challenges, coping strategies, and factors at play in the process of pursuing sustainable practices in association with other system players. Finally, this work reflects on the tensions arising between the perceived urgency of radical change and the global fashion system's intrinsic disconnection and complexity. It prompts consideration of the pivotal role that networks can assume within this context and underscores the critical necessity of fostering robust and substantive dialogue between bottom-up innovative sustainable practices and top-down regulatory frameworks.

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Introduction

Over the past several decades, the term “sustainability” has become a ubiquitous and trending expression in discussions of global development. The World Commission on Environment and Development (WCED) defined sustainability in the 1987 Brundtland Report, *Our Common Future*, as development that “meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED 1987, 43). Although countless definitions of sustainability have emerged in the intervening years, this remains one of those most widely used formulations to define the concept (Ashby, Smith, and Shand 2013).

In this context, the fashion industry represents a distinctive case that requires examination. On one hand, the frequent use of the term “sustainability” in both industry and academic discourses reflects the growing awareness and pressing need to re-evaluate the non-sustainable “make-use-dispose” model that has defined the sector to date (EMF 2013; Niinimäki 2017; Stahel 2019). On the other hand, the global

fashion system is highly complex and characterized by multiple layers and fragmented structures that necessitate systemic interventions to produce visible sustainable effects across the entire supply and value chain (Ashby 2018; Beard 2008; Buchel et al. 2022).

Scholarly contributions addressing sustainability in the fashion industry consistently exhibit a common pattern of identifying and framing challenges associated with the implementation of sustainable practices throughout all stages of the supply chain. Hur and Cassidy (2019) conducted an empirical investigation that delved into the perceived challenges and opportunities of integrating sustainability in fashion design as observed through the lens of industry personnel. Their study revealed a multitude of internal and external obstacles that impede the implementation of sustainable practices. Notably, stakeholders expressed a perception that the intricate nature of sustainability issues extends beyond the realm of a company's organizational control, thereby posing additional challenges to be navigated. Abdelmeguid et al. (2022) provided a holistic

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understanding of the challenges associated with implementing circular economy business models, highlighting business, regulatory, stakeholder, consumer, and financial pressures. They also emphasized the importance of knowledge, skills, and structural and relational resources that companies should embed in their green intellectual capital to properly enable circularity.

In other work, Gonçalves and Silva (2021) conducted a literature review that shed light on the challenges associated with effectively establishing a consensus on measuring and evaluating key performance indicators (KPIs) of sustainable fashion products, specifically addressing their environmental footprint, social impact, and transparency. They acknowledged the need for a robust scientific methodology for assessing the sustainability in the fashion industry and encompassing all the above dimensions that can be easily comprehensible to consumers. Finally, Brydges et al. (2022) reported on the challenges faced by fashion brands in effectively communicating their sustainability-related actions, revealing a delicate balancing act between brand transparency and genuine sustainability efforts. According to these scholars, brands face the risk of being open about challenges they cannot or will not address, which contradicts their sustainability efforts and exposes them to the dangers of greenwashing.

In this ever-complex global industry, the layered and complicated nature of the supply chain – comprising raw materials and manufacturing, design and development, retail and distribution, and marketing and communication – has often been considered an inherent condition of the fashion industry. In this scenario, networks and collaborations have been identified as key factors that can either enable or hinder the success and survival of industry players (Simatupang and Sridharan 2002). Research suggests that collaborative networks, when properly implemented, can enhance a company's survival, competitiveness, and agility in dealing with market turbulence and complex challenges like sustainability, compared to individual companies operating in isolation (Camarinha-Matos 2009). Eckert, Crommentuijn-Marsh, and Black (2022) conducted a study of micro- and small-sized sustainable firms, confirming the importance of formal and informal networks, partnerships, and collaborations in enabling sustainable design practices.

However, as Buchel et al. (2022) pointed out, despite the emergence of alternative practices and industry collaborations, the fashion industry remains entrenched in unsustainable trends and has shown resistance to change. The authors propose to leverage existing niches and landscape pressures to

support a transition toward positive change that provides (1) new value-chain models based on mutual understanding and reciprocity, joint investments, and long-term partnerships; (2) opportunities for workers to exercise their rights; (3) establishment of stricter social and environmental standards to regulate production and consumption; (4) implementation of innovative products and manufacturing processes through research and development endeavors, collaboration between innovators and incumbent firms, and the accessibility of such knowledge and expertise to the system's players; (5) radical transparency about company impact through decentralized open information-assessment technologies; and (6) new business models that bring consumers to the forefront of circular economy practices. In this scenario, fashion startups and innovative partnerships promoted by incumbent firms can incorporate sustainability principles as an inherent condition and, given their newly born and flexible nature, act as resilient agents and enablers of change (Todeschini et al. 2017).

This study aligns with the existing scholarly literature and aims to examine how emerging and established firms at various stages of the supply and value chain, which are globally recognized for their dedication to forming partnerships within and beyond the fashion industry, perceive and navigate opportunities and challenges related to sustainable practices. It is important to note that our objective is not to conduct an exhaustive analysis of fashion businesses. Instead, we seek to engage in discussions with entrepreneurs about topics that scholars have identified as significant, and observe how these topics manifest in their diverse and context-specific experiences. Our main focus has been to investigate the factors that entrepreneurs perceive as either facilitating or hindering sustainable practices within a networked framework. We have also aimed to understand the strategies employed by frontrunners in pursuing these objectives. To achieve these ambitions, we conducted interviews with five key players operating in both downstream and upstream phases of the CCI and fashion system-value chain. These individuals were chosen as experts due to their unique perspectives, qualifications, and firsthand experience in the industry. The insights presented in this article are highly valuable, as they allow us to delve into the complex nature of sustainability in the fashion industry and to gather empirical lessons learned from an entrepreneurial standpoint. Unlike previous studies, this work extensively incorporates the interviewees' own words, presenting their perspectives in a roundtable-like format. By incorporating the

respondents' firsthand lived experiences, our approach aims to add depth and richness to their perspectives on sustainability.

This article is organized into several sections. First, we introduce our interviewees and describe the methods that we employed for data collection and analysis. We then present the results in four sub-sections, beginning with an exploration of how the interviewees conceptualize sustainability, emphasizing that its nature is simultaneously holistic, nuanced, and context-dependent. We subsequently discuss the dialogic relationship between the company's introspection, which involves re-evaluating its core resources and competencies in relation to sustainability, and collaboration approaches, which entail seeking synergies and facilitating networked sustainable practices. We underscore the importance of viewing these practices as iterative endeavors that require a work-in-progress (WIP) logic. Further, we recognize the fashion system's fragmentation and complexity as a factor that hinders systemic implementation. The interviewees propose aligning language and communication as strategic practices to navigate this complexity. Finally, we report on tension between the perceived urgent need for radical change and the slower pace at which global fashion-industry infrastructures are advancing, highlighting that this is a key systemic challenge to address when envisioning future actions to realize a sustainable transition.

Materials and methods

To gain comprehensive insights into sustainability from an entrepreneurial perspective, we conducted a series of one-on-one semi-structured interviews with a heterogeneous cohort of globally recognized front-runners committed to a systemic vision of sustainability (Bogner, Littig, and Menz 2009). The interviews were designed to explore the respondents' approach to sustainability from organizational, technological, and socio-cultural perspectives, as well as their contribution to sustainable development within the fashion industry from a holistic and networked viewpoint. We also questioned them on current challenges, future milestones, and further issues that arose throughout the conversations. In selecting the interviewees, we applied specific inclusion criteria including:

- Involving a diverse range of businesses, encompassing both startups operating in the fashion industry with a strong dedication to sustainability and established companies pursuing groundbreaking sustainability-related projects.

- Prioritizing businesses actively engaged in collaborative and strategic partnerships for sustainability-driven initiatives, involving stakeholders from various sectors within and beyond the fashion industry.
- Ensuring representation of interviewees from different roles and stages of the fashion system's supply and value chain, allowing for a comprehensive perspective on the topic.

For participant selection, we utilized purposeful sampling by reaching out to businesses that aligned with the aforementioned inclusion criteria. During our recruitment process, we employed diverse strategies to establish contact with potential participants. Specifically, we utilized multiple approaches, including leveraging our own organizations' networks, reaching out to businesses' public relations (PR) representatives, and sending direct emails as well as reaching out through professional networking platforms like LinkedIn. We extended invitations to various companies to participate, providing them with comprehensive details regarding the purpose of our research, the topics to be discussed, and the interview format. Out of the twelve companies contacted, five agreed to participate in the study.

The interviewees included:

- The Founder and Chief Sustainability Officer of ACBC, a footwear industry Certified B Corporation company that supports brands in their material- and process-sustainability transformation.
- The Head of Content and Strategy at The Fabricant, a digital fashion house that drives the fashion industry toward digital-only clothing.
- The Founder and President of Italian Artisan, a business-to-business marketplace that facilitates meetings between international buyers with small- and medium-sized enterprises of "Made in Italy" fashion.
- The Head of Strategic Marketing at Fulgar's, an international leader in the human-made fiber market that researches and develops bio-based, recycled, and high-tech yarns and manufacturing processes.
- The art directors and curators from the Milanese multidisciplinary agency 2050+ and the streetwear retailer and distributor Slam Jam, in their role as editors of CIRCLE (a joint project between 2050+ and Slam Jam, an ongoing digital think tank investigating "People, Health, Green, and Waste" using Milan as a blueprint for exploring planetary challenges).

We conducted the interviews online between February and May 2021 and each lasted for approximately 30 to 45 minutes. We recorded and transcribed all of the interviews with the consent of the participants.¹ We adopted the “denaturalized transcription” method (Nascimento and Steinbruch 2019; Oliver, Serovich, and Mason 2005) to facilitate the content analysis and improve the contribution’s comprehensibility. Denaturalized transcription is designed to enhance the data’s clarity by correcting grammatical errors, removing interview noises, and standardizing nonstandard modes of speech. By emphasizing written language’s characteristics over those of spoken dialogue, the transcription includes such elements as commas, extended pauses, and completed sentences that are not found typically in natural conversations (Nascimento and Steinbruch 2019). In contrast, “naturalized transcription” transcribes the speech as it is, preserving spoken language’s characteristics and features, rather than adapting the spoken discourse to fit written language’s rules (Oliver, Serovich, and Mason 2005). All of the interviewees received and agreed on the transcript’s final version, granting consent for their respective role and affiliation to be disclosed.

We then performed an inductive data-driven thematic analysis in six steps (Maguire and Delahunt 2017): familiarizing ourselves with the data; coding; generating initial themes; reviewing, defining, and naming themes, and writing-up. We selected interview extracts that made the networked perspective visible specifically, although many other stimulating insights extended beyond the scope of this article.

Other scholars such as Pedersen and Andersen (2015) who have adopted expert interviews as an empirical method in sustainable fashion research have noted that

the knowledge, values, attitudes, and cultural stances of the participating experts...cannot claim to provide a picture of the “real world.” Nonetheless it contributes with a nuanced understanding of current challenges and opportunities within the industry, as experienced by key stakeholders in the field. (Pedersen and Andersen 2015, 315)

Similarly, the empirical results we provide in this study are not intended to be universally applicable. Instead, they acknowledge the unique and situated perspectives of industry experts, who can serve as inspirations for future research in the field and guide like-minded professionals. In light of this context, the following discussion devotes a substantial portion of its content to the interviewees’ statements. This deliberate approach aims to comprehensively convey their distinct viewpoints and personal

experiences, enabling a holistic understanding of challenges and coping strategies associated with the adoption of sustainable practices within the fashion industry ecosystem. It is worth noting that the participants that we selected all have a vested interest in presenting their company’s sustainability approaches in a favorable light. This is due to their active involvement in promoting their businesses’ sustainability agendas, occupying key positions as founders, heads of strategy and marketing, and editors. We are fully aware of the potential biases stemming from the participants’ roles and their potential influence on the gathered data. To address this situation, we have taken measures to acknowledge and transparently account for their situated perspectives throughout the discussion. By doing so, we aim to ensure the integrity and validity of the data are not compromised.

Results

This section comprises four subsections. The first offers an overview of the interviewees’ conceptualization and pragmatic view of sustainability. The second deepens the sequence described as “introspection, collaboration, and iteration,” as a best practice in engaging with and evolving sustainable practices. The third explores challenges and opportunities when practicing and extending sustainability beyond the company’s boundaries by taking advantage of “language and communication.” The last provides a broader reflection on the tension throughout the entrepreneurial world with respect to practicing sustainability.

The many facets of sustainability

This subsection illustrates the interviewees’ perspectives on their mission and concrete experiences with sustainability. The professionals who participated in this study have diverse backgrounds and possess unique viewpoints situated in their context-specific practices. Through their narratives, the objective was to highlight the diverse nuances of similar actions, to connect differing perspectives, and to identify common ground that unites their outlooks. The first interviewees, CIRCLE’s editors, begin the conversation by offering an account of this concept’s multifaceted nature.

The word “sustainability” is a bit narrow, it is very often an abused term used in an imprecise way, used partially to refer only to a particular type of environmental sustainability. We like to think of the word “sustainability” as an expanding theme, which manifests itself transversally in the field of social

justice, as much as in ecology, and work relationships. The ideological cornerstone is understanding sustainability applied to different fields of human action...Sustainability emerges from the topics we deal with in CIRCLE, the famous four categories, people, health, waste and green," which are not particularly specific but give the idea of the perimeter in which our conversation takes place (*Curator at 2050+, partner in CIRCLE project*).

This perspective underscores the need for a more expansive and inclusive definition of sustainability that extends beyond a narrow focus on the environmental dimension and manifests across different aspects of human life. Italian Artisan's mission reflects this expanded view, as the company asserts its commitment to supporting local manufacturing communities with respect to their survival, visibility, and development by promoting and protecting traditional artisanal practices, while advocating for economic, social, and cultural sustainability.

We help international brands to produce in Italy in a simplified way and we help Italian manufacturers like small and medium artisans and businesses to get access to new clients internationally...We apply an inclusive and sustainable business model, following the logic of shared assets and respecting the local manufacturing ecosystem. When we're talking about "Made in Italy," we're not just talking about products, but heritage and tradition. We see companies that are run by the seventh family generation. When you enter those companies, you don't just acquire a shoe, a tee-shirt, or a suit; you get access to hundreds of years of knowledge and know-how. It's essential for us to communicate to brands that producing in Italy is ethical because of the district's ecosystem and kilometer zero.² Most of the districts inherently embody sustainability, even if they do not actively promote or emphasize it. The full ecosystem to produce a good can be found in a radius of 15 kilometers, so we talk about very short distances, compared to other supply chains (*Founder and President, Italian Artisan*).

This respondent emphasizes that sustainability can manifest itself on multiple levels, including the preservation of heritage, culture, and tradition, the acknowledgment and valorization of district communities' social dimension, the environmental benefits of supporting proximity and short supply chains, and the opportunity to incorporate sustainability into company operations through a revised business model. Similarly, Fulgar recognizes the different spheres of sustainability's interdependence (Williams et al. 2019) and reports how this perspective applies to the exemplary case of waste management and circularity.

When we talk about sustainability, the meaning of this concept lies in the environmental, economic, and social dimensions; these are at the center of

sustainability. The very concept of sustainability is contained in these three directions; all three must co-exist because if you remove one of the three spheres, you lose all of the value...The more we go forward, the more the need to optimize the industry, be sustainable, and achieve savings grows. Waste management will be even more critical because waste is a high environmental, social, and economic cost...Today, brands and companies are much more aware of the issues waste management poses at a cross-cutting level. Waste is becoming a valuable resource. In our journey, we have recently explored the concept of biodegradation, we are moving step by step. We have achieved preliminary results, even if not optimal for us. We have developed a type of nylon that can biodegrade within five years, creating biogas. These biogases may be used to produce, for example, energy. We are moving toward a closed cycle, a circular logic from an inorganic chain to an organic one (*Head of Strategic Marketing, Fulgar*).

The interviewee stresses the importance of sustainability and the need to optimize industrial processes, achieve savings, and manage waste efficiently by changing the lenses through which reality is observed by transforming previously considered costs and burdens into valuable assets (Nogueira, Ashton, and Teixeira 2019). The Founder and Chief Sustainability Officer (CSO) of ACBC, a company recognized for conducting substantial research to develop innovative alternative materials with a focus on minimizing waste throughout their production and end-of-life processes, echoes this sentiment.

At ACBC, we do significant research, and we provide it to as many brands as possible including the ones we build collaborations with and we produce for. For example, we are making a heel in polyhydroxybutyrate (PHB), a bio-plastic. PHB is a natural bio-derived and biodegradable polymeric material, a technology that comes entirely from nature, that dissolves without undergoing toxic chemical processes, and it is injectable, like plastic. So, it's a perfect replacement for plastic on a conceptual level... We are now applying this research with a fashion brand (*Founder and Chief Sustainability Officer, ACBC*).

Both ACBC and Fulgar exemplify the significance of research and development in sustainable practices, emphasizing the relevance of innovation and exploration in making sustainability operational as a tangible reality. Their approach revolves around re-valuing existing resources and pioneering novel processes that optimize the utilization of materials throughout their entire lifecycle. This includes various stages, such as research and development, initial results that have room for improvement, and ultimately applying these advances within the fashion industry. Moving toward the downstream stages of

the fashion industry's value chain, The Fabricant offers an interesting outlook on how digitalization practices and digital fashion can contribute to reducing the carbon footprint and encouraging sustainable innovation in the fashion industry.

We were founded with quite strong sustainability principles. We don't think of ourselves as a sustainability company. It's not how we talk about ourselves externally. Still, within the company, it is sort of one of the founding principles. It's interesting when many brands come to us with this desire to de-carbonize parts of their industry. But, indeed, 3D sampling and creation is an easy win; making digital marketing assets is an easy win. According to our sustainability report, de-carbonizing all those things allows up to a 30% reduction in carbon impact. When it comes to our own digital-only work, the carbon-impact reduction from a physical garment is 97%...What we imagine when we talk about it internally is that physical fashion will become much simpler and less expressive because of the environmental effect of physical fashion. Digital fashion will become more powerful and more widely taken up. Digital fashion will stay where you express the more outlandish aspects of your personality, and you can be creative and playful at no cost to the planet. That's not correct, at a much-reduced cost to the planet (*Head of Content and Strategy at The Fabricant*).

This respondent provides valuable insights into the potential advantages of digital fashion in facilitating waste reduction within traditional value chains through the streamlining of resource-intensive operations. Additionally, the quote emphasizes how digital fashion can introduce consumers to new means of engaging with fashion while significantly minimizing environmental impacts. However, it is important to note that while The Fabricant may promote the idea of digital fashion as a pathway to a more sustainable future, the company also recognizes the challenges associated with carbon emissions linked to server-farm usage and the understanding that digital fashion does not equate with waste elimination. Expanding upon this perspective, CIRCLE's editors draw attention to the growing issues in digital-mediated actions and their energy consumption, warn of the virtual realm's material wasteful dimension, and provide insights into the way that this perspective has affected their practice.

Our two editorial releases on CIRCLE on the waste topic precisely investigated digital waste and the material effect of each of our daily digital micro-actions, from taking a selfie to sending a photo via WhatsApp to having a website with many bombastic graphics. These practices consume significant energy and generate high pressure on data centers (*Curator at 2050+, partner in CIRCLE project*).

Of course, every upload and download, every megabyte on the web generates energy traffic. In general, the CIRCLE platform limits the uploadable megabytes for each entry to a rigorous level. The reasons are in line with the concept of awareness that each megabyte generates energy consumption and the need to make the platform's navigation accessible and usable for the most significant number of people...A next step that would be interesting to tackle is to transform CIRCLE into a more responsive and sensitive platform to renewable energy...This discourse is still in an embryonic phase (*Architect at 2050+, partner in CIRCLE project*).

This statement by CIRCLE's editors' is centered on increasing awareness of the carbon footprint of digital practices powered by unsustainable energy and it stimulates critical thinking on the material dimension of virtual activities with respect to processing data and delivering information (Kokke and de Oliveira 2018). The restrictions CIRCLE places on the number of uploadable megabytes for each entry provides a tangible example of the way that sustainability can be incorporated into the development of specialized communication channels and tools. In line with this, Fulgar's Head of Strategic Marketing underscores the importance of contemplating the consequences inherent in every decision, posing questions about the feasibility of achieving a carbon-neutral state.

The issue is that ultimately any choice has an impact. The goal is to figure out what is the least impact you can make in the future. Is it possible to be zero impact? One day, probably, there will be self-generating energy-production systems, but there will always be an emission. It is very complex to go below zero; reaching zero would already be one thing. Going below zero would become the goal (*Head of Strategic Marketing, Fulgar*).

Defining the concept of "sustainability" has been a topic of much debate among scholars, and many acknowledge the challenges of setting strict boundaries given its pervasive and broad nature (White 2013; Giovannoni and Fabietti 2013). Rather than attempting to resolve these debates, this section acknowledges the multifaceted nature of sustainability and its dependence on context, aligning with Hur and Cassidy's (2019) perspective. Each participant in the study offers a unique understanding of sustainability, albeit with overlapping viewpoints, as it relates to their respective practices. These understandings span practical approaches to addressing environmental concerns, as well as business model innovations that embrace sustainable growth and cultural preservation. Ultimately, the aim is to embrace a holistic vision of sustainability that encompasses environmental, cultural, social, and

economic dimensions (Williams et al. 2019), though achieving this comprehensive perspective appears extremely challenging.

Despite the diversity in how sustainability is practiced, a shared paradigm emerges from the discussions: that of work-in-progress (WIP). This paradigm entails an ongoing cycle of practice and learning, an acknowledgment of responsibility, and a continual refinement of objectives based on emerging elements and challenges within the ecosystem. In this context, the identification of best practices and their recognition as WIP becomes crucial for establishing new milestones (Pedersen and Andersen 2015) to address sustainability considering the interdependence of its various dimensions (Williams et al. 2019). The following section will provide a more in-depth exploration of practical implementations of the WIP logic at a network level.

Introspection, collaboration, and iteration

The insights, experiences, and knowledge gained from the past and present partnerships of the interviewees provide valuable perspectives on meaningful strategies and practical operations that affect other fashion value-chain stakeholders. These strategies encompass a reciprocal interplay between introspection and collaboration, supported by an ongoing iteration of best practices. In this context, introspection involves the company critically reevaluating its core resources and competences in response to internal and external sustainability demands. Collaboration, by contrast, involves actively seeking synergies and fostering networked sustainable practices with external partners to collectively address complex sustainability challenges and to leverage shared expertise and resources. One example of the way that introspection has played a role in promoting sustainable practices can be seen in Fulgar's experience, as their Head of Strategic Marketing describes.

[I]n the last ten years, we explored recycling in terms of output. Out of every 100 kilograms of yarn produced by Fulgar, 26 million kilograms is waste. Basically, we had to recover everything that we found at home and in our satellite companies and then we moved toward finding materials from outside. Before we started, we had to do a material audit. We were able to experiment through our scraps, knowing the material we were working with. So, we started and created a database to see if we could lean on another waste supply. And by looking for a material that was more compatible with our standards, we were able to move a step further. However, it was born from an internal necessity pushed by an external market that was beginning to have this need. (*Head of Strategic Marketing, Fulgar*)

In this instance, the principle of introspection is depicted as a resource-based approach of knowing one's materials, resources, and capacities to plant the seeds for collaboration. This internal reflection and understanding allowed the company to identify ways to recover waste and find compatible materials from outside, which eventually helped it move toward more sustainable practices. The tension between internal necessity and external market need that shapes a company's core approach is particularly visible in the experience of startups, flexible entities that shape their offers dynamically to fit the market need better (Blank and Dorf 2012). The Fabricant's case provides an interesting representation of this tension.

There are two different strands in our business. When we are creating for our own fashion label, our garments will never be made. The Fabricant makes couture that will never be made, this is what we do, and we insist on. When we work with other brands, obviously, brands are physical, they have physical contents, so we digitize what we can in terms of the supply chain and marketing content creation. So the carbon impact is reduced with our own work...the pandemic has absolutely accelerated everything that we do. We became in the fashion industry's minds not something that was a novelty nice to have, but something that had the resilience and sustainability that worked with creativity and set out a plan for how fashion would operate in the future. (*Head of Content and Strategy at The Fabricant*)

The company's commitment to virtual-only fashion clothing and accessories that will never be worn in the physical domain represents an inward focus on its own creativity and vision to explore its capacities and resources fully. At the same time, the company's collaboration with other brands involves an outward focus that complements other players' specific necessities. This dynamic tension between introspection and collaboration underscores the importance of a holistic approach to sustainability, one that balances internal reflection with external engagement and collaboration. In this respect, ACBC mirrors The Fabricant's approach, where core brand activities and collaborations are parallel but complementary paths:

ACBC has a particular business model. The ACBC brand entails creating a collection of sneakers that has the lowest possible effect on the environment, from a scientific point of view, and can convey messages about social and environmental issues through a coherent aesthetic, interpreting sustainability in a futuristic way. Co-branding is a collateral activity... We have a fundamental research and development division. We believe in sharing our research with as many players as possible. We don't care if you are

Boxeur des Rues or Chanel, if you come from the mass or the luxury market; what counts for us is supporting a brand to improve itself and materialize this development leveraging the certified supply chain we provide them. We work with factories undergoing audits, and raw material suppliers with certifications. We work according to these principles; we ask for documents before working with them. Then we start collaborating, analyzing, and doing research. Sometimes we work with small suppliers that don't have certifications yet but are under development....All these activities feed into a business model that is built on various pillars. Survival force is what drove us to look for all these different revenue sources. (*Chief Sustainability Officer and Founder, ACBC*)

The perspective shared by ACBC's founder sheds light on the dual impact of diversifying the company's business channels. On one hand, introspection cultivates and reinforces an internal vision that distinguishes the company from others in its approach. On the other hand, collaboration increases the company's own viability through the generation of multiple revenue streams, while also empowering other companies to embrace sustainability practices. The urgency of making this process accessible to as many brands as possible, regardless of their market positioning, is also reflected in what Fulgar refers to as a "freestyle" company:

We consider ourselves a "freestyle" company; this is our philosophy. Sustainability can't be exclusive to just a few brands. If we start excluding companies, we're not allowing them to practice sustainability. More experienced companies are out there, as others are beginning to approach it right now. Limiting these products exclusively to luxury brands for purely communication reasons implies losing the opportunity to develop such textiles. (*Head of Strategic Marketing, Fulgar*)

While Fulgar stresses the importance of a freestyle logic in approaching sustainability from a collaborative perspective, The Fabricant provides an account of how this collaborative and dialogic effort works in sorting things out, and combining internal and external competencies, needs, and opportunities:

When we work with brands, it's a collaborative process. Lots of the big fashion houses have an awareness of the digital space, but they don't necessarily have an awareness of how we can help them. So, they come to us and say they really want to do something with us, without knowing exactly what they should be doing, which is entirely reasonable today. Therefore, we try to get them inside. We try to check their requirements and find how that could manifest in what we do, and then we guide them. We are in this process of iteration of working things out with them collaboratively and it's very much about how can we meet the brand needs and make

it a big deal. So, it's a very co-creative process. (*Head of Content and Strategy at The Fabricant*)

The quote above emphasizes that in innovative and underexplored fields, collaboration assumes the features of mutual discovery and co-creativity, as many fashion system players are aware of the opportunities offered by the digital realm, but do not know how to enter it. The search for complementarity as a trigger to initiate collaboration may also be conceived beyond the boundaries of the textile and fashion system. Fulgar's experience suggests that industrial synergies are additional routes that companies may follow to extend their sustainability practices through cross-sectoral interactions (Patwa and Seetharaman 2019).

We launch[ed] a project on a post-industry recycled product. We were looking for an industry that could constantly supply waste because its products are necessary and indispensable. We found a particular industry fitting our requirements: automotive. So, we connected with the automotive industry; we worked on tires through a chemical process respectful of sustainability principles to obtain valuable material by "simplifying" a longer, more complex production chain. Tires are re-valued: from a valuable" product to a more valuable one. This type of sector was chosen because it creates critical mass...The project does not stop here because this industrial process will also make it possible to evaluate the recycling of garments. In the second step of the process, there will be the possibility of recovering dyed clothes—one of the main weaknesses of recycling processes—bringing them back to their initial state: as polymers that are still suitable for textile use. (*Head of Strategic Marketing, Fulgar*)

With this statement, Fulgar's Head of Strategic Marketing establishes a connection between the company's internal reflection process, which involves auditing material and assessing resources, and their perspective on how collaborating with other industries can enhance waste-management processes and inspire future recycling innovations that feed back to the company and the overall fashion industry. The concept of iteration emerges as a crucial factor that may allow partnerships and projects to be initiated and evolve over time. The genesis of CIRCLE's platform exemplifies this process, and provides a noteworthy illustration of the relevance of cross-sectoral collaboration and iteration of partnerships in sustainability-driven endeavors.

Our first interference in the world of sustainability and fashion began with a dialogue with Nike. We entered the world of fashion through the door of the more expanded world of sport and movement

through research lasting more or less a year. (*Architect and Creative Director at 2050+, partner in CIRCLE project*)

[CIRCLE] was born from the need for Slam Jam to look out into the world of sustainability, broadly speaking, trying to find a way that was authentic and compatible with our DNA. With 2050+, we found ourselves in a common language, even if they are two realities dealing with different areas. (*Art Director (until July 2021) at Slam Jam, partner in CIRCLE project*)

We have found a commonality of purpose concerning the issues we believe is crucial and urgent to discuss. (*Curator at 2050+, partner in CIRCLE project*)

The multiplicity of outsiders who may play a role in the fashion system's sustainable transition shows the importance of listening to and engaging in conversation with players from other industries, sectors, and disciplines to discover how these worlds may overlap, inspire, and feed each other (Bourlakis et al. 2014). The personal experience of The Fabricant's Head of Content and Strategy reflects again the need for cross-sectoral conversations as they highlight sustainability's transversal nature in that compatible intents and visions from professionals in different fields intersect.

It's very interesting this sort of blending of cultures. I have many conversations with people in other industries to collaborate and understand where we're coming from. There is a gamification group in Finland whose field of research is entirely on gamification and sustainability, specifically how gamification influences the nature of sustainable consumption...I met one of the researchers at a sustainability conference. It had nothing to do with The Fabricant, and we just got into this great chat. A couple of years down the line, it turned out that our worlds had a brilliant overlap. (*Head of Content and Strategy at The Fabricant*)

Overall, the insights gained from the interviews underscore the significance of having a clear vision and a comprehensive understanding of internal resources for enterprises to position themselves and start embracing sustainable practices. This process involves introspection, which entails an inward endeavor to identify, evaluate, and establish the core resources, capabilities, and commitment to sustainability at the company level. Notably, the drivers for this process of introspection extend beyond mere internal motivation, as market needs and consumer pressure may play influential roles in shaping companies' sustainability strategies and initiatives (Abdelmeguid et al. 2022). Furthermore, collaboration may play a vital role in outward efforts to seek

complementary resources or to address the needs of others in order to promote sustainable practices (de Abreu et al. 2021). By collaborating with entities from diverse market positions or sectors, organizations not only have the potential to contribute to making sustainability an inclusive and viable path for other players within the ecosystem but also have the opportunity to diversify their revenue streams and strive for long-term business viability. Additionally, our study highlights the iterative approach, recognizing that each project's outcome serves as a novel starting point within an ongoing WIP logic. This approach views every partnership and collaboration as an opportunity for experimentation, enabling expansion of the company's portfolio of experiences and enhancing its reputation within a broader context. In the next section, we explore the role of language and communication in establishing collaborative practices, broadening the sustainability discourse to encompass other relevant actors, such as consumers, who can play a key role in the process.

Language and communication

The value of establishing sustainability practices as the product of a collective effort among players within and beyond the boundaries of the fashion system is clear from the expert experiences reported in the prior subsection. However, what factors can foster or hinder these collaborative sustainable practices? The following discussion explores what the respondents described as the principal barriers to implementing a systemic and networked approach to sustainability and characterizes the practical tactics and strategies that they adopted to address these difficulties as a map of approaches. A common theme that all interviewees indicated is a stumbling block in achieving sustainable systemic practices is the intrinsic fragmentation and intricacy of the fashion industry-supply chain where language and communication play a crucial role. Fulgar's Head of Strategic Marketing illustrates this concept by sharing an entrepreneurial experience and pointing to the information gap in traceability arising from the complexity of exchange and communication dynamics between production phases.

H&M recently launched "Conscious Collection that basically includes some sustainable materials, among which is Fulgar's Evo® fiber...Before launching it, we dedicated a minimum of five months just to align all the parties in terms of communication. We discussed how to talk about it and design the label and explain to the consumers what they were buying. On the bio-based material, we have weaknesses too; Fulgar is not perfect. There are many complex

elements that should be considered. The initial part of the supply chain is perhaps the most complicated. When we start working with different minds in the first production phases various forces and different balances come into play. The information exchange and communication between the agriculture and chemistry worlds is still very complex. For example, Evo[®] is a bio-based product derived from castor oil. The goal for us was to understand exactly where this castor oil came from. Unfortunately, we cannot pinpoint the exact origin of this castor oil because the chemical production is a combination of multiple cultivations. So, we may have cultivation coming from an area in India, another cultivation coming from northern China, and so on. This is an essential element that we have emphasized and an important thing to say.... Today, we have a very good level of traceability, but a piece of history is often missing. Even in a narrower value chain, an information gap is there. (*Head of Strategic Marketing, Fulgar*)

While the previous subsection emphasized cross-sectoral collaboration as a driver of sustainable innovation, this perspective highlights the challenges faced by textile and fashion companies in effectively communicating with suppliers from different sectors and industry partners. It underscores the need for these companies to dedicate considerable time and effort to carefully convey their commitment and progress to consumers, while also remaining mindful of the risks associated with greenwashing (Nemes et al., 2022). The interviewee also points to other challenges that emerge when the ecosystem's various and multiple players lack proper communication, both due to the inherent complexity of the supply chain and different languages (Gonçalves and Silva 2021). Being aware of the complexity of communication processes among the subjects in the system is crucial to beginning the search for suitable tools to limit misunderstandings. Italian Artisan moves in this direction in the effort to address this misalignment by mediating communication for complementary players with different backgrounds.

[W]e had to deal with a mismatch in communication, since we were talking about connecting different domains and languages, between brands and producers. So, the producers with a technical background, and brands with a creative one. And our job was a matter of aligning information for them... We gained significant experience and learned a lot about the characteristics of a highly fragmented supply chain, such as the "Made in Italy" one. There are several players and many entities in the ecosystem, making the full picture...[and] by growing slowly, we had the chance to understand which small data are moving within the whole communities and value chain. We identified who is working inside the ecosystem of producers, which is crucial...We invested time in understanding our users,

such as a concierge aptitude: so, we did everything for them, especially the first activities, and then we understood their needs. (*Founder and President, Italian Artisan*)

The importance of acknowledging the diverse identities and profiles in the ecosystem and investing effort to develop a shared vocabulary (Fletcher and Grose 2012) is also reflected in ACBC's interdisciplinary research and development environment and its interesting position as both a business-to-business and a business-to-consumer enterprise.

We try to speak the language of chemists, go deep in the matter, and understand, for example, what happens when a bio-acetate is created, how it is made, and why it is not sustainable. In short, going in deep, for me, means learning a bit of chemistry, a bit of transformation processes, etc...[At the same time] our contribution to the fashion industry, I hope, is educating consumers, finding a way to communicate what we do in a way that it's not boring, teaching people how to choose products like they choose their foods, so products that are safer for people and the planet, using our product as vehicles. (*Chief Sustainability Officer and Founder, ACBC*)

Being aware that the language used to communicate between enterprises differs from that used to establish relationships between firms and consumers leads to not only the search for specific forms of communication, but also what reflects the perceived need for strategies to convey key information to consumers about sustainable fashion products in effective and easy ways (Gonçalves and Silva 2021). As ACBC's Founder and CSO indicated, the communication may not be limited to verbal modes. It can assume different shapes and convey information by translating the message in an accessible way, aligning visual codes and tone of voice, and using products themselves as images and vehicles of sustainability (Peirson-Smith and Evans 2017; Brydges et al. 2022). CIRCLE's editors provide another account that reflects this perspective, where language and communication become multilayered resources.

Even the graphics and settings of the platform are straightforward to make it accessible to anyone. Any user must be able to use CIRCLE, make contributions and enjoy others. On the Slam Jam side, we also tried to create an appealing graphic design in line with the language that unites Slam Jam and 2050+. Furthermore, it is aligned with the visual characteristics the younger generations are familiar with and pushes them to focus on the content themselves...Having such a platform under Slam Jam allows younger generations not yet sensitive to this issue to explore sustainability through straightforward educational pills and more complex artistic interventions by contributors explicitly involved with publishing on the platform. And it's both a

communication method and a much more direct link. So, in the same flow, there are artists, citizens, people. It's a very inclusive type of platform where the intent is precisely to create a new language and a new way of communication, to expose different targets to sustainability through various means and experiences. (*Art Director (until July 2021) at Slam Jam, partner in CIRCLE project*)

CIRCLE is a tangible example of how the search for new and fruitful forms of communication has led to the creation of virtual meeting places engaged in an effective translation of different languages. By using creative interventions and conveying sustainability-sensitive experiences and reflections through “educational pills” – concise and easily digestible pieces of information – CIRCLE strives to make sustainability more accessible and comprehensible for individuals who are unfamiliar with its diverse aspects. While CIRCLE explores the diversification of sustainability manifestations through educational and artistic means to the wider public, The Fabricant actively engages in conversations with audiences that may not be familiar with the potential of digital fashion within sustainability discussions. They do so by using relatable examples, like everyday digital interactions, to convey their message as effectively as possible.

Well, for us, it is interesting. We just did this project with Buffalo London shoes. When we talk on all our platforms, we're very used to speaking to a very digitally-centric audience who, to a quite significant degree actually, is entirely onside with what we do. They get it. They're very excited and positive. When we go outside our world—this happened for the first time when we created the first sort of digital couture to appear on the blockchain that went into *Forbes*—it made people so angry...So, we've kind of dealt with that at the very early stage of our journey. So, when we went on this project with the footwear brand Buffalo London, it was the first time a digital product had been placed on the website of a regular brand. Usually, digital items are within the gaming environment. Everybody who is into gaming gets it. When we put it next to real physical inventory and then offered it just as a digital choice that does not physically exist, it made people really angry again because they'd never been exposed to it...When you put it in the context of how people mainly interact with others on a daily basis, probably through a screen, why do you need to create something physical for that interaction? You probably don't. And once you start to frame digital fashion as a way to begin to impact the carbon footprint of the entire fashion industry, and in ways that people understand, it does really land with them. As we engage in more projects that intervene in the physical realm, there is still a sense of shock that people experience. It'll just take a little more time to get there, there's work to do yet. (*Head of Content and Strategy at The Fabricant*)

In line with the opinions of all of the interviewees, Fulgar's Head of Strategic Marketing stresses the importance of clarity and simplicity when communicating sustainability to make it accessible and straightforward along the supply and value chain (Gonçalves and Silva 2021), from businesses to consumers.

The language between fashion-industry companies collaborating with each other is different from those who work with the public and consumers. They often struggle to dialogue even at this stage...The goal is to convey the messages we said today in the simplest way possible because not everyone deals daily with these issues. I find it very interesting who manages to transfer concepts practically, simply, without artifice. Because the problem is that information passes through so many people that it is transformed when it reaches its destination...Actually, the companies that will make a difference are those that will be able to provide data. Transparency helps the companies to grow. You say where you arrived and where the issues are, you point out these issues, and the value chain starts moving toward them. The more attention is created, and the problem becomes of interest, the more companies are interested in investing and solving it because there is a business opportunity behind it and, of course, an economic value. (*Head of Strategic Marketing, Fulgar*)

In a fragmented supply chain, it is indispensable to acknowledge the ecosystem members' different languages, approaches, and competencies. However, the interviews revealed how language barriers and differences in communication styles can create challenges and misunderstandings that lead to conflicts and hinder progress. The likelihood of disseminating sustainable practices arises, again, from the players' ability to create effective communication strategies and profitable forms of interrelationship (Simatupang and Sridharan 2002). The respondents explore different strategies to align themselves with their interlocutors: getting to know other stakeholders through research and observation, learning and developing shared lexicons, multiplying formats through which sustainability may be communicated, taking advantage of the materiality or virtuality of products and systems that embody sustainability principles, and/or aligning content and tone of voice with the interlocutors' style to make sustainability an accessible and practicable concept for the multiple players in the global fashion system. While navigating these complexities appears extremely challenging given the fashion system's intrinsic layered nature, the testimonies highlight the necessity of establishing practical methods and shared parameters to find productive ways to communicate the state of the art transparently with the ultimate goal to inspire targeted joint actions for the ecosystem players to pursue (da Silva et al. 2021).

Balancing radical and gradual change

The previous subsections have highlighted the complexity of addressing sustainability challenges across various levels, from individual to global. Throughout these conversations, a recurring tension emerged between practical and operational dimensions of sustainability and idealistic aspirations for transformative change. While practical measures are necessary for immediate progress, they often fall short in addressing the systemic root causes of sustainability challenges if not iterated consistently over time. This section addresses this tension by exploring the balance between radical and gradual change in practicing sustainability, as the interviewees' reported.

In my opinion, radicality is the biggest challenge when we think of the fashion system. I believe that in the current state of things, speaking of production, storage methods, unrealistic demand-offer dynamics, and greenwashing, there is a need for a truly radical change. This change certainly involves enormous risks and huge investments. In the future, there must certainly come support from the institutions; there is an urgent need for these radical changes to happen. I see that things evolve much faster than we think and what we used to think. *(Art Director (until July 2021) at Slam Jam, partner in CIRCLE project)*

In this statement, Slam Jam's Art Director calls for a radical change in the unsustainable pace of the fashion industry's production and consumption patterns that require enormous risks, huge investments, and institutional support to limit uncontrolled and deleterious consequences. This sentiment aligns with the views of ACBC's Founder and CSO, who emphasizes the necessity of regulating the material processes and outputs of fashion companies as a top-down endeavor to achieve tangible sustainability outcomes at a systemic level.

Organization, regulations, and a reorientation toward prioritizing sustainability at the product level, rather than exclusively within company practices, are essential. Frequently, particularly in larger corporations, there is significant focus on aligning with internal processes but insufficient emphasis on product development and production. Of course, it takes more time, but that's the urgency because that's where real improvements must be achieved. *(Founder and Chief Sustainability Officer, ACBC)*

By contrast, The Fabricant representative acknowledges that not all players within the fashion ecosystem may be prepared to handle such a radical change, highlighting again the industry's infrastructural disconnection and inherent characteristics as key challenges to implementing extreme operational shifts (Beard 2008).

Many brands come to us with this desire to de-carbonize parts of their industry. They can't de-carbonize it all right now because, realistically, the supply chain is disconnected. You can't change all of it at once. *(Head of Content and Strategy at The Fabricant)*

Similarly, Fulgar's Head of Strategic Marketing stresses the importance of considering that companies progress at varying speeds in terms of innovation and sustainability practices, emphasizing the need to strike a balance between sustainability aspirations, competitiveness, and economic viability.

We have to consider the adaptation time of companies. Manufacturing companies need time to reorganize themselves to be more sustainable and competitive at the same time. The issue of costs and prices is a stumbling block for the entire textile industry. We cannot offer hyper-sustainable products based upon fascinating concepts that can't be realized because they are not economically sustainable. *(Head of Strategic Marketing, Fulgar)*

This recognition reflects the complexity of the fashion industry's sustainability journey, where companies must navigate financial constraints alongside environmental, cultural, and social objectives. Consistent with these reflections, Italian Artisan advocates for an incremental approach to change, whereby industry frontrunners can serve as guides for other stakeholders:

We believe in innovative evolution; I personally believe that disruption sometimes can be dangerous for some industries. Since the beginning we knew we could have a strong impact on the local territories and on the companies of our network. So, we had to consider an approach to build the company that could be sustainable for the ecosystem of our community, too. Evolution can happen with balance: walking beside smaller players, enabling growth, and evolving the traditional industry without disrupting it. *(Founder and President, Italian Artisan)*

This perspective emphasizes the importance of considering that companies are entities situated within wider ecosystems, rather than solo riders, and recognizes the significance of a gradual sustainable development fostered by mutual support relationships and networks. As ACBC's Founder and CSO explains, networks and collaboration are not a nice-to-have condition, but a matter of survival.

The starting point is the survival instinct. As a start-up, you need to find different sources of income. You need to activate in more than one direction, even if probably they're not so coherent at the beginning with your core activity. You need to activate those routes and find coherence later. But it's really for survival. Networks help survival, it's a

rule. So networking, building strong relationships with partners, and helping each other are key to survive.

The interviewee further stresses the value of this condition bringing the company's experience as a B Corporation-certified business.³

The B Corp Certificate is a value. It is more and more recognized by the market players for being a guarantee of seriousness concerning sustainability and social practices...It's a great chance to get in contact with other B Corps, discover other products or services, connect with them and co-create, build networks to help each other. It's about networking, reputation, and visibility. It's valuable. Moreover, it's a challenge because you want to get better in the score once you start, so you try to get better and better. (*Chief Sustainability Officer and Founder, ACBC*)

ACBC's experience points to meaningful informal and formal networks as a key enabler for gaining reputation and visibility as a trustworthy entity practicing sustainability (Eckert et al. 2022). This recognition may attract collaborations and expand the company's impact, inspiring other actors to embrace similar initiatives, as exemplified by Italian Artisan's founder's direct involvement.

In 2018, together with the Organization for Economic Co-operation and Development (OECD), I got hired as a field-peer consultant to explore replicating our systemic approach within national natural clusters from the Mexican government in Hidalgo. The value of what we're doing is internationally recognized, such as by OECD and policymakers. On the other side, we are eager to show our Italian policymakers that these conversations are already happening. We created the first working model, which can be replicable, but it started from the bottom, not from the top. This is a massive challenge for us. (*Founder and President, Italian Artisan*)

The words of Italian Artisan's Founder and President underscore the potential of bottom-up approaches to influence policy discussions and showcase the opportunities and challenges involved in transitioning from grassroots initiatives to top-down practices, both internationally and nationally. Furthermore, it aligns with the aspiration expressed by Fulgar's Head of Strategic Marketing, emphasizing the potential for one company's strong commitment to sustainability to inspire and influence other players, including businesses and consumers, creating a ripple effect throughout the industry.

While initially, the benefit is mainly for the company, the net effect could stimulate other companies to slowly embrace the same approach and generate benefits for the whole community. In this sense,

benefits reach the final consumer, the manufacturing and business ecosystem at large. (*Head of Strategic Marketing, Fulgar*)

In the realm of sustainability, the tension between radical and gradual change is a multifaceted issue that warrants thoughtful consideration. On one hand, while addressing systemic root causes may necessitate radical change, companies may encounter obstacles in implementing such transformations because of supply-chain disconnections, adaptation-time requirements, as well as economic and financial barriers (Beard 2008; Buchel et al. 2022). On the other hand, taking an incremental approach may be more practical, enabling companies to align their internal sustainability goals with external ecosystems. Nevertheless, this approach necessitates active engagement and participation in sustainability practices through the establishment of fruitful partnerships and collaborations. In this context, the visibility of sustainable practices facilitated by well-structured and emerging networks can act as a powerful source of inspiration for others. Over time, these actions have the potential to extend their benefits beyond the boundaries of individual companies, as highlighted by Eckert et al. (2022).

In line with Buchel et al. (2022), our suggestion is that these emerging collaborative approaches hold the potential to create a substantial impact by facilitating the widespread adoption of sustainable practices throughout the entire supply and value chain (Simatupang and Sridharan 2002). This impact should be realized across multiple levels, encompassing diverse stakeholders, including both smaller and larger players, agile innovators and incumbent firms, and cross-sectoral partnerships, public institutions and universities, policymakers, and consumers (Williams et al. 2019). Finally, based on the insights shared by the interviewees, it becomes evident that there is a perceived urgent requirement for institutional and governmental policies that align with sustainability objectives while accounting for the existing informality and fragmentation of the global fashion system.⁴ Policies may play a crucial role in providing incentives to support both established companies and those lacking the necessary resources to align with sustainability objectives. In doing so, they may specifically foster the establishment of innovative networks and collaborations to jointly address the ever-challenging transition toward sustainable development of the global fashion system.

Conclusion

This study aimed to explore how emerging and established firms within the fashion industry

perceive and navigate opportunities and challenges related to sustainable practices, through the lenses of collaboration and networking. Through semi-structured interviews with key players in the supply and value chain, we gained valuable insights into the multifaceted nature of sustainability and the strategies employed by frontrunners in jointly pursuing sustainability objectives.

The findings highlight the complexity of defining sustainability, acknowledging the diverse perspectives among participants. A shared paradigm of continuous learning, responsibility, and objective refinement within the ecosystem emerged, emphasizing the importance of a WIP approach. A central and transversal theme that emerges from their discussions is the recognition of dialogue, cooperation, and shared objectives as a collective, rather than an individual effort. In this context, the interplay of introspection, collaboration, and iteration was identified as a crucial factor in embracing sustainable practices. Organizations must critically assess their capabilities and commitment to sustainability while seeking complementary resources through collaboration. An iterative approach allows for experimentation, enhancing reputation and expanding the portfolio of experiences. In this scenario, collaborations can be highly beneficial for companies new to the concept of sustainability since, by engaging in collaborative efforts, they can gain a deeper understanding of it, actively practice sustainable initiatives, and expose their audience to the importance of sustainability.

For frontrunners in the field, consultancy, collaboration, and networking focused on sustainability-driven projects offer a range of perceived benefits. These initiatives can expand their portfolio of experiences in sustainability, allowing them to further explore innovation and develop their capacity. Moreover, by engaging with other players, frontrunners can share their sustainable practices, differentiate themselves from competitors, and create multiple revenue streams. Additionally, these endeavors can enhance their visibility and reputation, attracting new potential collaborators and opening doors to further opportunities. Effective communication through language alignment was recognized as essential in a fragmented supply chain, requiring the development of shared vocabularies, multiple communication formats, and transparency. Overcoming language barriers and aligning communication preferences among stakeholders appear crucial to inspire joint actions and disseminate knowledge. Balancing radical and gradual change was recognized by the study participants as a necessity for effectively contributing to the fashion industry's sustainability transition. While radical transformation was seen as

crucial to address systemic root causes, practical challenges such as supply-chain disconnections and economic barriers can hinder implementation. Incremental approaches, supported by collaborative networks, were proposed as viable paths to drive widespread adoption of sustainable practices.

The interviewees are neither academics nor politicians, but entrepreneurs and industry professionals. Their discussions revealed a dual nature: a problem-solving approach to practical issues and a personal sensitivity to global sustainability concerns. As industry players, each participant demonstrated a pragmatic approach to considering how concrete corporate actions can either promote or hinder sustainable practices at various levels, including products, processes, and ecosystems. As individuals, they tended to abstract sustainability principles as higher-level concepts that need to be acknowledged and pursued. However, a key question arises regarding the adequacy of decentralized motivation in driving substantial change. The study participants acknowledged the limitations of individual actions and emphasized the importance of institutional and governmental policies in supporting sustainability goals through direct interventions. These interventions included incentivizing companies, fostering collaborations, providing financial support, combining bottom-up and top-down approaches, and establishing operational guidelines and regulatory frameworks. However, to ensure a successful transition toward sustainable development, it is essential that policymakers comprehensively consider the informality and fragmentation of the fashion system.

While it is crucial to recognize the limitations of this study, such as its non-generalizability and the questions that it opens up for further research, validation, and extension, the insights gleaned from the participating entrepreneurs offer valuable understanding of the intricate dynamics of sustainability within the fashion industry. This knowledge provides important lessons that can guide future research and inform industry practices.

Notes

1. The interviews with Italian Artisan and The Fabricant were held in English while those with ACBC, CIRCLE project partners, and Fulgar were conducted in Italian.
2. In this context, kilometer zero refers to the concept of sourcing materials and production processes within a close geographic radius.
3. B Corp certification is a model gaining recognition as a guarantee that a company upholds exceptional standards of social and environmental performance, corporate responsibility, and public transparency

while striving to balance both profit and purpose (Diez-Busto, Sanchez-Ruiz, and Fernandez-Laviada 2021).

- See, for example, the European Commission's "A Green Deal Industrial Plan for the Net-Zero Age" (2023) based on the establishment of a streamlined regulatory framework, ensuring easier access to adequate funding, fostering the development of skills, and promoting open trade for supply-chain resilience.

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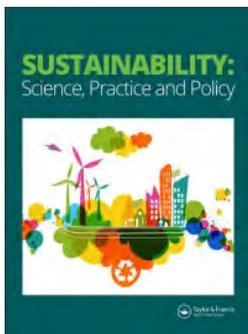
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Traceability and transparency: enhancing sustainability and circularity in garment and footwear

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Traceability and transparency: enhancing sustainability and circularity in garment and footwear

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ABSTRACT

This Brief Report on the sustainability and circularity of global fashion-value chains discusses the content and potential impact of Recommendation No. 46, “Enhancing Traceability and Transparency of Sustainable Value Chains in Garment and Footwear” developed under the auspices and approved by the United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT) in April 2021. It is a key output from a project undertaken by the United Nations Economic Commission for Europe (UNECE) and currently being implemented by UN/CEFACT in collaboration with the International Trade Centre (ITC) and financed by the European Union. The COVID-19 pandemic has highlighted the weakness of opaque garment- and footwear-value chains that lack traceability or transparency for brands, suppliers, and consumers. The public health crisis also increased consumer awareness of sustainability and the need for sustainability information. Recommendation No. 46 starts to set global standards for traceability and transparency and this Brief Report highlights its potential benefits on garment- and footwear-value chains that include nudging single consumer behaviors, supporting broader societal inclusiveness, helping manufacturers to implement circularity, and offering governmental bodies new tools for guiding the sustainable transition and verifying its effectiveness.

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Introduction

This Brief Report on the sustainability of global fashion-value chains discusses the content and potential impact of Recommendation No. 46 developed by the United Nations Economic Commission for Europe (UNECE). Known as “Enhancing Traceability and Transparency of Sustainable Value Chains in Garment and Footwear,” the document was approved by the United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT) in April 2021 (UNECE 2021a). This Recommendation is a key output from a UNECE project of the same title being implemented with UN/CEFACT, in collaboration with the International Trade Centre (ITC) which is financed by the European Union.

UNECE Recommendation No. 46 highlights the importance of traceability and transparency to sustainability and circularity.

Improving traceability and transparency has become a priority for the garment and footwear industry. Consumers, governments, and civil society

are demanding responsible business conduct and are calling upon the industry to identify and address actual and potential negative impacts in the areas of human rights, the environment, and human health.

By creating enhanced visibility in value chains, companies are better equipped to manage such impacts, and address financial, operational, and reputational risks. Also, traceability in value chains allows companies to respond more effectively to unforeseen disruptions, conform with applicable laws and regulations, ensure product quality and safety, combat counterfeits, and protect cultural and industrial heritage.

On the other hand, greater transparency empowers consumers to make better-informed consumption choices, as they have more reliable information about the sustainability and circularity claims about products and processes. As a result, traceability and transparency have great potential to build trust among all industry actors... effectively addressing risks to responsible business conduct depends on all the links in the value chain and requires the active and effective engagement of both upstream and downstream actors.

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The latter, who make the final decisions about which materials are used and which products are placed on the market, also are expected – and at times, legally required – to identify and mitigate risks that might result in harm to humans or the environment throughout their entire value chain. (UNECE 2021a)

The following sections discuss the role of the COVID-19 pandemic in framing the contents of Recommendation No. 46 with a focus on traceability and transparency; the societal implications of traceability and transparency on customers' behaviors and societal inclusion, in particular with respect to women, informal actors, and other vulnerable groups; and the possible impacts of traceability and transparency on the transition of supply chains toward a circular model, with a specific focus on measures taken by small- and medium-sized enterprises (SMEs).

In addition to explaining how Recommendation No. 46 can contribute to facilitating a sustainability transition by the global garment and footwear system, this Brief Report introduces the set of tools developed by UNECE to enhance traceability and transparency toward a circular and sustainable economy in these value chains.

Role of the COVID-19 pandemic: challenges and opportunities for advancing traceability and transparency in garment- and footwear-value chains

The garment and footwear sector is part of the apparel industry which has one of the highest environmental footprints and also contributes to increased risks for human health and the environment (UNECE 2020). During the last decade, supplier relationships have been especially affected by local and global events. For example, the 2013 Rana Plaza disaster in Bangladesh, among the world's largest garmentmanufacturing hubs, awakened the industry to the need for safer working conditions.

COVID-19 has been an even broader source of disruption to supply chains with global impact. The public health crisis has widened existing cracks in an industry already challenged by excessive inventories and charged with fostering a culture of consumerism and contributing heavily to the amount of waste going to landfills. The Ellen MacArthur Foundation (EMF 2017) has observed that the number of times a garment is worn before being discarded has decreased 36% compared to fifteen years ago, starting globally from an average of 200 times to the current average of 126 times.

The pandemic has increased consumers' demand for sustainable products and sustainability information. It has also generated new opportunities for

companies to communicate the sustainability impacts of their products and processes (McKinsey and Company 2020a, 2020b). In fact, the pandemic has accelerated a process already in place as “key actors in the [garment and footwear] industry have identified traceability and transparency as crucial enablers of more responsible production and consumption patterns, and a core priority for immediate action” (UNECE 2020).

The implications of the public health crisis have amplified the need to invest in traceability and transparency, and particularly Recommendation No. 46 underlines a number of key benefits that can accrue to all actors (UNECE 2021a):

- For consumers by giving access to transparent and authoritative information that enables them to make more responsible purchasing and consumption decisions.
- For garment and footwear companies, both upstream and downstream, by allowing them to verify their sustainability claims, to better manage their value chains, and to leverage sustainability as a stronger source of competitive advantage.
- For manufacturers by protecting them from false claims of provenance and in turn by exposing companies that exploit workers.
- For governments by gathering the information needed to regulate markets, to support companies, and to target incentives for sustainable production and consumption.

To ensure achievement of these multilevel impacts, traceability and transparency policies need to be based on new alliances between industry and civil society, with particular attention devoted to customer engagement and societal inclusiveness.

Participation of consumers and enterprises in achieving sustainable consumption and production

A recent survey by management consultants McKinsey & Company (2020a, 2020b) confirms a strong desire on the part of consumers to reduce the social and environmental impacts of the clothing that they purchase. Enterprises that want to increase their sustainability performance need to rethink the role of consumers who want to be activated in creating a circular economy, for example by bringing products back to retailers for recycling or simply repairing products to extend their life (Rinaldi 2019). For consumers to play an active role in enhancing sustainable consumption, they need to be empowered via consumers' rights and have access to

harmonized and reliable information (EC 2020a, 2020b).

With regard to garment- and footwear-value chains, consumers need information concerning the environmental and human-rights dimensions of products expressed in a clear, trustworthy, easy-to-understand, and verifiable way. Furthermore, the information needs to be in alignment with Target 12.8 of Sustainable Development Goal (SDG) 12 (Responsible Consumption and Production) which calls for consumers to “have the relevant information and awareness for sustainable development and lifestyles in harmony with nature” (United Nations 2016). In particular, according to several European policy recommendations and initiatives, relevant information regarding all actors along the supply chain should be publicly available to consumers (see European Parliament (2017) for details on a flagship initiative for the garment sector).

The establishment of legislative frameworks on traceability that look to ensure accurate, accountable, and transparent information could increase consumer awareness about the sustainability of products and encourage companies to invest in sustainable production. In fact, as pointed out by the European Parliament in its resolution “Towards a More Sustainable Single Market for Business and Consumers” (European Parliament 2020a), sustainable consumption and sustainable production are very closely interconnected, and supporting companies in traceability and transparency will help to raise consumer awareness on the impacts of their purchasing choices.

The introduction of mandatory labeling requirements could also support the objective of traceability and transparency along the entire value chain, as underlined by the European Union “Circular Economy Action Plan” and by the European Parliament in its resolution on the impact of international trade and the European Union’s trade policies on global value chains (EC 2020a; European Parliament 2020b). Considering that consumer awareness about sustainability in the production of garment and footwear products is key to making a sustainable industry competitive, the European Union is highlighting the need to introduce Union-wide labeling standards for responsibly produced clothing, accessible to both large companies and SMEs. In this way, when consumers purchase products they can be informed about the degree to which producing companies demonstrate respect for environmental and human rights. Various policies of the European Union aim to shift consumers’ preferences to more sustainable choices since a green transition requires the participation of consumers. For this reason, the European Circular

Economy Action Plan also focuses on legislative initiatives that empower consumers.

Another important step in this direction is provided by the new Consumer Agenda launched by the European Commission in November 2020 to respond to the recent crisis caused by the COVID-19 pandemic (EC 2020b). This strategy aims to tackle the increasing importance of environmental issues and the need to protect vulnerable consumers in the context of new economic realities created by the public health crisis. It enumerates as a priority and key action point the introduction or revision of European legislation to provide more effective information on sustainability to consumers. Consumer protection and awareness could be further strengthened by strong traceability and transparency frameworks which, on one hand, tackle misleading claims that are especially crucial for vulnerable categories of consumers and, on the other hand, encourage sustainable consumption and production (European Parliament 2020a).

The need to include women, informal actors, and other vulnerable groups to enhance traceability and transparency

From a societal perspective, sustainability goals do not only require a more active role on the part of customers, but new inclusive and equitable approaches for workers and especially to women, informal actors, and other vulnerable groups which are still highly exploited within the global fashion system. The inclusion and representation of these stakeholders in the garment and footwear sector are crucial for sustainable development and economic growth and they have to be considered when policies are developed and organizations implement traceability and transparency systems, as confirmed by the European Parliament in its resolution on gender equality and women’s empowerment (European Parliament 2018).

In particular, women account for a majority of the workforce in garment- and footwear-supply chains (ILO 2018). At the same time, many producing countries perform poorly on gender equality and women’s economic empowerment. Therefore, measuring progress on global priorities for women as reflected in the United Nations SDGs is fundamental to enabling complete traceability and transparency.

The European Union through several policy documents has already shown its commitment to putting gender equality and women’s economic empowerment forward as focal points and priorities of its legislation. In fact, several directives on gender equity have been adopted and there is now a European strategy and an action plan that aims to eliminate inequalities and promote parity in all its

activities (European Parliament 2010, 2012, 2017; CEC 1992, 2004; EC 2020d, 2020e). The development of policies and other measures tailored to women's needs can, in fact, play a fundamental role in strengthening their rights and supporting gender equity. To achieve this objective, traceability and transparency systems are needed.

In this regard, the Organization for Economic Co-operation and Development's (OECD) Due Diligence Guidance for Responsible Supply Chains in the Garment and Footwear Sector and the OECD Due Diligence Guidance for Responsible Business Conduct both encourage all actors to systematically consider the position of women at all stages when implementing traceability and transparency systems (OECD 2017, 2018).

Gender issues in the garment and footwear sector start in the fields and on the manufacturing floor and include the "glass ceiling" for woman's promotional opportunities (Campopiano et al. 2017). As pointed out by the Federal Glass Ceiling Commission convened in the United States in 1995 (which remains extremely relevant today), gender issues constitute the invisible barrier that keeps "women from rising to the upper rungs of the corporate ladder, regardless of their qualifications or achievements" (FGCC 1995).

The European Parliament highlights the importance of encouraging women's access to leadership positions by teaching female workers about their rights, labor legislation, safety and health issues, as well as by providing training and awareness information for male managers regarding gender equity and discrimination (European Parliament 2020a). The European Parliament has also asked the European Commission to develop policies and legislation to support women entrepreneurs via micro-loans to enable them to gain from private sector-led growth.

Vulnerable workers such as women, as well as minorities and informal workers, in developing countries are not properly and sufficiently protected under current policy and regulatory frameworks established at the national and international levels (ILO 2018). In particular, it is important to consider the informal sector given that, according to the International Labour Organization (ILO), more than half of the global workforce and more than 90 percent of micro and small enterprises (MSEs) worldwide are part of the informal economy (ILO 2018). However, given the high level of fragmentation of production across different countries in the garment and footwear sector, undeclared informal work is a critical challenge. There is often a lack of compliance with international labor standards and this leads to deficits in decent work and a lack of transparency (EC 2017). Implementing traceability and

transparency systems could play a crucial role in reducing informality while guaranteeing protection of vulnerable groups, thereby contributing to a more sustainable economy.

How traceability and transparency can support the transition toward a circular economy and sustainable growth

The positive impacts of traceability and transparency on social sustainability cannot be detached from their effects on environmental sustainability, which rely significantly on the transformation of the fashion-manufacturing system into a circular model. The circular economy constitutes a necessary step toward economic growth and development that respects the environment through the efficient use of natural resources, as well as sustainable production and consumption models. These factors will also be crucial in building a resilient economy in the post-COVID-19 era because the pandemic has demonstrated that current garment and footwear global value chains have critical gaps with regard to protection of the environment, human health, and the economy. To enable a circular economy, the European Union has adopted various policies and documents many of which highlight garment- and footwear-value chains as key areas where changes are needed to accomplish policy objectives (EC 2020a).

Traceability and transparency in support of circularity could significantly benefit the garment and footwear sector. First, as highlighted by the European Circular Economy Action Plan and the European Chemical Strategy for Sustainability, to build a strong circular economy traceability and transparency systems for the use and management of chemicals are powerful tools to support more sustainable practices (EC 2020a, 2020c). Second, the implementation of traceability and transparency frameworks is relevant for waste prevention and waste management (particularly with regard to hazardous waste for which data on treatment are missing) and should be the center of efficient sustainable production and consumption (EC 2020a, 2020c). In fact, traceability is key for reducing risks to human health and the environment by allowing companies to gather information on the production and use of chemicals and the disposal of waste. It is also essential to share this feedback with relevant actors in the value chain, consequently enabling them to take needed action. In addition, traceability can support transparency for consumers at the point of sale, informing them about a product's entire lifecycle, thus contributing to their participation in the transition toward a circular economy.

UNECE Recommendation No. 46 and other outputs from the same project identify powerful strategies and tools to accelerate traceability and transparency for circularity and sustainability in the garment and footwear sector. These tools are outlined in [Table 1](#) along with the relevant actors for their implementation.

More specifically the tools listed in [Table 1](#) should be implemented by three categories of actors with specific goals.

Policymakers who need to adopt norms on traceability and transparency and international standards for data collection and exchange, with the support of international organizations; set financial and non-financial incentives, including sustainable procurement and rapid customs clearance; invest in advanced technologies; define extended producer responsibility (EPR) schemes; and support training and education for sustainable production and consumption.

Companies and industry associations that need to formulate industry commitments and company-action plans with targets for traceability and transparency; invest in advanced technologies; and develop programs on training for sustainable production and support consumer education about sustainable consumption.

Civil society organizations that need to develop information campaigns and collaborative initiatives to achieve industry-wide change and support consumer and citizen education on sustainability.

The effectiveness of traceability and transparency policies for the transformation of the global fashion-manufacturing system also depends on their capacity for properly adapting to the specificities of this particular context. Among these requirements, the prevalence of SMEs compared to large companies is massive and calls for ad hoc policies as outlined in the following section.

Tailored measures to support SMEs

Fostering traceability and transparency requires a multi-level approach with a strong focus on SMEs.

The fundamental importance of SMEs for the European economy has long been recognized by the European Commission and it is committed to putting promotion of the creation, growth, and internationalization of SMEs at the core of the Union's integrated industrial policy (EC 2010).

Indeed, over the last fifteen years, the European Union has launched several policy initiatives for supporting SMEs (EC 2005, 2008). One of the more notable undertakings has been the establishment of the Executive Agency for Small and Medium-sized Enterprises (EASME) which was launched in 2014 to manage several European Union research and innovation programs in the fields of SME support and innovation, environment, climate action, energy, and maritime affairs. In the garment and footwear sector, SMEs have specific needs when implementing sustainability and circularity. The main challenges identified in the literature are summarized in [Table 2](#) (see also Centre for Sustainable Fashion et al. 2019).

An extensive literature review highlights some specific challenges regarding circularity affecting all enterprises such as:

- Barriers related to design for recyclability and access to resources (Sandvik and Stubbs 2019).
- Issues related to consumer perception of circular offerings (Camacho-Otero, Boks, and Pettersen 2019).

With reference to implementation of circularity some additional challenges that are especially relevant for SMEs include:

- Lack of management support for 4.0 technologies (Kumar, Singh, and Dwived 2020).
- Issues related to waste recycling (Patricio et al. 2018).
- Lack of tailored regulations and incentives, insufficient data and indicators to measure and communicate impacts, cost of product/waste take-back, inadequate awareness and market demand,

Table 1. Most relevant tools to enhance traceability and transparency toward a circular and sustainable economy in garment- and footwear-value chains (adapted from UNECE 2022).

Tools to enhance traceability and transparency toward a circular and sustainable economy in garment- and footwear-value chains	Relevant actors
1. Regulation supporting traceability and transparency	Policymakers
2. International standards for traceability and transparency of data	Policymakers and international organizations
3. Financial and non-financial incentives for companies and especially SMEs	Policymakers
4. Industry commitments and collaborative initiatives	Companies and industry associations, civil society organizations
5. Product passports and other advanced technologies	Policymakers, companies and industry associations
6. Extended producer responsibility schemes ³	Policymakers
7. Action plans with quantitative targets for traceability and transparency	Companies and industry associations
8. Training and capacity building	Policymakers, companies and industry associations, civil society organizations
9. Consumer awareness and education	Policymakers, companies, industry associations, and civil society organizations

Table 2. Most relevant challenges to implement sustainability in garment and footwear value chains (adapted from Centre for Sustainable Fashion et al. 2019).

Topic	Challenge/Obstacle	Illustrative literature
Competition and scale	Competition from high volume/low price corporations	MISTRA Future Fashion (2017); Cipola, de Roy van Zuidewijn, and Thureau (2017); HCEAC (2019)
	Finding own voice in a market geared to large-scale operations	Cipola, de Roy van Zuidewijn, and Thureau (2017)
	Affordability and availability of materials linked to minimum volumes for orders	Aakko and Niinimäki (2018); Cipola, de Roy van Zuidewijn, and Thureau (2017)
	Aligning values across a supply-chain and encouraging sharing of knowledge and resources which is likely to require value-chain coordination	Todeschini et al. (2017); Fischer and Pascucci, (2017)
Consumer awareness	Attitude-behavior gap – awareness not yet matched with action	MISTRA Future Fashion (2015); Todeschini et al. (2017); Boiten, Li-Chou Han, and Tyler (n.d.)
	Visibility of sustainable options – lack of consumer awareness/knowledge of alternative models	MISTRA Future Fashion (2017); Todeschini et al. (2017); Boiten, Li-Chou Han, and Tyler (n.d.)
	Managing the high expectations of niche consumers	Todeschini et al. (2017)
Lack of finance	High startup costs	MISTRA Future Fashion (2017)
	Lack of growth and income generation, uneasy cash flow management	Centre for Fashion Enterprise (2008)
	Lack of funding and sufficient support from banks	Centre for Fashion Enterprise (2008); Thureau (2017); MISTRA Future Fashion (2015); Accenture and Global Challenge Awards (2018)
	Risk aversion and lack of business knowledge and awareness of available funding options	Accenture and Global Challenge Awards (2018)
Technical challenges	Increased working capital needed for product-service systems	Fischer and Pascucci (2017); Accenture and Fashion for Good (2019); SITRA and Circle Economy (2015)
	Technical challenges related to rethinking the design phase of products and access to design tools	Cipola, de Roy van Zuidewijn, and Thureau (2017); Todeschini et al. (2017)
	Low quality/durability of textiles on market	MISTRA Future Fashion (2017)
	Commercially viable recycling options for low-grade textiles	Boiten, Li-Chou Han, and Tyler (n.d.); Euratex (2017)
Infrastructure and regulation for reuse and recycling	Scaling up and commercialization of new recycling technologies such as fiber to fiber processing	WRAP (2019); ESBF (2019)
	High demands on human resources in sorting	MISTRA Future Fashion (2017)
	Collection infrastructure for reuse and recycling – local, national, regional and global	Euratex (2017)
	Lack of harmonization of requirements and regulation related to textile waste management and reuse across the EU and globally	Euratex (2017), Rreuse (2017)
Microfiber release	Lack of clarity in classification of textile waste – end of waste criteria	Euratex (2017)
	Insufficient incentivizing through policy tools	MISTRA Future Fashion (2017), HCEAC (2019); Rreuse (2017); ESBF (2019); Euratex et al. (2019)
	Current status of knowledge on variables linked to microfiber shedding (e.g., industrial and domestic conditions) – more research needed	HCEAC (2019); ESBF (2019)
	Lack of harmonization and coordination of test methodology	Euratex (2017)

complex product or packaging design that prevents proper reuse/recycling (Veleva and Bodkin 2018).

- High startup costs, complex supply chains, challenging business-to-business (B2B) cooperation, lack of information on product design and production (Jaeger and Upadhyay 2020);
- Low price of virgin materials compared to recycled materials and difficulties establishing cross-organizational collaborations (Guldmann and Huulgaard 2020).

All of these insights emerged from both scientific studies and surveys carried out by private and public institutions and political bodies and this work has contributed to the growing relevance of SME-oriented policies on the agenda of the European Union. However, there is still a strong need to develop legislative and non-legislative measures to

support SMEs with financial and non-financial incentives, information and training, and research and development that allow these actors to access markets and start implementing traceability and transparency systems and to ensure a level playing field in the market (UNECE 2022).

The UNECE project suggests that when implementing traceability and transparency systems, tools and guidelines can be adapted for these actors through special training and action plans. In the language of the report, “[A]wareness campaigns and training programs are necessary to explain, particularly to SMEs, why traceability is a competitive key and can provide organizations with marketing benefits” (UNECE 2022). The participation of representatives of SMEs during the consultation phases for the development of traceability and transparency systems could also have an important role in their acceptance and implantation.

Moving forward and creating impact

Together with Recommendation No. 46, which contains specific proposals for actions, an extensive toolbox for implementation has been developed by UNECE.¹ This assemblage includes several components that range from guidelines on how to implement recommendations to reports on the current state of the art in sustainability and circularity. In particular, it includes:

Guidelines for Recommendation No. 46 (starting on page 10 of the Recommendation document) (UNECE 2021a).

A Call to Action entitled “The Sustainability Pledge” (UNECE 2021b) that provides a mechanism for governments and value-chain actors to declare their intention to implement all or part of Recommendation No. 46 and in due course to report on their progress.

- A report on business process analysis for sustainability and circularity in the textile-value chain.
- A report on business-process analysis for sustainability and circularity in the leather-value chain.
- A framework for a high-level process and data model for traceability and transparency in the textile and leather sector.
- Cases and data structures for traceability and transparency in the textile and leather sector.
- A mapping of the garment- and footwear-sector ecosystem.
- A mapping of policies, regulations, and guidelines related to traceability and transparency.
- A policy brief on harnessing the potential of blockchain technology for due diligence and sustainability in cotton-value chains.

In addition, UN/CEFACT has created a team of specialists to work on environmental, social, and governance traceability of sustainable value chains in the circular economy that is open to subject experts from around the world to contribute to moving forward traceability standards and implementation efforts in sectors that are critical to the circular economy (UNECE 2021c).

Impact requires action. The above recommendation and their accompanying toolbox need to be adopted and implemented by governments, industries, and all other stakeholders in order to address the environmental and social impacts of the garment and footwear industry.

Conclusions and policy recommendations

Traceability and transparency in the garment and footwear industry require harmonized regulatory frameworks and commonly defined standards, with

the participation of all relevant stakeholders (UNECE 2022). With this aim, the UNECE project on “Enhancing Traceability and Transparency of Sustainable Value Chains in Garment and Footwear” has produced several outputs (Recommendation 46, Call to Action, toolbox) which need to be promoted and implemented by governments and relevant value-chain actors. Among them consumers, vulnerable groups, and SMEs will play especially critical roles in pursuing sustainability in the sector and they need specific measures addressed to them.

It is time to develop a smart policy mix that fosters coherence at the international, regional, and national levels, providing incentives to support the uptake of responsible business conduct, promoting innovation through the adoption of new technologies, raising businesses and consumer awareness and education, and incentivizing public and private partnerships to move toward the transition to a circular economy.

Appendix 1 provides the text of Recommendation No. 46 of UN/CEFACT (UNECE 2021a) on which the authors of this brief report have been working with the goal of disseminating it to the scientific community and the wider public as a contribution to expand global commitment toward a sustainable transition.

Notes

1. For further information refer to <https://unece.org/trade/traceability-sustainable-garment-and-footwear>.
2. See <https://unece.org/trade/uncefact/brs> for the list of business-requirement specifications (BRs).
3. Extended producer responsibility (EPR) is a policy approach under which producers have significant responsibility – financial and/or logistical – for the treatment or disposal of post-consumer products (<https://www.oecd.org/env/tools-evaluation/extendedproducerresponsibility.htm>).

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Appendix 1

United Nations Economic Commission for Europe, Recommendation No. 46, *Enhancing Traceability and Transparency of Sustainable Value Chains in Garment and Footwear*

The United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT) of the United Nations Economic Commission for Europe (UNECE), at its twenty-seventh session, agreed to recommend that governments take the actions listed under the areas shown below.

Policy actions, norms and standards

- (a) Establish harmonized policies and regulations that support the implementation of traceability and

transparency, in order to achieve higher environmental and social standards, economic viability and circularity in garment and footwear value chains by:

- i. Encouraging responsible business conduct, which addresses actual and potential adverse impacts resulting from companies' decisions;
 - ii. Ensuring the reliability of non-financial reporting and sustainability claims about materials, products, processes and facilities;
 - iii. Contributing to international policy coherence, thereby addressing the challenges for producers and consumers that are created by a proliferation of similar, but different, policies and regulations, while also establishing a more level playing field for companies operating in this industry.
- (b) Define minimum levels of traceability across garment and footwear value chains (from raw materials sourcing to consumption and post-consumption activities) and the minimum data that need to be collected in order to show due diligence and transparency in support of claims regarding the origin, composition and other characteristics, including the sustainability performance of products, processes and facilities.
- (c) Encourage companies' efforts to embrace higher transparency in value chain operations, for example by disclosing the names and addresses of suppliers' factories and sharing relevant information on their sustainability performance with stakeholders who are impacted, or potentially impacted, by enterprise decisions. This should be done in a timely, culturally sensitive, open and accessible manner, in line with international data protection norms and standards.
- (d) Reduce the implementation burden on businesses and support SMEs by promoting the use of international standards, such as the UN/CEFACT standards for traceability and transparency of sustainable value chains in garment and footwear² or the equivalent, and by encouraging the use of existing data.

Incentives

- (e) Provide economic and fiscal incentives (positive and negative) for establishing and implementing value chain traceability and transparency systems, especially in support of SMEs, small farmers and producers, and other vulnerable groups such as women, young workers, home-based workers and migrant workers.
- (f) Provide non-financial incentives, including measures to facilitate access to markets; fast-track processes; public procurement criteria that are green and socially responsible; specialized managerial and workforce training; public visibility; peer-learning and non-financial reporting requirements.

Research and development

- (g) Support research and development, and identify and scale-up innovative solutions for:
- i. Advancing the sustainability and circularity of production and consumption processes;

- ii. Tracing and verifying products' authenticity and provenance;
- iii. Increasing the lifespan of products;
- iv. Creating more sustainable materials;
- v. Recycling, reusing and redesigning garments and footwear.

Awareness and education

(h) Provide education in order to:

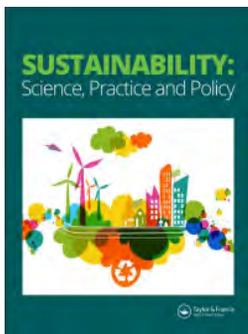
- i. Allow consumers to make informed choices;
- ii. Create awareness of the shared responsibility of all stakeholders, including both business and consumers, to take an active role in preserving our planet;
- iii. Increase the demand for materials, products and processes that are more responsible and sustainable.

Multi-stakeholder collaborative initiatives

(i) Stimulate and support multi-stakeholder, collaborative initiatives that seek to achieve industry-wide change and create shared value for all industry actors. These should be inclusive, benefitting especially SMEs and vulnerable groups in developing and transition countries while, at the same time, addressing garment and footwear value chains' sustainability risks and impacts. Such initiatives could include:

- i. A global, open-source knowledge platform to make guidance available and ensure that industry actors receive appropriate training and information;
- ii. Multi-stakeholder policy dialogues for the sharing of good practices and lessons learned at the international, regional and national levels;
- iii. Pilot projects to experiment with innovative approaches and advanced technologies in traceability, including blockchain technology, artificial intelligence (AI), the internet of things (IoT), and biotechnology markers to ensure an effective connection between digital and physical assets.

When deciding upon specific actions to be taken, multi-stakeholder consultations are recommended in order to strike a balance between the different interests at stake, and to identify targeted implementation support for vulnerable groups. Special attention needs to be given to SMEs, smallholders, farmers, and other groups affected by unfair practices in this sector, including (as appropriate) women, young workers, home-based workers and migrant workers. To monitor and keep track of the implementation of this policy recommendation, stakeholders are requested to report on commitments to the recommended measures starting in 2022, and thereafter every two years. Such pledges are to be expressed in accordance with the Call to Action (ECE/TRADE/C/CEFACT/2020/6/Rev.1), which is open to all industry stakeholders and actors embracing transformational change for a responsible and sustainable garment and footwear industry of the future.



Fashion as diversity and care

Ezio Manzini

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Fashion as diversity and care

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ABSTRACT

This short contribution offers a perspective on the general topic of the Special Issue reflecting on the evolution of fashion and its contemporary meaning. Starting from a discussion of how the nature of fashion was shaped and contributed in turn to shape several founding ideas of modern civilization, it introduces some possible directions for re-signifying fashion, transforming its social and cultural function toward more sustainable paradigms.

ARTICLE HISTORY

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Fashion sustainability; diversity

To discuss fashion and the whole panorama of different meanings related to this term, here I will first consider the idiom of “being *on fashion*.” This phrase refers to a condition that I consider to be linked with the idea of *resonance*: things *on fashion* are fashionable because, in a given time, in a given space, for a given group of people, they *vibrate* together, creating a resonance. However, as this idea may perhaps be evocative, it is certainly not very useful: what does *vibrate in this resonance*? How do new *resonances* emerge?

To prepare the ground for my discussion, it is necessary to introduce a few concepts that are a little more operational. It can be observed, for example, that things *on fashion* are media that are communicative objects: those who adopt fashion items use them to say something about themselves and about the world in which they live, they partake in defining individual and collective identities. But there is more. They are, in fact, maieutic instruments that support certain behaviors. And, finally, they work as relational objects to promote dialogues and to foster the adoption of social practices and interaction.

On a theoretical level, every product can play these three functions. The truth is, some products more than others, such as those related to clothing, do it more frequently and in a more obvious way. That is why, as a first approximation, when we speak of items as “being on fashion” we refer to clothing, and vice versa.

First, fashion, conceived as I am proposing, has a history as old as that of humanity. However, in the

pre-modern era, fashion was strongly intertwined with tradition: at a certain time and in a given place, the communicative, maieutic, and relational aspects of clothes were largely defined by social customs. They were unique indicators of social status: apart from some details, how to dress was not the result of individual choices, instead it was the outcome of deep-rooted social conventions and practices.

With the rise of the modern era everything changed. As everyone was suddenly in the condition to freely decide about his life project on a daily basis, individuals were also free to choose which objects to surround themselves with, and therefore how to dress. Consequently, for better or worse, fashion as we intend it today, emerged. A fashion crossed by the same contradictions of modernity. A fashion that speaks both of individual freedom as well as of individualism; of personal expression, as well as consumerism.

Today, in the midst of the environmental, social, and cultural crises we are facing, we cannot avoid acknowledging how much fashion has been an agent for accelerating unsustainable ways of being and doing. Nonetheless, in my opinion, these effects are not inscribed in fashion’s nature. Instead, they resonate with some ideas and practices that have become dominant in recent years. Different ideas and different practices could have led to different ways of using fashion. Furthermore, I do believe that if we will ever reach a form of sustainable society, it should allow people to choose how to dress: therefore, there will exist a fashion. In any other

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case, it would mean there will be some form of coercive society: a dictatorship of the self-image (of how anyone should look), possibly an expression of a broader coercion that will act upon the right of expression as well as upon any other personal freedoms.

Therefore, today and for the future, the question is not whether there will be fashions, but what do they talk about? Which behaviors do they promote? And which conversations do they trigger?

Furthermore, as today's efforts are all focused on solving the current socio-economic-environmental crises, we should first ask ourselves not only how fashion could reduce its environmental load but also how it could become an agent for positive regeneration.

In other words, the question is: could fashion communicate ideas, stimulate behaviors, and promote relationships in order to deviate from the catastrophic direction the system has taken? Could fashion objects become agents for positive change, to reweave the web of life which, in recent years, we have so recklessly torn apart?

Further, I do not have exhaustive answers to the previous questions. However, observations can be made by referring to the notions of newness, diversity, and care. And therefore quality.

Newness

I believe that the pleasure of discovering something that appears new and fresh is embedded within our human nature. Therefore, this search for newness is entirely understandable and desirable. What is not acceptable, however, is its amplification that feeds a continuous acceleration of producing "variations of the new," which have led to a hyper-exaltation of what is being proposed as "new." This causes a problem of exponential increase in consumption. But not only. It results as well in a double loss: the loss of our capability to evaluate and recognize the deep quality of things and the loss of caring about them. This drift toward "newism,"¹ for which fashion has been one of the main engines, is completely consistent with some key ideas and practices of modernity. And as we can all acknowledge today, it is intrinsically and dramatically unsustainable.

The connection between newness, increased consumption (and therefore waste), and global environmental issues is clear and widely discussed. Equally important, but much less considered, is the link that "newism" has with the impoverishment of quality and care. And, therefore, the loss of the human capacity of imagining and concretely pursuing the new kind of civilization we must contribute to build.

Diversity

Saying that a new global civilization founded on the values of care and regeneration should emerge, and it is possibly emerging with difficulties and contradictions, does not mean imagining a future of homogeneity. On the contrary, a sustainable civilization can only be conceived as widely diversified and should produce dynamic socio-technical and cultural ecosystems, rich in diversity.

This is because their variety is a prerequisite to guarantee adaptability and durability. Within this conception, the ideas of care and capacity of regeneration should not be seen as a sort of "patina" covering and homogenizing diversity, but rather as humus for growing the new "garden of diversity," that existence is allowed precisely by this common nourishment.

From this standpoint, the metaphor of the garden seems to me very eloquent: the more it is beautiful, durable, and able to face adversities, the more it is variegated. And the more this diversity is consistent with the shared rules of ecology. No need to be said that fashion could be a catalyst for this ecological diversity.

Care

Putting the idea of caring at the very center of our discourse on fashion its meant to link it with the broader ongoing discussion that puts "care" at the core of the needed reorientation of our culture, especially the western one; that is to say leaving anthropocentrism for developing a new capacity to care even for what is non-human, but which is never less fundamental to preserve the planetary web of life.

The concept of care is intertwined with that of time and durability. In short, care requires time and attention, the time and attention needed to connect all the different threads, to act in complexity without reducing it.

Care, therefore, implies an intrinsically artisanal approach: doing things taking the required time, giving them the required attention, using thorough know-how, layered in time. Consequently, we can affirm that relationships created by care produce sound qualities, including the deepest of all: the quality of being sustainable.

Finally, until now, despite some exceptions, fashion has promoted a civilization based on accelerated times and its resulting lack of care. Nonetheless, as anticipated, it does not necessarily have to be that way. Fashion has the capability to nudge and nurture other ideas, and to enable different behaviors, putting the topic of care at the heart of them.

Therefore, in pursuing it, developing new ideas of quality.

From this standpoint, the relationship between fashion and sustainability should not only reply to the question about how to reduce the environmental weight of fashion products, but it should also be investigated from the standpoint of seeking to understand how to turn fashion into a positive agent contributing in the transition toward a sustainable civilization.

Therefore, how to make fashion, in its communicative role, able to spread the ability to produce and recognize sustainable qualities; moreover, in its maitetic function, how to make it an enabler of new practices of caring; and ultimately, in its relational role, how to make it a promoter for the creation of networks of people capable of operating as transition agents. In short, going back to the earlier metaphor, we should ask ourselves how fashion can help

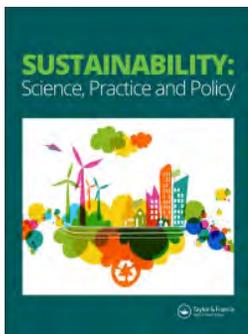
diverse individuals to live their own lives as they prefer, allowing the garden of varieties to flourish, being in harmonic resonance with others: with some of them by sharing certain qualities and related practices of care. And with everybody by tuning with the deep vibration produced by the web of life on our planet.

Note

1. This Brief Report has been translated from the Italian by the co-editors of this Special Issue; the word used here by the author is “nuovismo.”

Disclosure statement

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Perspectives: earth rising

Kate Fletcher

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Perspectives: earth rising

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ABSTRACT

This Brief Report argues for approaching fashion sustainability as a whole systems issue and outlines some of the systems insights already uncovered. It also calls out the logic of economic growth as a key factor that limits the prospects for whole sector change. I propose an alternative logic – Earth Logic – which prioritizes Earth and all its species, including humans as a way to diversify and vivify fashion activity within planetary limits. The fashion territory cultivated by this changed logic is unfolding already today and will continue to do so, with roles for existing and entirely new actors, garments, and ways of organizing clothing, albeit configured differently with altered priorities.

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Systems change; Earth Logic; growth logic

There are many ways to tell the story of refinement and revision of the global fashion system for sustainability. Some of these stories start by telling about the paths we travel as we act for social justice, while others recount routes that open up to us as we pursue environmental change, and others still tell us about diverse contexts and concepts. Indeed, the pages of this special issue contain a wide variety of these stories. The stories are both a cause for celebration and an indicator of rising interest in sustainability work. They are also a powerful signal of intent: *we are engaging in processes of fashion-sector change*. They also mark an increasingly sophisticated understanding of what this change involves:

- Some processes of change are easy and some are difficult, but we must commit to them all.
- Only some of what needs to happen aligns with conventional ideas including business practices, but we will keep working in these uncomfortable zones, even when it causes friction and challenges conventional ideas and priorities.
- Much of what needs to happen will not take place in the market.
- Some types of change will be quick to enact, while others will take generations, but we know that both types are our responsibility.
- The space in which we are working requires collaboration and entirely new forms of organization and governance.

- Sustainability change requires many ways of knowing.

When I did my PhD in the 1990s, I think I managed to read almost every academic paper in the field of fashion, textiles, and sustainability. I mention this experience not because reading everything is worthwhile in and of itself or because I am prolific at reading (I am not) but to try to convey something about how the field has grown. In 1995, it was physically possible to read all papers in the field because there were relatively few of them. Not so today; today it would be impossible. The fashion and sustainability complex is both large and busy and getting larger and busier. It is a hotbed of activity, an “industry” in itself, with a range and scale that is certainly impressive. It spans initiatives ranging from cross-brand projects, the goal of which is to raise standards across global supply chains, to the decentering of fashion-sustainability knowledge and practice away from Western perspectives; from innovative design concepts to new roles for the media; from an evolution in terminology to sustainability filters offered by popular online retailers to encourage buyers to shop differently. Today, in the fashion sector, sustainability is a familiar refrain. It has entered scholarly, industrial, and public consciousness and has resulted in an unprecedented acceptance of sustainability as a system of ideas. Not only that, but fashion is becoming viewed by other sectors, including food for instance, as a testbed of

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sustainability transformation. Other sectors look on with interest as fashion – a cultural, ecological, and industrial process – experiments. These sectors pay special attention to whether fashion can address its profoundly problematic relationship with excess, rapid product obsolescence, and consumption.

Yet even from within the excitement of this current wave of sustainability-focused activity, there is evidence of the worrying state of the larger “ocean.” Data suggest that despite decades of scientific inquiry and countless rounds of industry initiatives, academic research, and design intelligence, the cumulative environmental impact of the fashion and textiles sector is *increasing* (Lehmann et al. 2019). At this same moment, we are in a climate emergency, with environmental scientists declaring that there is less than a decade to avert catastrophic climate change and to embrace a necessary shift in knowledge and behavior (IPCC 2018). We are also on the cusp of a sixth mass extinction of life on Earth with levels of biodiversity loss reported of around 50% in 50 years (SCBD 2020). Further, we are still in the grips of a global pandemic which has revealed society as desperately unequal and us humans as profoundly interdependent beings, dependent on each other for both transmission of disease and for health.

This current moment is perhaps the right one to pause (although not for too long as rapid action is needed!) to understand why we are where we are and then to make change. The reasons why levels of environmental impact across the fashion and textile sector as a whole have shown no net reduction are relatively straightforward, although they are uncomfortable for many of those who are invested, for many different purposes, in the status quo. The primary reason is due to the underlying purpose of the fashion and textile sector being set to economic growth. With such a precondition, continuous expansion becomes a structural requirement of the sector along with concomitant resource drawdown, waste, and pollution effects. The “better” the sector performs, the worse these problems become. Any attempts to mitigate the negative effects of this growth logic are constantly hampered by the expanding size of the sector itself. It is the gross impact of the collective system that is the indicator that matters, as it is the collective effect that causes total ecological harm.

So where next? The short answer is a changed system purpose, one that puts Earth, and all its species, including humans, first. Mathilda Tham and I put forward one such vision in *Earth Logic: Fashion Action Research Plan* (Fletcher and Tham 2019), but there are others – and indeed this plurality matters.

If we follow the logic of Earth first, fashion becomes a way to drive regeneration of ecosystems and human health, to transform the places in which we live. In it there are legion opportunities for fashion activity including, but not limited to, industry. Indeed, going forward “industry” will occupy a less dominant role in our textile and clothing lives and livelihoods. We will instead work with communities of makers, producers, wearers, reusers, within and across households with entirely new configurations. New roles will emerge, new opportunities for the media, for citizens, for skilled craftsmen and women, for teenagers, for progressives, for those who appreciate tradition and material qualities.

Earth Logic mobilizes the practice of systems thinking in which the work of transformation is incumbent on seeing the entirety of the fashion sector as a system – and then intervening to affect whole system change. Systems thinkers such as Donella Meadows (2017 [1997]) highlight how the places where efforts are most often focused are typically the places where the smallest benefits can be gained, underscoring instead the need to direct attention at high level systems questions such as the rules and the goals of the fashion system. This makes sustainability initiatives in fashion as much a political challenge, involving structural choices and governance, as it is a technical challenge, focusing on fibers, supply chains, and consumer behavior.

Inevitably within Earth Logic there are hard choices, and these cannot be avoided. Ecological systems both enable fashion activity and also limit it, firmly drawing a line around the scale of activity that is possible within planetary boundaries. The implications on the fashion system of *less*, that is of materials-demand reduction, are profound for ecological health and livelihoods. A recent study by Cambridge University investigating carbon neutrality for the UK suggested that absolute zero carbon emissions by 2050 would only be possible by reducing demand for all goods by 40% while simultaneously redirecting production and consumption to low-carbon alternatives (Allwood et al. 2019). Such a challenge is not for the faint hearted, nor for those without imagination. As Frederic Jameson memorably stated, “It is now easier for us to imagine the end of the world than an alternative to capitalism” (see Boehnert 2018, 24). Yet many alternatives already exist in the fashion context and these are being enacted in a wide range of communities already today. They often work within a frame of localism where place adaptation, mixed with regional distinctiveness and more direct influence over the decisions that affect a community’s life, create a system with changed priorities including for

how we dress and the way to decide how much is enough.

The window for action on climate change underscores the fact that time is short and that every action counts. Time then for us to move at pace into the broad, inclusive, creative, richly fertile ground opened up when we recognize that to drive long-lasting, life-giving change we must scrutinize fashion-system priorities. Time to employ a new logic, the logic of Earth.

Disclosure statement

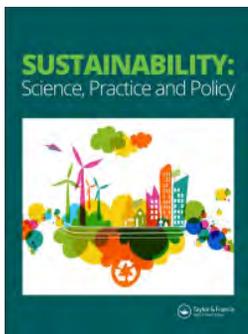
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RESEARCH ARTICLE



Exploring the nature of digital transformation in the fashion industry: opportunities for supply chains, business models, and sustainability-oriented innovations

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ABSTRACT

This article provides a comprehensive overview of the digital transformation of the fashion industry and describes the opportunities and influences on supply chains, business models, and sustainability-oriented innovations that it offers. Desk research was performed to review emerging cases of companies that engage actively in using 3-dimensional virtual and digital (3DVD) technologies, such as 3D modeling, virtual and augmented reality (VR and AR), 2- and 3-dimensional (2D/3D) scanning, and digital twinning (DT). The analysis shows how the adoption of digital technologies provides opportunities to dematerialize the traditional fashion supply-chain model of garment production and distribution and maps the innovative shifts occurring in the fashion industry's processes, products, and services. The adoption of 3DVD technologies by fashion companies unleashes new opportunities with respect to innovation in products/services and optimization of operational processes to streamline activities, shorten the lead time for designing, prototyping, manufacturing, marketing and retailing, and reorganizing the working phases. These capabilities also drive multicentred business-model innovations and thus affect value creation and delivery and capture changes. In addition, the analysis shows that digital transformation affects the four dimensions of sustainability that are interconnected intrinsically across supply-chain processes. Cultural sustainability is paramount, as fashion is a complex cultural system that is able to create products/services that influence the environment, economy, and society. In particular, 3DVD technologies promote cultural transformation of design processes to achieve a remix of skills and open knowledge, a behavioral shift from the consumer perspective in terms of diversity and self-expression, and a change in the organizational culture of companies that drive the digital transformation.

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Digital fashion; digital twin; digital transformation; culture; fashion design; business model; sustainability

Introduction

Researchers contend that the application of Industry 4.0 technologies in the fashion sector is bringing about transformative and disruptive changes in the back and front ends of the value chain and these alterations are resulting in more innovative (faster, more intelligent, and efficient) processes, products, services, and business models (BMs) (Bertola and Teunissen 2018; Kalbaska and Cantoni 2019). However, the application of digital technologies in the fashion industry has long remained in an exploratory stage due to a number of inhibitors and barriers that affect the pace of adoption (e.g., financial constraints, insufficient expertise, resistance to adoption) (Pal and Jayarathne 2022; Santos,

Montagna, and Neto 2020; Sassi et al. 2021). The COVID-19 pandemic has propelled a digital shift of the fashion industry toward the virtual dimension with a promise to enhance innovation and sustainability in all phases of the system (Brydges, Retamal, and Hanlon 2020; Gonzalo et al. 2020). Digital technologies are likely to have significant effects on the industry's future by providing opportunities to dematerialize resource-intensive practices in traditional fashion-supply chains and to co-create value in different sustainability dimensions (Business of Fashion and McKinsey & Company 2020).

Existing research has focused primarily on technological advancements that are required for widespread adoption (Papachristou and Bilalis 2015; Spahiu et al. 2021). However, the majority of these

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studies have tended to overlook a comprehensive business perspective on the way digital technologies diffuse through current industry practices (Ibarra, Ganzarain, and Igartua 2018; Parida, Sjödin, and Reim 2019). In particular, only a limited number of systematic overviews to date have covered transformation in products and processes and BM innovations attributable to the digitalization of fashion systems throughout the value chain. In the literature on digital transformation of the fashion industry (with a specific focus on 3-dimensional (3D) digital technology), we identified only two studies that provide a comprehensive value-chain perspective (Arribas and Alfaro 2018; Noris et al. 2021). Moreover, empirical evidence of the influence of 3D digital fashion remains scant (Arribas and Alfaro 2018). In summary, the effects of digitalization on the sustainability of the fashion system represent an emerging topic of research and is one that currently lacks a holistic perspective because inadequate attention has been devoted to its cultural dimensions (Malin and Ryder 2018). This is a major limitation in light of the fact that fashion is one of the most culturally intensive industries (Bertola et al. 2016; Martin and Vacca 2018).

This article provides a comprehensive overview of the nature of digital transformation in the fashion industry, describes the influence of digital technologies on the fashion-supply chain, considers innovation in the digital business model, and focuses on the digital effect from a multidimensional perspective of sustainability. By conducting a systematic review of the grey literature, we derive empirical evidence from companies that engage actively in using digital technologies (e.g., 3D modeling, virtual and augmented reality (VR and AR), 2- and 3-dimensional (2D/3D) scanning, and digital twinning (DT)). Our data analysis focuses on the effects of digitalization on the fashion-supply chain in product design and development, business-to-consumer (B2C) marketing processes, retailing, and production phases. In addition, we map emerging shifts in BMs with respect to supply-chain processes, products, services, and value-architecture dimensions (e.g., value creation, delivery, and capture) that are occurring because of digitalization. Finally, we highlight the dematerialization and sustainability effects of adopting 3D virtual and digital (3DVD) technologies by taking a holistic approach that includes culture as a fourth dimension of the phenomenon in different phases of the supply chain. The overarching scope of the article is intended to support academics and practitioners as they navigate this novel, dynamic, and applied research field by discussing emerging limitations and sustainability challenges attributable to digital transformation in the fashion-supply chain.

Literature review

Overview of digital transformation of the fashion industry

Industrial digitalization involves structuring, shaping, and influencing transformation along different, albeit overlapping, dimensions – economic, societal, and cultural (Brennen and Kreiss 2016).¹ Enabled by digital technologies, digitalization and digitization of data and processes lead to digital transformation that is associated with altering value-creation paths and offering new products and services while managing the structural changes in, and the barriers to, the transformation process (Vial 2019).²

The digital transformation of the fashion industry affects the entire value chain in which radical changes occur in the relationships with customers and in supply-chain operations as a result of adopting 3DVD technology (Arribas and Alfaro 2018). The application of 3DVD technological systems that use computer-generated representations of a garment or accessory in the different stages of production and distribution influences customers' experiences and behaviors and offers opportunities for dematerialization of the fashion sector. Analysts have long defined dematerialization as reducing the amount of materials and energy used in the production and consumption phases of finished products and services (see, e.g., Wernick et al. 1996). Adopting 3DVD technologies in the fashion industry allows a nonphysical economy to emerge in which garments and services exist beyond the physical realm and contribute to dematerialization because they will never be produced in reality. Further, 3DVD technologies are associated with the digital transformation of several phases of the life cycle of fashion products and this allows some material activities to migrate to digital activities while enabling continuous information flow to improve product life-cycle management (Riedelsheimer, Dorfhuber, and Stark 2020; Brynjolfsson and McAfee 2014).

In the following sections, we present a detailed overview of the effects of 3DVD technologies on the fashion-supply chain, provide a design-driven perspective on the phenomenon, and describe digital BM innovations.

The effect of digital technologies on the fashion-supply chain

A review of the existing literature shows that adopting 3DVD technologies leads to structural changes in the traditional supply-chain model of fashion companies. The use of 3D modeling allows the design and development workflow to be integrated,

optimized, and enhanced through complete digitalization and integrated processes of design and iterative prototyping, including tests of fit, simulation of functional performance (e.g., thermal), visualization of esthetic features (e.g., color, pattern, and material), and manufacturing specifications (Papachristou and Bilalis 2015). This digital approach optimizes material-resource consumption for physical sampling, shortens the time for production, fosters design creativity, and reduces costs (Demarco et al. 2020). The 3DVD technologies allow for made-to-measure algorithmic and computational design (Volino et al. 2005) that improves the way garments can be personalized and adapted to the needs and behaviors of users (Carulli et al. 2017). In the production stage, machinery that is able to read digital models allows operations to be streamlined; enhances precision, efficiency, and time; and optimizes resources to produce more complex and customized products (Paritala, Manchikatla, and Yarlagadda 2017). Digital production-on-demand permits lead time and logistics to be reduced through eco-efficient, localized, and on-demand small-scale, urban micro-factories that configure a shorter supply chain by eliminating the stock of unsold products and offering better working conditions (Clarke-Sather and Cobb 2019; Ashby 2016). Furthermore, 3DVD technologies have widespread applications in the final steps of the supply chain, particularly in the retailing stage that provides virtual fitting opportunities and reduces returns of items purchased online (Robertson et al. 2020). In addition to the mere physical ownership of goods through commercial transactions, digital retailing allows enhanced customer experiences by providing new services (e.g., personalization) and transporting people in imaginative, gamified, and immersive contexts (Silvestri 2020).

Digital business-model innovation

Previous research has only to a limited degree investigated how digital technologies – specifically 3D, VR, and AR – influence BM innovation in the fashion industry (Arribas and Alfaro 2018; Bertola and Teunissen 2018; Noris et al. 2021). Building on Osterwalder and Pigneur's (2010) definition of BM, this article addresses this research gap by mapping changes in value creation, delivery, and capture that these digital technologies in fashion firms can trigger. The fundamental changes in these value dimensions attributable to digitalization are referred to as digital BM innovations. According to Osterwalder and Pigneur (2010, 14), "A business model describes the rationale of the way an organization creates, delivers and captures value." To further illustrate

the firm's logic of doing business, these authors propose the BM canvas, a conceptual tool that consists of nine interconnected building blocks. In particular, value creation accounts for key activities, resources, and partnerships. Value delivery includes value propositions that are encompassed in product and service offerings, customer segments, relationships, distribution, communication, and sales channels, while value capture describes the financial implications of value creation and delivery (i.e., cost structure and revenue streams).

Among the existing studies that have investigated the effects of digital technologies on business logic, Ibarra, Ganzarain, and Igartua's (2018) literature review identified the shift to a service-oriented, network-based, and user-driven approach. Consistent with this strategy, innovative product-service offerings are co-created through extended stakeholder networks as the result of horizontal and vertical value-chain partnerships that are more aligned/responsive to users' needs (e.g., personalized and on-demand small batch production) (Arnold, Kiel, and Voigt 2016; Ehret and Wirtz 2017).

Usually, the extending and reshaping of the value proposition behind traditional product/service offerings is attributable to the digitalization of operational model/business functions and the use of digital interactive technologies in communication and marketing that lead to more effective customer satisfaction (Berman 2012; Colombi, Kim, and Wyatt 2018). Further, new digital products and services that can be produced at relatively low startup costs are emerging, the value of which is determined in the use phase (Remane et al. 2017).

Bharadwaj et al. (2013) and Remane et al. (2017) have referred further to the shift toward a service-oriented platform model that takes advantage of the business ecosystem to co-create and capture value. In particular, multi-sided platforms are becoming a popular digital business archetype that increases product/service value through network effects and generates platform revenues (Teece and Linden 2017). In addition to cost savings attributable to automation, resource efficiency, and improved decision making in the operational model, the shift from physical and digital product offerings unleashes new revenue streams (Dijkman et al. 2015). New pricing models emerge, such as dynamic pricing, subscriptions, and performance-based contracting (Ibarra, Ganzarain, and Igartua 2018).

Multidimensional perspective on sustainability

This article applies a holistic definition of sustainability that accounts for the fourth – the cultural – pillar that was not envisioned in the Brundtland Report (WCED 1987). Given that fashion is

defined by two main components – the intangible values encapsulated in its cultural significance and imagination and the tangible values that consist of the physicality of materials, fabrics, and production processes – we assert that the four pillars (environmental, economic, social, and cultural) should be considered as intrinsically interconnected. In particular, cultural sustainability refers to preserving and cultivating creativity, knowledge, beauty, identity, diversity, heritage, and history. It contributes to positive social and economic outcomes via education and the protection of intangible and tangible heritage (UNESCO 2010; UCLG 2010; British Council 2020). In the realm of the digital transformation of the fashion industry, exploring the adoption of digital technologies is particularly relevant for understanding their effects on traditional processes and techniques, in which innovation is fostered based upon the synergistic use of cultural heritage and new collaborative practices are pioneered, such that the engagement of communities allows cultural capital to be preserved (Bertola et al. 2016; Martin and Vacca 2018; Twigger Holroyd 2018). Cultural sustainability can also produce a change in the organizational culture of the suppliers involved in the fashion-supply chain. All internal and external supply-chain actors need to adopt holistic, systematic, and durable sustainability practices that include shared multidimensional sustainability values, norms, and beliefs (Linnenluecke and Griffiths 2010) and lead them to change their attitudes as well (Lopez-Torres et al. 2019). This holistic change in cultural mindset is also significant from a consumer point of view: more than any other industry in the world, fashion consumerism is supported by cultural norms and motivated by perceived physical or psychological obsolescence (Assadourian 2010). The possession of garments nurtures fashion consumption and use intended to fulfill cultural aspirations, perceived personal happiness, social status, and success (Ekins 1991). Nowadays, consumption models are becoming more eco-oriented and consumers are making choices based on companies' ethical conduct and social responsibility and supporting environmentally friendly or green practices/products (Rinaldi 2019). However, even consumers who show great concern for environmental and social issues experience conflictual behavior between the desires to be fashionable and to reduce their consumption habits (Mandarić, Hunjet, and Vuković 2022). Therefore, a cultural shift in consumption behaviors and a change of mind-set at the industry and business level is required to achieve an effective sustainable change (Niinimäki et al. 2020).

Methodology

Research design

This study was conducted through desk research that entailed collecting, analyzing, and evaluating cases derived from the grey literature and comparing them through qualitative analysis. Our approach was intended to achieve a more comprehensive and profound understanding of how fashion companies use 3DVD technologies to transform business practices in their supply chain because this knowledge is lacking in the peer-reviewed academic literature. The grey literature sources in the review included corporate and third-party industry reports (e.g., from nongovernmental organizations (NGOs) and consultancies); news articles; interviews; videos and presentations; and websites of fashion companies and projects that use 3DVD technologies to virtualize products, services, and processes along the entire fashion-supply chain.

Previous researchers (Adams, Smart, and Huff 2017) have acknowledged the advantages of using the grey literature as knowledge artifacts in a novel field of inquiry and applied subjects on which scholarship is lacking. Moreover, the overarching rationale of this article is to inform practice, so a systematic review of the grey literature is an appropriate strategy to conduct such a research inquiry (Adams, Smart, and Huff 2017).

We focused our systematic collection of resources on mapping the existing practices of established and emerging companies engaged in the 3DVD fashion sector worldwide. The research was conducted between January and June 2021 through a twofold approach to data collection. On one hand, we analyzed the companies that use fashion-design software for 3D modeling by browsing the websites of the current leading software houses for digital fashion (i.e., CLO3D, Browzwear, and Optitex). Concurrently, we broadened the research with the most common search engines (i.e., Google and Google Scholar) using specific keywords in English (i.e., “digitalization,” “phygital fashion,” “digital fashion,” “virtual fashion,” “3D modeling,” “rendering,” “companies,” “start-up,” “designer,” “agency,” “supply chain”) to obtain a comprehensive and updated pool of data. The 245 companies that we initially identified (31% in Asia, 30% in Europe, 17% in the United States, 14% in Turkey,³ 5% in the UK, 2% in Canada, and 1% in Russia) were filtered according to the following preliminary eligibility criteria: public data available from different sources, English as the primary language, and fashion as the main field of application. This selective evaluation excluded the vast majority of the Asian cases because of language issues and data

availability. We further screened the resulting 89 firms to filter the cases with respect to national/international positioning (e.g., balance of origin and location on a global scale), national/international coverage (e.g., balance of companies' reach), explicit focus on 3DVD technologies (e.g., level of investment/interest in digital transformation), and coverage of 3DVD technologies along the supply chain. We analyzed the shortlisted sample of 36 companies based on the following criteria: year and place of founding; type of business; level of maturity (established/startups); company size (see Figures 1 and 2); specific type of technologies applied – 3D modeling, VR, AR, 2D/3D scanning, and DT; type of digital transformation occurring throughout the supply chain (design and development, presentation business-to-business (B2B), marketing business-to-consumer (B2C), manufacturing, retailing) in processes and products innovation; and sustainability aspects (cultural, social, economic, environmental) associated with digital transformation (see Table 1).

This analysis also allowed us to identify opportunities for BM innovation, specifically in terms of changes in the value creation, delivery, and capture associated with the adoption of 3DVD technologies. We did not perform a detailed review of changes in

each building block of the BM canvas (Osterwalder and Pigneur 2010) for this article as that would have required more detailed data not accessible directly in the grey literature. The purpose of BM analysis here is to pinpoint emerging, yet not exhaustive, opportunities for digital BM innovation in the fashion industry. Previous research along these lines in other industries has adopted a similar level of analysis and concentrated on changes in value creation, delivery, and capture (Ibarra, Ganzarain, and Igartua 2018). With respect to value capture, the data that we collected from the grey literature allow only for a general evaluation of the way revenue streams are enhanced, with some examples of novel revenue models.

Other limitations of the grey literature are its moderate credibility (Adams, Smart, and Huff 2017) and tendency to downplay any negative implications associated with digital transformation. The prevailing emergent and positive image attributable to marketing and commercial interests should be considered when evaluating the results of the grey-literature methodology. To account for these limitations, we refer to the literature review in the discussion section which critiques the potential drawbacks of adopting 3DVD technologies in the fashion-supply chain.

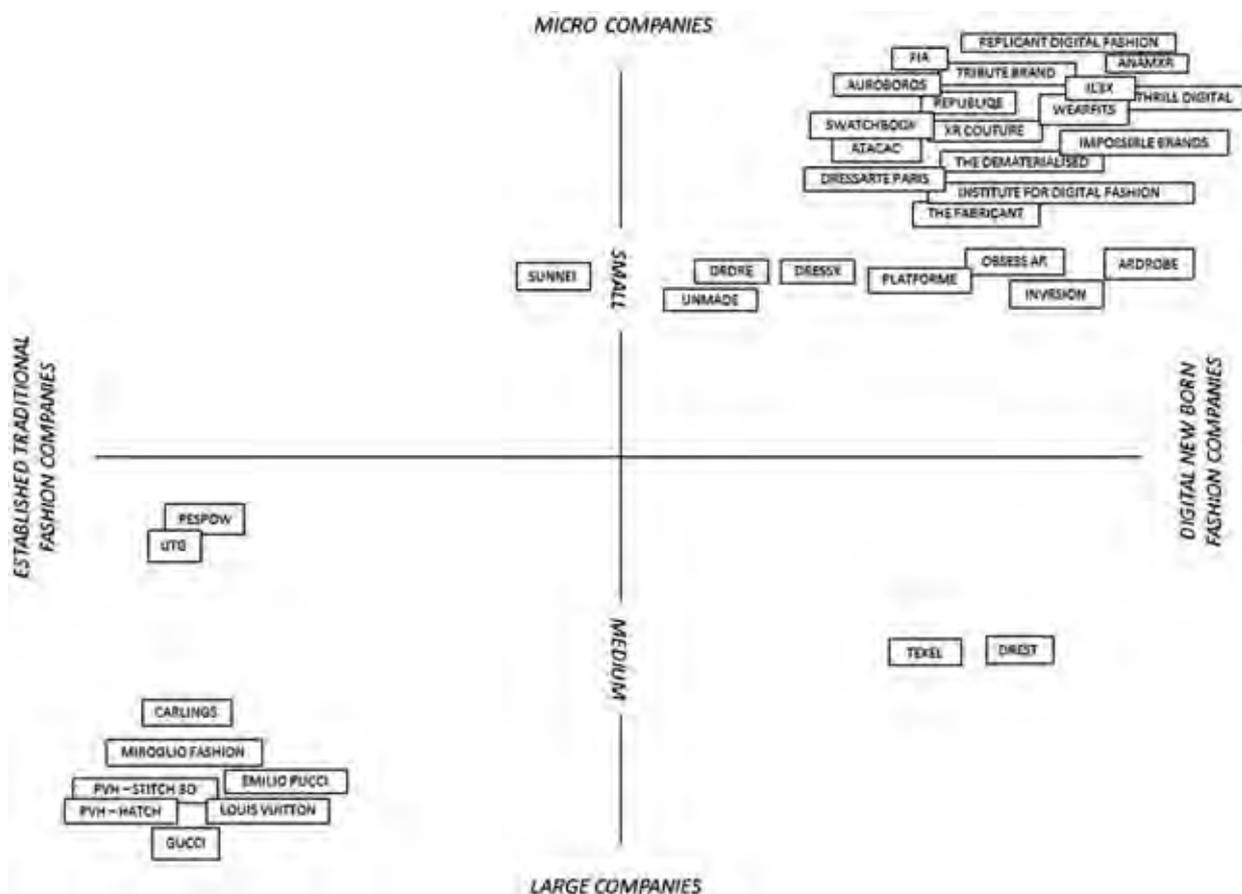


Figure 1. Taxonomy of selected cases mapping companies' dimensions (micro, small, medium, and large) vs. organizational typology (established traditional and digital new-born fashion companies).

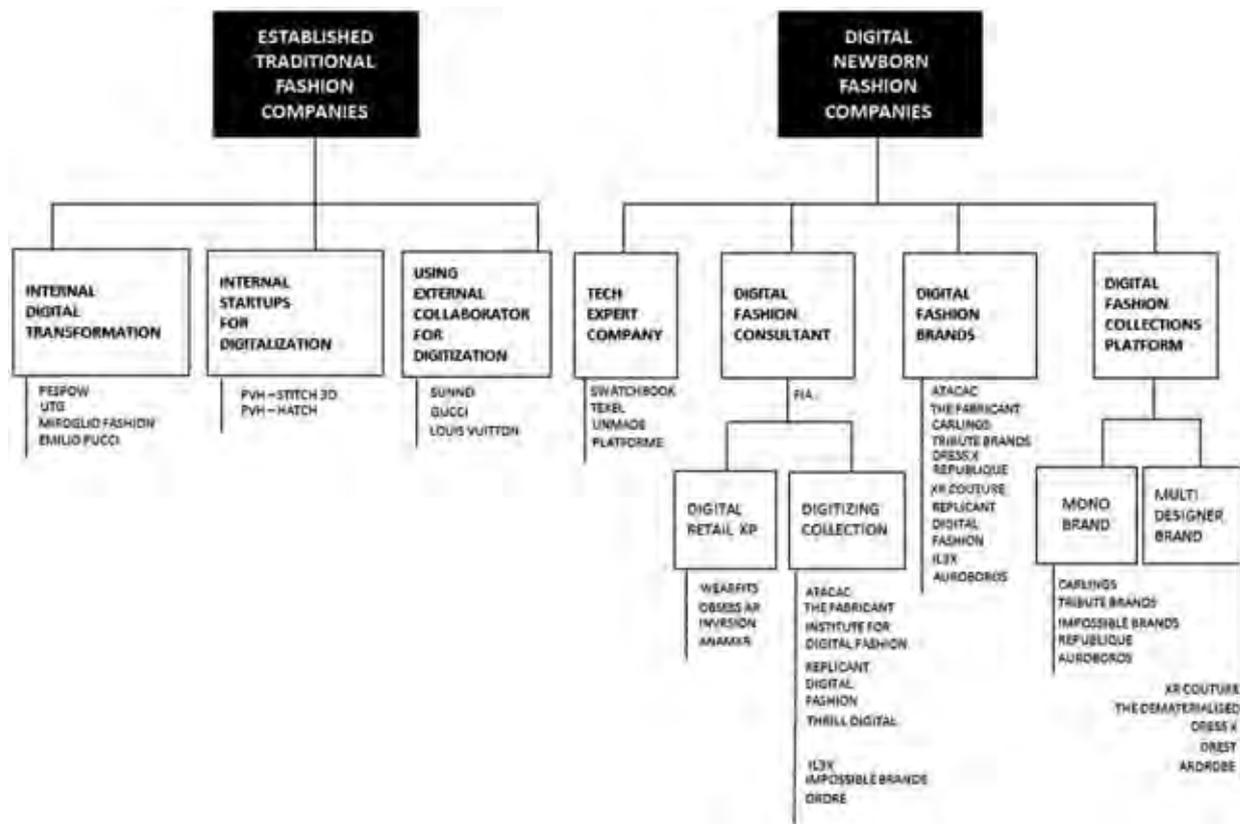


Figure 2. Taxonomy of cases that map companies' approaches to digital transformation through 3DVD.

Results

Company cases: analysis and taxonomy

The current situation is that 3DVD technologies are applied in two contexts: (1) established fashion companies and (2) innovative digitally-born startups/small- and medium-sized enterprises (SMEs), manufacturing, and e-commerce/retailing firms.

The first group approaches the digital transformation in three ways. First, they collaborate with external consultants to develop strategic partnerships with computer-generated imagery (CGI) expert agencies and digital fashion-design offices to digitize part of their business (e.g., Gucci, Louis Vuitton, Sunnei). Second, this group of firms incubates digitally-born startups (e.g., Hatch and Stitch 3D in PVH). Finally, they acquire internal competence (e.g., UTG, Emilio Pucci, Miroglio Fashion, Pespow).

The second group comprises micro and small digitally-born fashion companies that in the first instance exploit the maximum opportunities from 3DVD. Notable examples include digital fashion-consultant agencies that digitize collections (e.g., Atacac, The Fabricant, Ordre, FIA, Institute for Digital Fashion, Replicant Digital Fashion, Thrill Digital, Il3x) and support/create digital retail experiences (e.g., ObsessAR, Invrision, Anamxr, Wearfits) or provide specialized technology-expert

digitalization services (Swatchbook, Texel, Unmade, Platforme). Second, digital fashion brands operate their collections and also collaborate as consultants with traditional and established fashion companies (e.g., Atacac, The Fabricant, Replicant Digital, Il3x). Finally, digital fashion-collection marketplaces sell their own collections (e.g., Carlings, Republique, Impossible Brands, Auroboros, Tribute Brand) or host multiple brands as collective platforms (e.g., Dress X, XR Couture, The Dematerialized, Drest, ARdrobe).

In both groups of companies, 3DVD technology is applied in different phases of the supply chain to explore and exploit the new design and business opportunities of digital technologies, thus transforming the traditional fashion-supply chain either partially, (i.e., through limited digitalization of value-chain processes), or entirely, (i.e., through end-to-end digitalization of design, production, and selling of digital-only garments). With respect to supply-chain transformation that the application of 3DVD technologies allows, companies can be further divided into three clusters. Cluster 1 includes partial digitalization of the fashion-supply chain. Companies use 3DVD in production and distribution to generate virtual garments to support their traditional physical production and to run presentations and marketing in parallel to satisfy the interests of both distributors and retailers before they

move into production (e.g., PVH, Pespow, UTG, Gucci, Miroglio Fashion, Emilio Pucci). Cluster 2 entails full digitalization of the supply chain with virtual and physical garments. Companies implement virtual products and digital processes to support on-demand physical production. Virtual garments are used for presentations as well as trade and marketing activities to reach distributors/retailers and final users to customize and calibrate the production (e.g., Atacac, Impossible Brands, Sunnei, Dressarte Paris). Cluster 3 involves full digitalization of the supply chain with virtual-only garments. Companies deliver these products through digital processes and services that allow nonphysical economies. They reach customers directly which allows digital distribution, customization, and consumption (e.g., The Fabricant, Replicant Digital Fashion, Republiqe) (Figures 1 and 2).

Influence of digitalization on the fashion-supply chain

Digitalization of product design and development

As considered in this study, the traditional fashion-supply chain is a structured process of sequential phases that embraces several steps: (1) research on market trends and fabric availability; (2) creative and technical design of new collections from style sketches to 2D drawings; (3) product-development analysis; (4) prototyping/making samples of the new models; (5) presentation/trade B2B; (6) manufacturing and assembly of garments known as cut-make-trim (CMT); (7) marketing garments by matching retail outlets to the new collections to achieve the broadest possible market access; (8) distribution through sophisticated logistics operations, and (9) retailing/selling garments to consumers through various retail channels. Even if represented linearly, the final samples that emerge from Step 4 are realized typically through iterative cycles of sampling/alteration/design (Steps 2, 3, and 4). In this process, the 3DVD technologies change both the design workflow and product output dramatically as described below.

Streamlined and faster workflow. Design and prototyping become a unique digital process that integrates pattern-making, fitting, and testing into the same virtual space for shortened cycles of iterations: Virtual samples can be ready within hours rather than days or weeks. This workflow also reduces/eliminates physical sampling, manual work, and fabric use as a single refined physical sample can be prototyped at the end of many virtual interactions.

Cross-department professional collaboration through enhanced communication. 3DVD is introduced more easily in the pattern-making and styling department. However, more creative and streamlined processes derive from a cross-use of digital tools among these departments, which allows for enhanced communication among stylists, designers, and pattern makers. Thanks to a more accurate representation of garments, closer cross-disciplinary collaborations of hybrid teams are enhanced compared to traditionally siloed design strategies, and allow rapid and simultaneous small iterations to achieve faster and shared local/global decisions. The virtual prototype gives designers a more detailed visualization of their initial ideas to control more effectively such functional and esthetic features as the three-dimensional shape of garments (volumes, length, details), the material variations, and the graphic positioning. It is also a faster way to express and exchange ideas with pattern makers who find real-time 3D model visualization an easy way to manipulate, correct, and perfect patterns.

Enhancing creativity and providing more informed design and research expertise.

3DVD provides designers with greater creative freedom and a broader space of expressiveness. Virtual-only products (Cluster 3) may be made of unreal materials with no physically-based features but virtual-only behaviors (e.g., fire flames, liquid silver). Digital to physical products (Clusters 1 and 3) need the correct digital twin of the physical materials to create the best photorealistic simulations of the 3D digital garments. Digital agencies such as Swatchbook provide services to create high-resolution scanned images and metadata to create a digital replica of textiles. 3DVD design is also used as an exploratory tool for new design methodologies. For instance, Lindqvist (2015) from Atacac prototypes his kinetic garment construction in 3D as an innovative pattern-design approach based upon crucial biomechanical points tested on digital bodies (avatars). His digital prototyping allows to check better garment fitting and to match natural human movements. Furthermore, McQuillan (2020) uses 3D software to demonstrate that it can facilitate hybrid design and prototyping to achieve zero-waste fashion design.

Sharing knowledge for its widest adoption in collaborative open-source communities.

Digital fashion agencies and mono/multi-brand digital platforms build collaborative communities of experts with different digital competencies (i.e., designers, stylists, fashion bloggers, artists, and 3D, VR, and AR technicians/creators) proactively. This approach helps identify new talents in 3DVD design to speed

and spread the knowledge of 3DVD technologies in fashion and to efficiently advance an open-source fashion-design attitude.

Digitalization of B2B presentation and trade.

3DVD technologies are used primarily to visualize merchandizing for presentations and trade (both wholesale buyers and retailers) from the simple digitization of communication tools (i.e., digital lookbook, line sheet, and collection catalogues), to the digital transformation of fashion shows, exhibition events, and interactive digital showrooms, to the creation of advanced virtual hyper-sensorial narrative experiences.

Enhancing communication. Digital garments populate online virtual and dynamic platforms, including digital portfolios, enhanced digital assets, and wholesale pricing specifications. In addition, platforms allow interactive meetings and better visualization of all of the possibilities and collection variations of stock-keeping units (SKUs).

Enhancing digital presentation: realism, interaction, and value experience.

To recover the loss of tangibility of garments, the best visualization of a collection shows the construction by mimicking every detail (e.g., fabrics, textures, patterns, fastenings, prints) precisely with 360° view images and videos with super-zoom capabilities to reveal the expertise and know-how of the brand. Further, dedicated immersive virtual environments allow spectacular fashion experiences (showcases, runways, and presentations) to be created that transport people in imaginative and immersive contexts, and thus limit travel, but enhance the narrative and perceived value of the collection. Further, visual experiences may be enhanced through sonic and haptic technologies in VR/AR to stimulate sensory perceptions in the digital realm.

Enhancing the one-to-one relationship between brands and buyers.

Interestingly, digitally-driven wholesale activities can track and archive the interactions between brands and buyers. The resulting data analytics and metrics can provide insights for developing customized and collaborative digital collections and managing the global wholesale network for successive on-demand production (Cluster 2). For example, the Sunnei Canvas digital platform permits selected buyers to intervene in the design aspects of each collection item (i.e., shape, fit, materials, colors, dyeing, stitching) to differentiate their assortment and customize exclusive products for each stakeholder. To enhance the one-to-one relationship with buyers, the company can base

production on their intentions, cut costs, and limit the wasteful sampling process.

Digitalization of B2C marketing processes

At their best, digital images are exploited to create contents for static, dynamic, and interactive audio/visual commercials for marketing campaigns. Digitally-based marketing is designed to attract customers in both partial and complete digitalization of fashion systems, particularly in the new workflow of “virtual to consumer” in which the intermediaries (buyers, distributors, retailers) are eliminated and brands communicate directly to the final user with tools similar to those described for the B2B presentations and trade.

Digitization of retailing

3DVD technologies affect new digital retailing experiences on e-commerce that allow users to be clothed digitally with images for their virtual use on social media (Cluster 3) and also to support more automated buying experiences, such as digital try-on and customization (Cluster 2).

Digital try-on and customization. Computer visioning and machine algorithms for automated 3D body scanning, measurement, and reconstruction help retailers (e-commerce or physical stores) provide digital try-on of virtual garments with a highly personalized fit, visualization of comfort, and size recommendations that reduce returns. VR technologies allow consumers to walk around a 3D store and to try on and purchase clothes through virtually-based experiences that require tangible tools such as a VR headset and touch controller. Further, the use of product configurators, including UnmadeOS and Platforme, allow products to be customized to provide consumers with self-expression and to allow them to manipulate data variables supported by the visualization system which delivers photographic renderings of the customer’s unique design before it is made (Cluster 2) or never made (Cluster 3).

Immersive retailing experiences. Digital physical retailing allows consumers to engage in real-time, reliable, seamless phygital experiences of purchasing digital garments and seeing themselves dressed in them through a smartphone via camera access for AR (Clometrica/Replicant Digital Fashion, ARdrobe). Although this technology is in its infancy, it allows multiple and durable uses by creating an AR digital personal wardrobe (MyARdrobe) and uploading different digital contents for a physical garment that is purchased (The Last Statement T-Shirt, Carlings).

Digitization of production

The application of 3DVD technologies allows for optimization of traditional production processes, digital made-to-measure, and production-on-demand approaches that are sometimes supplemented by locally-based micro-factory production. A firm's business strategy influences the way 3DVD technologies transform its production processes. Using 3DVD technologies to optimize the physical production process alone is more common on the part of companies that started as traditional fashion brands and for which physical garments form the basis of the value proposition (Cluster 1). In contrast, digital made-to-measure and production-on-demand is an approach common among small, digitally-oriented fashion firms that focus on selective, unique, and customized digital (Cluster 3) and digital/physical garments in their product portfolio (Cluster 2).

Optimization of traditional/physical production processes. 3DVD technologies allow for more informed decision making and collaborative planning and thus lead to faster and more resource-efficient production cycles. Companies in Cluster 1 use 3DVD in the backend to generate virtual garments to help optimize traditional physical production.

Digital made-to-measure approach. Digital garments used as virtual filters superimposed onto the digital identities of users (static images or videos) on social media are manipulated on demand (Cluster 3) with a made-to-measure approach. Digital tailors that manipulate digital clothes to fit the client's body image precisely mediate the process of digital dressing. For example, Dressarte Paris (Cluster 2) uses 3DVD in its made-to-measure custom tailoring services through accurate digital virtual measurements of a customer's body shape and offers a digital preview of personalized garments on a customized avatar.

Production-on-demand using virtual products first.

The information collected during presentations and marketing campaigns, the data derived by tracking the use of virtual products in social media, and the preorder mechanism serve to determine the strategy of production-on-demand in Cluster 2. Products are not static entities, but dynamically configurable systems in which users can customize the variables based on their virtual representation. Technological platforms such as Unmade and Platforme allow technical digital files to be sent to factories automatically and tracked throughout the production stages.

In some instances, locally-based manufacturing activities supplement the digital production-on-

demand that 3DVD technologies offer with a corporate strategy to further enhance the supply-chain craftsmanship, quality, speed, and flexibility. As a result, on-demand garments are developed with short production cycles (less than a week) which allow customer-driven services and environmentally-friendly trusted materials in niche market sectors (Atacac, Impossible Brands, Dressarte Paris). In addition to corporate strategy to enhance economic, environmental, social, and cultural value creation, the opportunity to implement consumer-driven local production depends upon the regional capacities available – for instance the ability to manage highly complex experimental processes and to access digital manufacturing laboratories (e.g., Atacac).

Digital business-model innovation

The analysis in this section is based on mapping the changes in value creation, delivery, and capture based upon Osterwalder and Pigneur's (2010) definition of BM.

Changes in value creation

Enhanced creativity, operational excellence, speed, and cost efficiency in design and production. 3DVD approaches improve the value creation process of physical and digital product offerings in established fashion firms and digitally-born startups. These improvements include enhancing creativity and flexibility to meet the needs of clients, shortening new product development (NPD) times, automating, and achieving cost efficiency and operational excellence in design and manufacturing processes.

Opportunities for open-source innovation and crowdsourcing.

Open-source fashion (giving Atacac and The Fabricant 3D files to download and use for free) and the organization of crowdsourcing events (The Fabricant's STEM event) can be viewed as value-creation approaches that facilitate digital fashion innovation by developing digital capabilities, networking, and increasing the community/network of 3D designers.

Value co-creation in the business network/ecosystem.

Virtualization allows fashion businesses to offer cloud platform-based services, thus enabling opportunities to transform their business model (Hatch, Stitch 3D, Sunnei, ARdrobe). These BMs facilitate value co-creation by managing transactional relationships/interfaces with other actors in the business network and unlocking opportunities for on-demand, customized, and personalized fashion offerings (both digital and physical garments).

Ability to create economic, environmental, societal, and cultural benefits simultaneously. Many firms refer to advancements in the sustainability of the value-creation process as a result of digital transformation. These improvements are based upon operational/resource efficiency improvements, on-demand production, and personalized/customized clothing, which leads to the production of fewer physical garments that are used longer (Atacac). Further, digital fashion offers opportunities to completely dematerialize the traditional physical value-chain infrastructure.

Open-source innovation and crowdsourcing are approaches that benefit individual digital artisans by helping them to develop talent and providing access to the rapidly-developing digital fashion business (Atacac, The Fabricant). As an example, IL3X intentionally created the ARdrobe, a digital marketplace for AR fashion designers to showcase their talent and creations (IL3X). In contrast, Atacac also takes advantage of the opportunities offered by the blockchain marketplace that uses cryptocurrency to include creative artisans from various cultural and geographical contexts who do not have access to traditional economies.

Changes in value delivery

Virtualization of B2C BM content: digital garments and services as new product offerings. Virtualization of product content – the shift from analogue to digital fashion – makes it possible to create new digital products and services that can be viewed as a disruptive innovation to traditional fashion BMs. Largely, startups exploit this BM innovation based on digital B2C offerings, but traditional firms have begun to follow this development as well by offering virtual collections that complement physical garments, thus diversifying their product portfolio.

Digital pieces are created to wear on social media (e.g., The Fabricant, Carlings, Tribute Brand, Atacac, Republique, Gucci) or in games (AR/VR skins or filters by Tribute Brands, Louis Vuitton, The Fabricant). The latter represents a shift to adjacent industries to reach new market segments that fashion brands have not targeted traditionally. Offering purely digital pieces is complemented by providing cyber-tailoring services to help consumers fit the digital clothes that they purchase on their avatars.

The value proposition of B2C digital offerings is packaged differently. Some brands (Atacac, The Fabricant) promote uniqueness by releasing limited one-of-a kind digital pieces with embedded cryptoart (generative art generated from a single algorithm/code that can create one-of-a kind digital

products) and nonfungible tokens (NFTs) based on the use of blockchain to prove the authenticity of garments. Using auctions to sell these pieces in a blockchain-enabled marketplace further enhances the exclusivity of owning these digital garments. Other brands, such as Gucci, frame their value proposition around affordability and accessibility to otherwise expensive luxury pieces. Many companies (e.g., Republique, Atacac, The Fabricant) articulate the sustainability benefits of digital clothes as part of their value proposition, namely by using fewer resources and addressing the wasteful consumption mentality.

Virtualization of B2B BM content: digital platform-based services. Virtualization of collections that 3D and VR/AR technologies offer is the basis for BM innovations associated with the provision of digital B2B platform-based services designed to digitalize parts of the fashion-value chain (Hatch and Stitch 3D startups spin-offs of PVH, and Sunnei's Canvas). In particular, Stitch 3D allows fashion brands to develop capabilities in 3D product creation that foster creativity, allow a faster process, and reduce waste in the design and product-development phases. The Hatch digital showroom solution helps reinvent the essence of the wholesale experience beyond digital collection presentation. Various customization services are built in to adjust quickly to retailers' demands and to make decisions about collections easier without depending upon samples. The collection's marketing is improved as well through attractive presentation and storytelling. Waste reduction, enhanced operational efficiency, speed to market, and improved B2B relationship management are among the delivered business benefits that form the value proposition. Stitch 3D and Hatch software provide fashion brands with better insights into their digital strategy with digital transformation services based on cloud analytics. It is worth noting that Stitch 3D appeared after Hatch which allowed digital creation and rendering for the showroom, and thus made the digital service offerings complementary.

An idea similar to Hatch's digital showroom is incorporated into a Sunnei Canvas, a five-step customization program based upon a VR-enhanced platform that offers retailers services to co-create personalized and co-branded collections (e.g., change the type of fabrics, colors, length of sleeves on shirts, dyeing, and stitching details).

Extension of value proposition in physical B2C product offerings. While the use of 3D and VR/AR in physical design and production of garments does not result in radically new B2C product offerings, it

still allows the value proposition to be extended compared to physical garments manufactured in traditional ways. For instance, kinetic garment construction results in clothes that are more comfortable/fit better, while 3D design and printing allow on-demand production and mass customization of individual physical garments (Atacac). Using AR/VR filters to augment physical garments improves customer engagement via user-experience gamification.

Changes in value capture

With respect to the way digitalization affects the revenue streams and drives the profitability of the organizations that were reviewed as part of this analysis, we derived the following key insights:

1. Cost savings in the value-creation process of physical/digital garments derive from increased efficiency in operations/productivity and dematerialization. In particular, virtualization of design and prototyping leads to faster workflow and less material usage due to sample reduction/elimination and improved collaborative planning process across different departments or parts of the value chain (e.g., brands and retailers/distributors as in case of Sunnei Canvas). 3D technologies used in retailing and marketing (e.g., digital try-on with customization features) allow for accuracy in production cycles leading to fewer returns.
2. Product-differentiation strategies are enabled by improved customer-value propositions and better customer experience and engagement. For instance, digitalization allows the value proposition of physical clothes to be extended by shifting the focus from the product to the service/experience (e.g., gamification of user experience based on AR/VR, personalization, on-demand, and mass-customization services). This shift to service and experience orientations allows brands to pursue a differentiation strategy, thus enhancing the competitive advantage and profitability of firms.
3. Fashion companies launch new digital products and services in new markets/adjacent industries. The cases that we reviewed indicated that digitalization allows companies to diversify their product and market portfolio (e.g., Louis Vuitton provides physical and digital products such as AR/VR skins to wear in videogames and thus enters the entertainment market).
4. The launch of service-oriented platforms entails smaller amounts of capital investment and enables value co-creation with other actors in the business network, as demonstrated by the cases

of digitally-born B2B and B2C startups (e.g., Stitch, Hatch, The Dematerialized, ARdrobe).

Specific examples of new revenue streams include software-licensing models predicated on cloud-based subscription-software licensing (Stitch 3D and Hatch), digital sales of virtual clothes in blockchain-powered marketplaces using cryptocurrency and NFCs to authenticate transactions (Stitch 3D and Hatch), and royalties from the fee charged to orchestrate digital fashion-collection platforms (The Dematerialized). Other more common revenue streams include online sales of digital clothes and revenues from consulting services to support the digital transformation of fashion. To enable the 3D-manufactured garments to be priced competitively, Atacac applies dynamic pricing based upon the pre-order model.

Sustainability effects

Sustainability in the design and development stage

A comparative life cycle assessment of environmental sustainability illustrates the positive effects of digital fashion sampling over physical sampling during the design and development phases. For example, Xiong (2020) found a considerable reduction in carbon footprint of up to 30%. Another study from Dressx (2020) compared the effects of creating a digital garment and e-mailing files to the clients to producing a physical garment. Creating garments digitally was found to reduce carbon-dioxide (CO₂) emissions by 97% and save 3,300 liters of water. However, neither study was complete, as they compared only simple garments, such as a tee-shirt that does not represent the average digitally-designed garment. Moreover, the studies did not describe the way digital garments are archived in the cloud, sold, and bought. These are considered energy-intensive processes that need to be included in the calculation of the environmental effects. Eliminating physical sample production completely (Cluster 3) and reducing sample production to only a few garments in the product-development process (Clusters 1 and 2) increase both environmental and economic sustainability. Iterating the design and prototyping activities digitally facilitates the product's development and achieves shorter cycles that hasten the time to market, cutting both costs and material waste. In addition, 3D modeling has been found to simplify the zero-waste design approach by making sustainability-motivated decisions in the early stages of the creative process and limiting the amount of textile waste in the design phase (McQuillan 2020).

The gender-neutral inclusive design approach that many of the emerging digital design companies (Cluster 3) are taking reflects the urgent need to remove from garments the social norms that inhibit the freedom of individuals. 3DVD technologies support cultural and social sustainability because of the opportunities they create for customization. The design of digital garments allows a more inclusive and democratic approach to the fashion industry's beauty standards, because, theoretically, each product can be personalized and fit to any body shape without traditional sizing constraints.

3DVD processes of design and development influence the design culture and methodology and facilitate a collaborative approach that helps to forge a community of people who work with 3D-fashion design tools to disseminate application of the technology in the sector (e.g., Atacac, Institute of Digital Fashion, The Fabricant). Team diversity is encouraged and supported to develop hybrid workforces that can bring different perspectives and expertise to fashion to achieve technological, cultural, and social innovation and sustainability. 3DVD technologies foster a cultural transformation in the design process and allow the exchange between established workers trained in updated skills and new professionals with enhanced expertise, thus altering traditional workflows based upon handcraftsmanship and material artifacts. The new design processes allowed by 3DVD technologies require a shared glossary and capacity to translate the material experience and the artisanal processes in a virtual modality to reach the same quality and attention to detail as that of the physical design.

Sustainability in the B2B presentation and trade and B2C marketing stages

The digitalization of wholesale and marketing tools contributes to reducing/eliminating physical sampling and fabric and waste from prototyping processes, thus limiting their adverse environmental effects and increasing cost efficiency in the time to market. Decreasing yearly worldwide travel and transportation of collections associated to B2B wholesale during international fashion weeks over the four major fashion seasons has been found to reduce carbon footprint (241,000 tons of CO₂) and financial costs (Carbon Trust and Ordre 2020). By contrast, HFW with Normative (2020) calculated the environmental effects of the first completely digital fashion week held in Helsinki in the Fall-Winter 2020 season. It was found that the overall carbon footprint – calculated following the Greenhouse Gas Protocol (GHGP) – was higher than that of traditional fashion shows, but lower if calculated per visitor.

Digital B2B trading allows different stakeholders (buyers, retailers, and customers) to participate actively in altering/personalizing a collection without using physical materials and samples prior to the manufacturing process. In addition, online selection and management of B2B orders allow companies to accumulate data, simplify logistics, and structure their economic strategies based on interactions, decisions, and customizations of digital buyers.

From the cultural perspective, 3DVD technologies drive a cultural transition to value experiences rather than solely presenting and selling products. Depending upon the medium chosen, 3DVD technologies enable designers to regulate the expressiveness of virtual products/collections, increasing both realism and sensorial content. Fashion shows and marketing campaigns are designed through VR and AR to enhance and expand storytelling capacity of brands in terms of meanings and values to engage users and recover the loss of information and interaction that occurs when products/collections are presented to buyers digitally (e.g., material touch and face-to-face exclusive trading sessions) in comparison to physical trades.

Sustainability in the retailing stage

The digital transformation of the retailing stage (Cluster 3) leads to new consumption behaviors linked to social media through an ethical reconsideration of the effects of fast fashion consumption and this can give consumers greater awareness of sustainability issues. The new interaction with clothing through digital purchases leads to environmental sustainability while it simultaneously takes into account the sociocultural aspects (Collins 2019): it fulfills fashion's social functions, such as self-expression, identity statement, and communication via social media, and reduces the size of the industry's carbon footprint as well as eliminates the buy once-dress/waste cycles in real life (Cluster 3). Nonetheless, a drawback is the replication of fast consumption behaviors in the digital realm.

Some attempts to create more durable experiences of digital consumption in Cluster 3 rely on the use of the same physical garment (tee-shirt) that can activate different filters automatically via AR and be transformed digitally to update the style and the digital contents (Carlings). Some examples allow a more durable digital experience by creating digital wardrobes for archival, resale, and reuse of digital garments (ARdrobe). Further, although materials, shipping, and returns are eliminated, digital garment consumption retains its carbon footprint because of the energy consumption associated with 3DVD systems. The highest engagement achieved in retailing experiences through VR and AR technologies has

the drawback of higher electricity use because of the power required for the constant connections between mobile telephones and the cloud, networks, and cellphone towers.

In Clusters 1 and 2, digital garments function to provide custom services through digital fitting and sizing tools that can check human measurements and try on garments digitally. These technological applications influence the minimization of returns positively and digital configuration, customization, and styling services can increase the ability of users to express themselves. In addition, creative industries use these experiences to design immersive virtual environments, thus shaping a new cultural universe, the Metaverse, around the brands and consumers that provide new values and meanings (Inversion, ObsessAR, Anamxr) and enhance customer experiences and potentially motivate new sustainable behaviors as well.

Sustainability in the production stage

The digitalization of the production processes in Cluster 3 affects both environmental and cultural sustainability as using digital models of garments cuts stockholding and overproduction. Further, the process of adaptation, manipulation, and customization to body size supports the cultivation of diversity and identity. In Cluster 3, companies create new roles and job profiles (e.g., digital tailors, AR/VR/MR experts) which increases social and economic sustainability.

In Cluster 2, the production-on-demand assisted by artificial intelligence (AI) and associated with the presentation of digital garments to consumers produces sustainability holistically. From an environmental perspective, it reduces/eliminates stockholding, overproduction, pre-consumer waste, and overconsumption of raw materials. It also affects garment prices, as it can eliminate the costs of unsold garments, define a more transparent price, and pay adequately for the work of designers and manufacturers and high-quality materials, thus contributing to healthy relations between productivity and employment. Further, it introduces a more sustainable BM, as in the case of Atacac. The preorder purchases and production-on-demand based upon the customization of digital previews of fashion items necessitate and drive a cultural and behavioral shift from the consumer perspective by enhancing the customization of garments to promote diversity and self-expression. Moreover, the reshoring of garment production on a local scale with controlled, durable, environmentally-friendly materials and managed quality of the workforce has positive outcomes with respect to environmental sustainability because the supply of long-distance materials and

labor is eliminated. Finally, it affects social and cultural sustainability positively through the more equitable and ethical treatment of the workforce and the cultural reappropriation of local manufacturing activities. Traditional manufacturing processes and techniques are interpreted from a new contemporary/digital perspective with the possibility of enhancing their innovative effect by integrating tradition synergistically.

Discussion

Analysis of the data collected in this study was based on the logic of inductive reasoning using a grey-literature review that allowed us to obtain insights into the effects of 3DVD technologies on processes, products, and BM innovations. The insights presented in the foregoing section primarily represent “the voice” of the companies which tend to view digitalization as a method that creates opportunities to generate digitally-transformed processes and positive sustainability outcomes. The emerging affirmative perspective is attributable to the novelty of the phenomena, as companies are in the early phase of commercializing digital technologies, as well as the prevailing industry discourse that digitalization is a “silver lining” to enable recovery from the adverse consequences of the COVID-19 pandemic and to achieve sustainable development in the fashion industry (Business of Fashion and McKinsey & Company 2020). In contrast, there are already some preliminary research results predicting limitations and criticism of 3DVD approaches in the fashion industry in relation to sustainability.

The grey literature shows that the adoption of 3DVD technology by the fashion industry unleashes new opportunities in products/services innovation as well as makes it possible to optimize operational processes to streamline and compress (design phase in Clusters 1, 2, and 3), eliminate (presentation B2B phase in Cluster 3), shorten time (Clusters 2 and 3), and reorganize operational models (repositioned manufacturing and retailing phases in Clusters 2 and 3) (Figure 3).

The use of 3D software changes the design process and associated methodologies and permits better and faster communication among different departments and professionals which increases the creative opportunities to achieve sustainable approaches. 3DVD design processes facilitate the ability to work across designated disciplinary domains and to enhance collaborative and transdisciplinary knowledge and hybrid design practices to increase creativity and innovation (Marshall and Pengelly 2006). Accordingly, both soft and subject-specific skills are needed to shape resilient digital

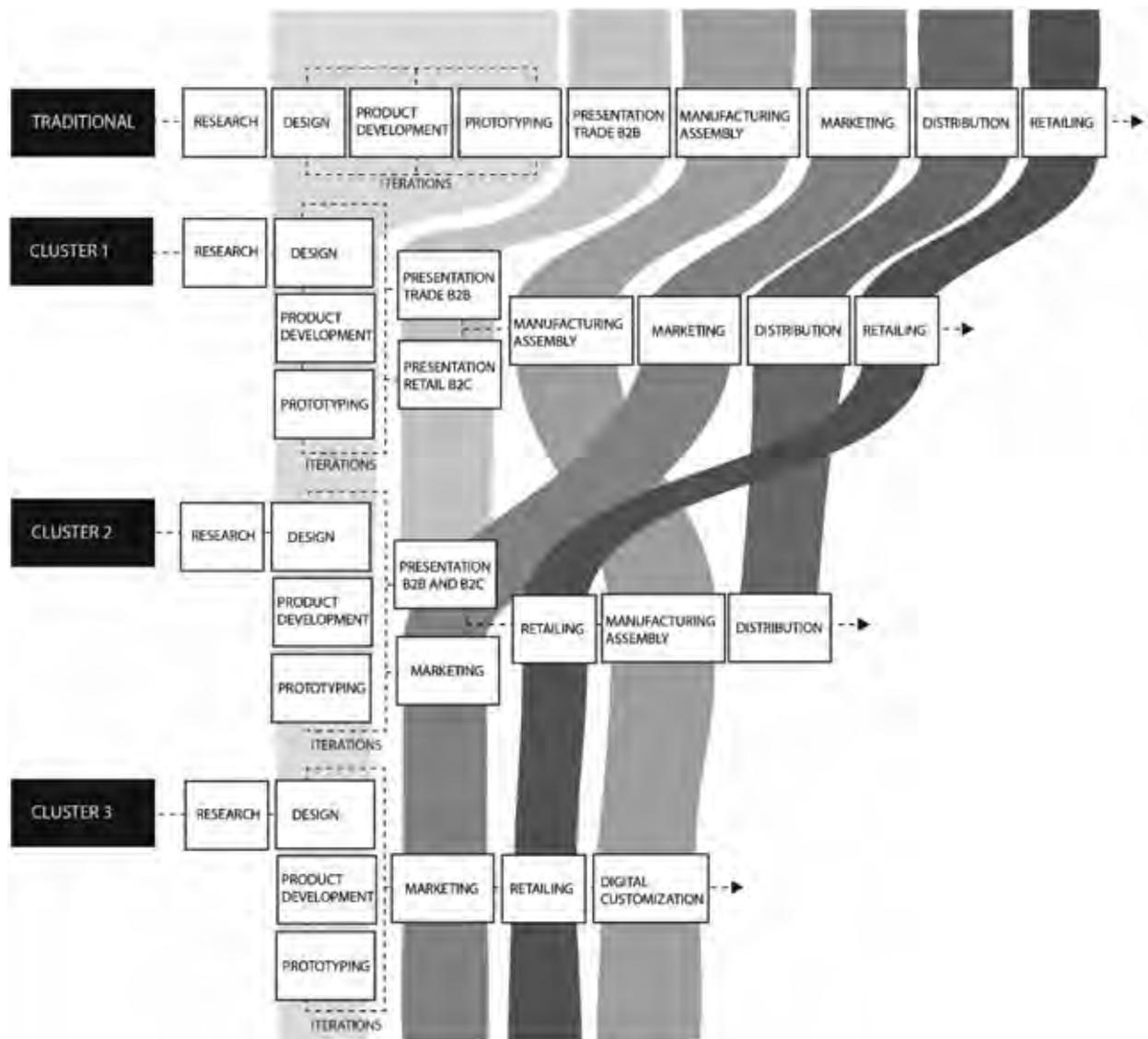


Figure 3. Map of traditional supply-chain model vs. supply-chain model informed by 3DVD technological transformation.

professionals. On one hand, companies today are searching for new hybrid professionals with combined digital, fashion, and business backgrounds (Kalbaska and Cantoni 2019). 3DVD technologies in fashion have motivated universities to plan to include 3DVD fashion design-related courses in their educational models (Ftalliance 2020) to train future professionals in the fashion-tech domain. On the other hand, firms in the industry that embrace the digital transformation risk job obsolescence of their workforce because of more demanding, digitally-based, and complex skills over manual skills, which causes vertical and horizontal skill mismatch, gaps, and shortages. Therefore, job-transition opportunities will be required to help workers engage in digitalization through participation in continuous education to update their skills. Digital fashion education introduces the dual topic of accessibility: 3DVD design processes require a laptop, Internet connection, and a 3D-software license that demands financial resources and a suitable infrastructure. By

contrast, digital fashion's open-source philosophy allows greater access to learning data shared across the digital fashion community (Särmäkari 2021). The innovation potential in using 3D modeling in design processes remains underexplored but appears to expand and enrich the portfolios of more explorative digitally-born companies (Clusters 2 and 3). 3DVD design guides decisions to achieve sustainability in styles, materials, shapes, and sizes in the initial design phase, and thus influences the remainder of the value chain in timing, efficiency, and costs. 3DVD design also simplifies the application of zero-waste design techniques, supports the use of innovative pattern-making approaches, and expands the opportunities to apply made-to-measure design approaches. Although, on one hand, these developments can increase opportunities for designers to participate in manufacturing processes, on the other hand, digital fashion may decrease their haptic and material knowledge (Atkinson 2017). Thus, further studies should focus on testing the effects of 3DVD

technologies in the design processes to understand their benefits and limitations with respect to feasibility, creative freedom, and design timing.

The design and development processes that occur in virtual environments allow streamlined activities and thus reduce costs. The creative process remains virtual until the manufacturing stages which changes the digitalization of wholesale trade and marketing communication. Further, processes and timing are reduced, for example, in Cluster 3, where wholesale activities have been eliminated because of the disintermediation effect of digital communication and sales tools as companies refer directly to final customers. Firms in Cluster 2 use the same digital tools, platforms, and experiences to approach different stakeholders (e.g., buyers, retailers, and final consumers). The emergence of interactive, digitally-based platforms changes the pace and modalities of fashion communication and dissemination and encourages fashion companies to change and enhance their fashion-media role (Cantoni et al. 2020). In contrast, Cluster 1 companies still display a very conservative attitude and introduce 3DVD technologies in specific processes without exploiting their full potential to achieve a complete digital transformation. Several small and niche companies (Cluster 3) are pioneering 3DVD technologies in end-to-end processes, including digital and virtual communicating tools and processes in all the steps of the workflow of the company. They show an interesting systemic approach that exploits the potential of 3DVD technologies through the digital transformation of the entire manufacturing life cycle and the creation of real-time virtual duplication (digital twin) of the entire system to promote a radical sustainable transformation (Bertola and Teunissen 2018; Bertola 2021). Digital processes and garments are used to change the physical world, both helping and disrupting physical products in the production and sales phases.

The production-on-demand approach coupled with 3DVD technologies affects the shift between the retailing and manufacturing phases (Figure 3). In Clusters 2 and 3, customers can configure their products and purchase a personalized experience based upon a preliminary digital visualization that becomes an actual unique product through digital data management and tracked logistics. Mass customization and production-on-demand typically favored through digital platforms allow personalization in style, color, size, and other preferences and pass through co-design processes between customer, retailer, and manufacturer (Maldini 2017), resulting in new business-to-business-to-consumer (B2B2C) business models (Mingione and Leoni 2020). In addition to the style, body scanning and digital

application eases the adoption of production-on-demand, as customers can include their measurements to perfect the fit of the garments. Maldini et al. (2019) show that garments co-designed digitally and produced-on-demand lead to longer product lifespans because of the attachment that users have to their enhanced emotional and functional values. Some cases in the grey literature review (e.g., Atacac, Dressarte Paris) show this pioneering approach in delivering co-designed services and experiences to manufacture garments with a personalized fit and style with which users feel an emotional connection that thereby affects the longevity of the garment.

Digital garments ease data replication, conversion, manipulation, and recombination, and thereby support the democratic cultural remix of information and products (Brennen and Kreiss 2016). The digitalization of the retailing phase includes the digitalization of products into their digital twins, the coupling with digital services, and the provision of new experiences incorporated into the purchasing processes. Sensorial and valuable storytelling in the experience is essential to recover the loss of information attributable to the dematerialization of products that provide visual, functional, and behavioral simulations of product attributes through zoom, 2D or 3D rotation, and virtual try-on with avatars via 3D or AR visualization that allow consumers to evaluate the items online more effectively and to overcome the relative sensory impoverishment compared to bricks-and-mortar retail. New design opportunities can emerge to overcome the limitations inherent in the ability of digital technologies to offer the physical and tangible experiences of materials to reveal their flow (weight, thickness, drape), movement (stretchiness, comfort), fabric-tactile feature (hand or feel of fabric such as softness, smoothness, and voluminosity), and details (stitching and seams) in the digital domain (Ornati 2021, 2022).

3DVD technologies appear to drive multi-centered BM innovations that affect changes in all three value-architecture dimensions. The cloud-based, service-oriented platforms that deliver digital fashion products and services (B2B/B2C customization/personalization) represent a radical BM innovation. This allows for breakthrough improvements in value co-creation and delivery (via a network and user/community-oriented approach) and provides new revenue streams as well. Because of the digital BM innovation associated with the virtualization of product contents, the borderline between fashion, entertainment, gaming, and arts is becoming blurred, representing a shift from “fashion as a service” to “fashion as a lifestyle.” Further, it offers the

ability to simultaneously create economic, environmental, and societal/cultural benefits. Previous research on digital BM innovations has mentioned the shift toward platform model and service, network, and user/community-oriented approaches (Noris et al. 2021; Ibarra, Ganzarain, and Igartua 2018; Teece and Linden 2017; Bharadwaj et al. 2013). Gregori and Holzmann (2020) also demonstrated that digital BMs create opportunities for socio-environmental value creation via more resource-efficient and faster processes, involvement of customers/communities in value co-creation, and network effects in platform-business models. Whether digital technologies have positive implications for multidimensional sustainable value creation and thus contribute to sustainable development depends upon the nature of the socio-technical transition. The way technology is used depends upon the values, objectives, resources, practices, and policies that accompany the firm and stakeholder adoption of technologies.

The analysis revealed that 3DVD technologies affect all four dimensions of sustainability that are interconnected intrinsically throughout supply-chain processes (Figure 4). Cultural sustainability is of paramount importance because fashion is a complex

cultural system that creates products and services that affect the environment, economy, and society. The results of the analysis indicated that the technological effect on design processes, production, and retailing brings about significant transformational changes in a company's organizational culture and consumers' cultural systems. In particular, new creative approaches in the design phases can be applied to disrupt traditional working modes and standardized production processes to achieve sustainability and innovation. Moreover, digitalization allows the rigid limitations in sizing and pattern construction to be overcome and opposes the secretive ways in which the fashion sector works to produce new open knowledge through an increase in collaboration, transparency, inclusivity, and democracy derived from customization opportunities. The digital transformation that occurs in the preliminary design stages shows that a real cultural effect can be achieved only if the entire supply chain is affected to sustain, promote, and deliver its full innovative potential.

3DVD technologies enable the digital conversion of "disposable fashion" in the virtual world and provide opportunities to have a positive effect on the environment and enhance the self-expression of

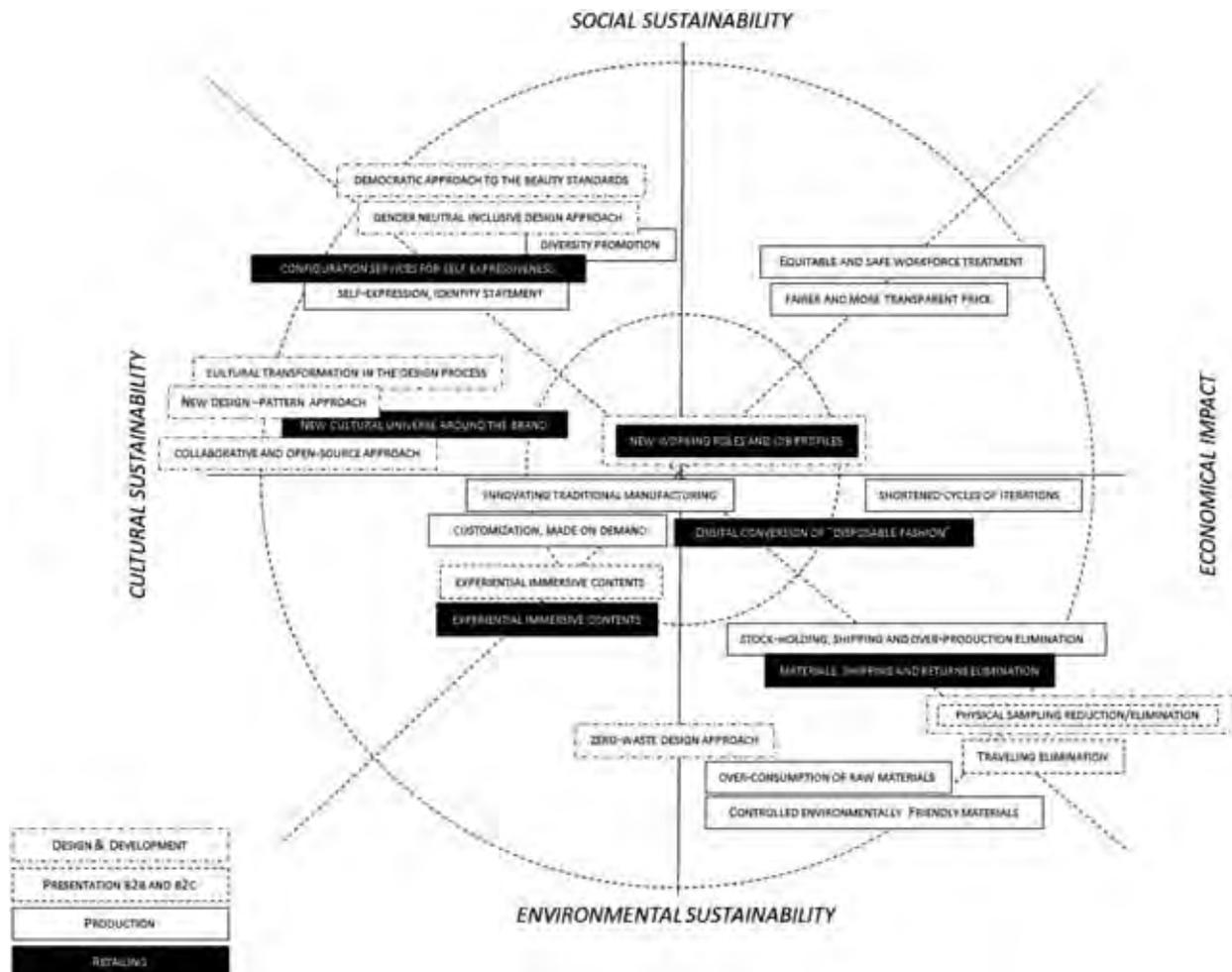


Figure 4. Map of 3DVD effects on the four pillars of sustainability through the supply chain.

individuals on social media. However, there are concerns that this will have a detrimental effect on the transformation to more sustainable consumer cultures against overconsumption habits (Crewe 2017). Instead, the outcome may be reiterated, similar to fast-fashion consumer behaviors through the social media domain. “While digitalization is already a key driving force in societal transformation, it has so far led to more consumption and inequality and remained coupled with the indirect use of energy and materials, therefore sustaining resource-intensive and greenhouse-gas growth patterns at the macro-economic level” (Wiedmann et al. 2020, 7). Only a few company cases analyzed in this study examined whether there is a fundamental cultural change among consumers of digital products/services that do not encourage the fast-paced production/waste of digital outfits used on social media but instead enhance ethical/responsible fashion-consumption behaviors.

However, the digital shift in design, production, retailing, and consumption does not suffice to conclude that 3DVD technological adoption is sustainable from an environmental perspective. The fact that garments, shows, presentations, and shops become virtual and digital does not mean that the system becomes intrinsically more sustainable as the information and communications technology (ICT) sector is a source of 1.8–2.8% of global greenhouse-gas emissions, and these values are underestimations because they fail to account for the full extent of the associated supply chain and life cycle impacts (Andrae and Edler 2015; Freitag et al. 2021). The invisible infrastructure that lies behind the programming, rendering, and digital consumption of 3DVD products accounts for the footprint of the digital fashion system (Andrae 2017). Calculations of actual environmental effects do not include the energy consumption of data centers, networks, and blockchain transactions, the specific architecture of which (proof-of-work vs. non-proof-of-work) determines greater/lighter environmental effects (Sedlmeir et al. 2020). Because the trend of the energy efficiency of ICTs indicates that the carbon footprint will not decrease, designers, policy makers, entrepreneurs and common users should undertake proactive decisions and responsible behaviors to limit their environmental effects. In addition, because of the Jevons’ Paradox (Jevons 1865), the increase in system efficiency creates higher consumption levels if consumer behavior and lifestyles are not addressed at their core. Therefore, sustainable digital and valuable fashion experiences for customers need to be supported by a sustainable design approach that interfaces with the experiences of users on the digital platforms. The intangible cultural values of companies through storytelling and the effects of technological choices on

consumption levels and patterns should be considered when seeking to design sustainable 3DVD-based fashion experiences along the entire supply chain.

Conclusions and future research agenda

This article provides a systematic overview of digital transformation in the fashion industry by mapping the effects of 3DVD technologies on the traditional fashion supply-chain model onto the four dimensions of sustainability and BM innovations. The structural shifts identified in the fashion industry that are attributable to digitalization create the following opportunities.

- Dematerialization of the supply chain with respect to improving resource efficiency and compressing, eliminating, and shortening various business activities, as well as reorganizing the operating model toward a more collaborative approach in different stages of the process.
- New B2B and B2C products and services with more focus on the experience and engagement of users (e.g., digital garments and cyber-fitting services, physical garments augmented with VR filters that provide the opportunity for constant updating, virtual B2B presentation, wholesaling, and design services).
- Network-, community-, and service-/experience-oriented BMs that offer the opportunity for simultaneous value creation along multiple dimensions of sustainability, in which platform-based services emerge as a new digital BM archetype.
- Studies of the innovation potential of 3DVD technologies in the design processes with respect to new methodologies and approaches to achieve creativity and sustainability.
- Investigations of the multiple dimensions of sustainability with a primary focus on the cultural pillar to design 3DVD technological products/services that can radically change the consumption behaviors of consumers to reach a more ethical/responsible paradigm.

The comprehensive overview in this article aims to facilitate multidisciplinary dialogue among fashion practitioners. To reach the promise of sustainable digital transformation to dematerialize resource-intensive, design-driven practices of the traditional fashion industry the application of digital technologies should be considered simultaneously at various design levels including:

- Product design to foster sustainable/valuable user experiences and lifestyles.

- Process design that considers the interconnections along the entire supply chain to realize shared value co-creation and sustain innovation.
- BM design to ensure that investments in the adoption of digital technologies capture value.
- Integrate sustainability design thinking into all of the above, including the cultural aspects.

Stemming from the results of this article, we provide research directions toward sustainability and innovation paths in the digital transformation of the fashion industry that could engage the interest of both academics and practitioners. A critical research study might focus on the environmental effects of 3D/4D technologies throughout the fashion-supply chain compared to the traditional chain. Such a study should focus on the energy consumption of ICT-based services including computing devices, data centers, and communication networks involved in the full digital process because the existing literature has investigated this issue only in part or not focused specifically on the fashion sector. Future research can address the missing systemic approach to sustainability. Comprehensive sustainable assessment models should be applied through a blended approach that includes the cultural dimension when considering complex phenomena. Another line of research could focus on the limitations of 3D/4D technologies to study the full potential of end-to-end applications as several examples have shown the systematic application of digital technologies in all supply-chain processes. Understanding socio-technological drivers and barriers to the digital transformation of the supply chain from the backend to frontend will provide relevant insights into systemic preconditions that need to be created at the individual, corporate, interorganizational, and policy levels to anchor the digital transition to innovation and sustainability.

Dematerialization of supply-chain processes and products offers the ability to make more informed design decisions to disrupt traditional and standardized logic. Further exploration could focus on the creative exploitation of technologies to modify the way garments are inspired (e.g., AI through data management and data science to inform sustainable choices and innovation), conceived (e.g., pattern-making explorations to achieve fit and sustainability), perceived (e.g., tactile and haptic experiences), and the ways in which digital BMs are designed (e.g., sustainable user experiences and value propositions).

Finally, digital transformation that addresses the systemic application of digital technologies is related to closing the digital capabilities gap by allowing access/developing relevant resources and skills

(Teece and Linden 2017; Pal and Sandberg 2017). The companies included in this study have demonstrated the diversity of organizational configurations necessary to acquire these resources, capabilities, and skills, from integrating digital competencies internally to acquiring them externally, and from initiating digital startups as spin-off new organizations to launching cloud-based service-oriented platforms. Therefore, exploring the factors that affect the digital organizational design aspects of BMs represents another future research direction.

Notes

1. Digitalization is defined as adoption or increase in the use of digital technologies that affect the economy, society, and culture and enable a business transformation in operations, functions, models, processes, and activities (Brennen and Kreiss 2016).
2. Digitization is defined as the material process of conversion, interpretation, storage, and transfer of analogue streams of information such as images, video, and text into a digital form (Negronponte 1995; Brennen and Kreiss 2016).
3. Bridging Asia and Europe, Turkey in 2020 was the fourth largest textile and garment manufacturer and exporter in the fashion industry (Statista 2022). Working today in a global context as supplier and subcontractor of the international luxury and fast fashion industries, many Turkish companies have already embraced the shift of their design and prototyping activities to a digital and virtual approach, being involved in the Industry 4.0 transformation to be more productive and competitive and to increase and accelerate communications with their stakeholders (Tokatli 2003; Gökalp, Gökalp, and Eren 2019).

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- DressX (<https://dressx.com/>)
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Sunnei Canvas (<https://sunnei.it/blogs/news/introducing-sunnei-canvas>)

Swatchbook (<https://www.swatchbook.us/>)

Texel (<https://texel.graphics/>)

The Dematerialised (<https://thedematerialised.com/>)

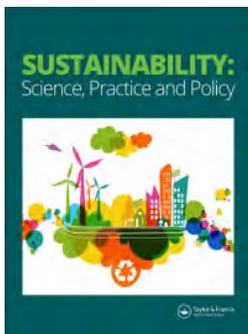
The Fabricant (<https://www.thefabricant.com/>)

Unmade (<https://www.unmade.com/>)

UTG (<https://utg.dk/>)

Wearfits (<https://wearfits.com/index.html>)

XRCouture (<https://xrcouture.com/>)



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Materials biography as a tool for designers' exploration of bio-based and bio-fabricated materials for the sustainable fashion industry

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ABSTRACT

The fashion industry is highly responsible for critical environmental problems and the sector is increasingly aware of the urgent need to embark on a sustainable transition. Materials, primarily textiles, are particularly problematic for the sector's unsustainability, despite the intensive research into alternative solutions that is currently underway. This article presents a comprehensive analysis of these socio-environmental challenges and describes how governments, industry, and designers are seeking to address the situation. Furthermore, it identifies a panorama of alternative bio-based and bio-fabricated materials that could facilitate the transition toward more sustainable fashion. We present a selection of 24 case studies of newly developed bio-based and bio-fabricated materials and group them by their origin. Analysis of the cases led to the delineation of five "materials biography categories" to help understand the prominent narratives and to communicate their characteristics and fundamental attributes. This taxonomy also serves to support concepts for a circular economy by helping to build a sort of "material passport" or "product biography," two concepts underpinning the outcome of this study, and emphasizes the need for tools to further the communication and traceability of these emergent materials. We propose "materials biography," an overarching idea that catalogues essential dimensions and offer it to designers, companies, and final users to enhance their perception and awareness of such novel materials.

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Introduction

The fashion industry, like other production sectors, has adopted the paradigm of continuous growth without considering the finiteness of resources, the complexity of human productions, and the related array of environmental issues. At the same time, firms in this industry seem at present to be most in turmoil around a purported transition toward sustainability, with public opinion focused on the mismanagement of environmental and social issues linked to fashion production (Gazzola et al. 2020).¹ As affirmed by the president of the United Nations Economic and Social Council (ECOSOC) at the Sustainable Fashion Summit in 2019, "sustainable fashion is key to the achievement of the 2030 Agenda."² Fashion is a US\$2.5 trillion dollar industry that employs approximately 60 million people worldwide, most of them women. Undoubtedly, fashion has a pronounced impact on the economy and the global environment (Brydges 2021). The model of consumption that characterizes our throwaway society has been vigorously advancing in the fashion sector, culminating in the

propagation of "fast fashion," the demand for disposable clothing at low prices (Jacometti 2019). Numerous studies (Niinimäki et al. 2020; Niinimäki 2018; Sandin et al. 2019) have described the considerable environmental and social costs and other negative impacts of the fast fashion phenomenon including the mistreatment of animals and the exploitation of people through poor working conditions (Moretto et al. 2018; Provin et al. 2021).

Considering garments as disposable goods implies excessive consumption of resources while disregarding the long and complex supply chains that characterize the textile and fashion industry (Moretto et al. 2018). Indeed, each production stage has an environmental impact due to water, materials, chemicals, and energy consumption. Although these impacts mostly occur in countries that manufacture textiles and apparel, waste is everywhere. Brands now produce nearly twice the amount of clothing they did before 2000. Current fashion-consumption practices result in large amounts of textile byproducts being incinerated, landfilled, or exported to developing

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countries. Only 1% of prematurely discarded clothing is recycled, primarily due to the widespread lack of adequate technology (Jacometti 2019).

For all of these reasons, there is a need to develop new materials and to rethink existing ones without foregoing their expressive, sensorial, and experiential dimensions (Neto et al. 2019; Provin et al. 2021). Materials have long provided cultural and innovative content for all the creative fields, including fashion design (Ricchetti 2017; Salolainen, Leppisaari, and Niinimäk 2018). The fashion expert Ayesha Ahmad (2020) stated, “The future of [the] sustainable fashion industry requires going back to nature and connecting with it on a deeper level.” The bio-based and bio-fabricated materials which form the subject of this study (explained in detail below) present alternatives that could transform fashion into a more sustainable industry. The economic and social benefits of bio-fabrication are evident and have already been extensively highlighted in the literature with respect to their ability to improve healthcare and biomedical products (Otto et al. 2016; Mironov et al. 2009). The uptake of new material development by society through tangible applications is a crucial undertaking, and, in the case of bio-fabrication, this is still an ongoing process. The latter accounts for the lack of specific literature on the social benefits that bio-fabrication can bring to design in general and fashion materials in particular. Notwithstanding, there are already specific projects initiated precisely to improve the social aspects of fashion through materials and production processes (Drazin 2015; Rognoli et al. 2017). Accordingly, it is plausible to imagine how, in the near future, the application of bio-fabrication to materials might contribute positively to the social and economic sustainability of the industry.

Achieving more sustainable fashion requires action on its complex and geographically expansive supply chain, of which the materials and processing technologies are key considerations. Researchers focused on sustainability and new possibilities for textile materials have recently identified upcycling, smart textiles, living organisms, and bio-based materials as possible new directions for sustainable fashion (Provin et al. 2021). These alternatives make sense because the use of resources from circular and/or bio-based origins can extend product-life cycles and establish diverse emotional bonds with future users. Initial research shows that the experiential qualities of bio-based and bio-fabricated materials can offer esthetic value by promoting new experiences and empathy for the natural environment (Sayuti, and Ahmed-Kristensen 2020).

This article discusses emergent material alternatives that could help catalyze the transition toward

more sustainable fashion. The general objective is to highlight how emergent approaches to textile design, as suggested by the “materials experience” concept (Karana, Pedgley, and Rognoli 2014) and DIY (Do It Yourself) Materials (Rognoli et al. 2015; Rognoli and Ayala-Garcia 2021), positively contribute to the proliferation of alternative and sustainable materials for fashion. The study evaluates the different materials solutions, focusing on bio-based and bio-fabricated materials. Further, we identify and explore 24 case studies, investigating fundamental traits by framing a taxonomy of biographical categories for some of the bio-fabricated and biomaterials already on the market. Analysis of these cases gave rise to the delineation of five “materials biography categories” that enable an understanding of prominent narratives by portraying their properties and characteristics, particularly those relevant to the materials experience. These categories can also contribute to the circular economy in building types of “material passports” or “product biographies.” The latter two foundational concepts, in combination with the outcomes of this study, demonstrate the need for tools that enable communication and traceability of emergent materials. We propose “materials biography” as an overarching concept that encompasses all categories that offer significant potential for exploration by designers, companies, and users to enhance their perception and awareness of these novel materials.

The remainder of this article is organized as follows. First, we provide an account of the socio-environmental problems linked to the fashion industry. The next section describes our cases of bio-based and bio-fabricated materials and outlines the “materials biography categories.” We then present and discuss our findings and, finally, conclude by providing a summary and suggestions for further research.

Socio-environmental problems linked to the fashion industry

Global awareness of the social and environmental impacts of the fashion industry is becoming more tangible and evident. Accompanying the exponential growth in output during the early 21st century have been major issues connected to materials with special concern focused on outsourcing and end-of-life management. The following discussion considers these issues in detail.

Materials

As one of the most important production sectors worldwide today, the textile sector is notable for its extraordinary amounts of waste and pollution derived from the fact that industrial operations are still characterized by a linear economy, with less

than 1% of the material used to produce clothing recycled into new garments (EMF 2017). Since 1975, the volume of textiles has almost tripled and the total production of synthetic fibers has expanded by 60% (EEA 2021). In the last decade, the price of clothing decreased drastically along with the length of its use life, leading to the “fast fashion” phenomenon (Niinimäki et al. 2020). This situation would not have been possible without the expanding use of polyester which is a relatively inexpensive and readily available raw material. In 2016, about 21.3 million tons of polyester were used in clothing, an increase of 157% from the about 8.3 million tonnes used in 2000 (Cobbing and Vicaire 2016). Synthetic fibers such as polyester increase the overall environmental impacts of textile production in terms of carbon-dioxide (CO₂) emissions and energy consumption (Zhao et al. 2021) to the point where apparel consumption represents the fourth most greenhouse-gas (GHG) intensive lifestyle domain in Europe (Vladimirova 2021). Moreover, with every laundering cycle, microfibers of this non-biodegradable plastic are released into the environment, evading wastewater-treatment plants, ending up in rivers and seas, and adversely affecting aquatic ecosystems (EEA 2021).³ Once present in ecosystems, microfibers can host invasive bacteria and be ingested by marine animals and thus lead to potentially harmful impacts on both aquatic life and humans.

Bio-based renewable materials have a long tradition in fashion history, but since the widespread industrialization and globalization of the sector even materials of natural origin are no guarantee of sustainability. Bio-based fibers can lead to reduced GHG emissions, but their production still requires a significant amount of water and land (Zhao et al. 2021). For instance, cotton, one of the most widely cultivated natural materials for apparel production, requires large amounts of water (2,700 liters of fresh water for a single cotton T-shirt). According to the United Nations Conference on Trade and Development (UNCTAD), some 93 billion cubic meters of water are used by the fashion industry annually.⁴ Moreover, textile processes have been estimated to be the second largest polluter of clean water globally (only agriculture is larger) (Kant 2012) and responsible for 20% of all contamination due to dyeing and treating fabrics with toxic chemicals and applying pesticides to grow raw materials.⁵

Outsourcing

The contemporary textile industry for fashion is highly globalized (Crewe 2017) and most of the pressures and impacts related to consumption of clothing, footwear, and household textiles in Europe

occur in other regions of the world where the majority of production takes place; this is the case for 85% of primary raw materials use, 92% of water use, 93% of land use, and 76% of GHG emissions (EEA 2021). Outsourcing to developing countries is a way to relocate impacts and is also associated with increased negative effects from outdated production facilities and coal-dominated electricity-generation infrastructures. The latter increases the environmental footprint of textile products, especially in countries that produce large amounts of polyester such as China, Taiwan, Korea, Japan, and Indonesia (Karthik, and Murugan 2017; Zhao et al. 2021; Aizenshtein 2017). Outsourced production, a common business practice for European and North American brands, also hides low labor costs and avoids adherence to strict regulations related to the safety of production, both for the environment and for workers. In recent years, the media have highlighted social and environmental issues and contributed to increasing consumer demand for ethical and sustainable manufacturing solutions (Cerchia and Piccolo 2019). Responses from companies and governments are slowly becoming manifest.

The Accord on Fire and Building Safety in Bangladesh (generally referred to as the “Accord”) is an independent, legally binding agreement between brands and trade unions to work toward a safe and healthy garment and textile industry in this South Asian country. It is intended to enable a working environment where no worker needs to fear accidents that could be prevented through appropriate health and safety measures.⁶ However, poor working conditions in developing countries are a fundamental feature of the low-cost clothing that drives the business model for fast fashion. Child and forced labor are deployed to produce cotton in at least 18 countries (Riordan 2020) and workers are routinely exposed to harmful chemicals used in the washing, dyeing, and finishing of fabrics. Approximately 3,500 substances are used in textile production and 750 of them have been classified as dangerous for human health and 440 as hazardous for the environment (EEA 2019).

Waste

At the end of the nineteenth century, the American sociologist Thorsten Veblen described fashion waste as a distinctive attribute of the wealthy class in his renowned book, *The Theory of the Leisure Class* (1899). However, this paradigm has changed over time, and accelerated from the prêt-à-porter fashion common during the 1970s. This growth is emblematic of the Anthropocene, thus transforming the entire sector and giving rise to the fast-fashion

phenomenon (Ricchetti 2017). The average European consumer currently discards about 11 kilograms (kg) of textiles per year. Some of this clothing may be reused at the end of life, but the majority ends up incinerated or in landfills.⁷ Today, despite professed eagerness for a circular economy approach, recycling rates are insufficient, with an estimated less than 1% of textiles worldwide being recycled and transformed into new products (EC 2020). Another issue in recyclability is the vast use of mixed fibers which are problematic for a circular flow of materials because they cannot be recycled profitably (Eppinger 2022). Yet, if, on one hand, the sector generates very high negative impacts due to synthetic and mixed fibers, on the other hand, progress toward more effective and sustainable solutions is to some degree evident and highlighted by the case studies presented in Table 1. Some countries have high collection rates for reuse and recycling, however, many of the salvaged garments are exported to developing countries that lack their own recovery infrastructure so clothing ultimately ends up in landfills or undergoing downcycling processes (Watson et al. 2016; EMF 2017).

Deadstock management is another environmental issue related to the end of life of textiles. Unfortunately, burning and destroying unsold goods became a common practice among fashion retailers starting in the 1980s due to overproduction caused by miscalculations of consumer-shopping habits (Napier and Sanguinetti 2020). High-end fashion brands regularly adopt this practice to prevent clothes/fabrics from being sold at discount prices in an attempt to preserve their exclusivity. In the face of rising environmental concerns, companies are currently starting to abandon this practice and to seek alternatives to manage unsold stock. Improvements in data analytics are also contributing to more effective efforts to manage the complex challenges of traceability in the intricate supply chains that characterize this sector (Sugumaran and Sukumaran 2019).

Jacometti (2019) observes that the limits of the linear economy model appear clearly in the garment sector and industry experts and practitioners also highlight the need to move to a circular economy model. Fashion design will need to facilitate the transition toward a sustainable bioeconomy in which raw materials derived from renewable resources replace those obtained from nonrenewable ones such as fossil fuels. Progress on this front could contribute to overcoming the problems of the linear economy model predicated on “production-use-abandonment” (Jacometti 2019).

Successful efforts to mitigate the environmental problems inherent in the contemporary fashion

industry will need a holistic view of the complex supply chain (Moretto et al. 2018) and this undertaking reflects a need for shared responsibility of the entire textile sector. It will be necessary to redesign textile production and consumption patterns based on sustainable innovation and knowledge exchange (Luján-Ornelas et al. 2020).

State of the art

The previous section outlined the major social and environmental problems of the fashion industry. The broad spectrum of complexity shows the need for an all-encompassing design vision that considers the entire production chain and the entire life cycle of the product. The literature demonstrates an in-depth understanding of the main challenges, highlighting what to date have been weak and uneven responses by key stakeholders. However, it is already possible to outline a series of guidelines and good practices as illustrated in this section. We consider three primary actors for an effective transition toward a more socially and environmentally sustainable fashion industry: governments, apparel industry, and designers.

Governments

Governments are critical change agents in developing the circular economy. The nongovernmental organization (NGO) Circle Economy observes that “When it comes to a circular economy, we are all developing countries” since no country today can satisfy its people’s basic needs within the ecological boundaries of the planet.⁸ In March 2020, the European Commission adopted a New Circular Economy Action Plan (EC 2020), including an EU textile strategy suggesting initiatives to achieve the circularity goals. The action plan anticipated development of eco-design measures to ensure that textile products are fit for circularity: incentives for and access to reuse and repair services; support for product-as-service models, circular materials and production processes; demand for increased transparency through international cooperation; support to reach high levels of separate collection of textile waste and boosting the sorting, reusing, and recycling of textiles; and encouragement of regulatory measures such as extended producer responsibility.

Concerning the extensive use of synthetic fibers, the EU strategy for a circular economy provides crucial proposals for good practices to address microplastics such as labeling, standardization, certification, and regulatory measures, including plans to increase the capture of microplastics at all relevant stages of the life cycles of products. These initiatives

emphasize the need to develop methods for measuring unintentionally released microplastics and related environmental risks (EC 2020; EEA 2021).

Apparel industry

How is the fashion sector responding to its socio-environmental challenges? Some researchers argue that there is a lack of tools and studies to provide environmentally friendly materials, to highlight the complexity of the impacts generated by creative industries, and to provide sustainable material solutions (Cicconi 2020; Pereira et al. 2021).

Alongside policy makers, coalitions of fashion brands are starting to develop tools and guidelines for sustainable fashion. A key factor is creating knowledge and awareness among designers and firms from open-access resources. An example is the sustainable strategies toolkit and materials database provided by the Council of Fashion Designers of America, a trade association founded in 1962.⁹ The Sustainable Apparel Coalition has also developed tools like the Higg Materials Sustainability Index to improve understanding of the environmental impacts of different materials and processes in the textile industry. These frameworks are useful for overcoming the difficulties that brands and designers face in not having enough energy and resources to access relevant and trusted data (Pollini and Rognoli 2021; Luo et al. 2021).¹⁰

Also, consultancies for sustainable fashion are developing tools to address the needs of clients in a sustainable transition. One example is the “seven strategies” concept formulated by consultant Anna Brismar for her firm Green Strategy which specializes in circularity and sustainability for fashion.¹¹

The sustainability efforts of companies address circularity with diverse foci such as reuse, controlled and efficient recycling processes, sustainable design, and innovative materials. LVMH Group sells dead-stock of high-quality fabrics and leathers from the company’s fashion houses at competitive prices to encourage the creative reuse of materials.¹² Post-consumer recycling can also be a sustainable way to source local raw materials for new circular production and this approach requires identification of the recycled content and its state of wear. While the process is not simple, a project like Textile Lifecycles by the Finnish company Tauko demonstrates its feasibility.¹³ The clothing firm Rapanui has adopted a policy of material recovery that uses its old products to produce new ones. As the company explains on its website, “A pure material makes remanufacturing possible, and means products that are softer, and not harmful to the environment.”¹⁴ These examples highlight how the selection

of materials is critical for effective and valuable recycling and determines the future material cycles (Pollini and Rognoli 2021).

Another instance is Salvatore Ferragamo which in 2017 introduced for its capsule collection a material called Orange Fiber, a silky fiber derived from the wastes of Italian citrus fruits.¹⁵ In 2021, the company created a limited edition of the iconic Top Handle bag made from certified cork, natural fibers, and finishing, while the zipper and thread were from certified recycled polyester. Materials are also critical in design for disassembly. Resortecs[®] produces a particular sewing thread that melts quickly to enable garment recycling during automatic demanufacturing of apparel at an industrial scale.¹⁶

Another central challenge for the fashion sector is corporate social responsibility which is closely linked to the social risks in the supply chain regarding material sourcing and manufacturing activities. To manage social issues, the actors operating in the supply chain can apply three main actions: compliance, supplier development, and communication practices. Unfortunately, these methods have not always been effective in finding a balance between economic self-interest and the costs of implementing social standards (Köksal, and Strähle 2021). The website Fashion Checker (by the Clean Clothes Campaign and funded by the European Union) tracks the social commitment of companies and in 2020 reported that 93% of surveyed brands were not paying garment workers a living wage.¹⁷ Excessive working hours, unsafe conditions, and violence are common in garment factories and the Clean Clothes Campaign reports that the COVID-19 pandemic has made the situation worse.¹⁸ While most brands cannot yet provide guarantees and transparency through the long and intricate supply chain, some pioneers such as Known Supply have made their simple and visible supply chain the company’s greatest strength.¹⁹ This brand is a partner of Fair Trade Certified[™], thereby creating direct trade relationships. Moreover, the website allows customers to determine who produced particular items using a “Meet the Makers” section.

Designers

In addition to governments and the apparel industry, designers are becoming more aware of their role in addressing sustainability issues. For this reason, there has been a growing interest in more conscious design and production techniques (Rognoli, and Ayala-Garcia 2019; Barati, and Karana 2019). Many designers started experimenting with alternative materials, bringing materials research into the focus of their projects, if not the purpose of the projects

themselves (Rognoli et al. 2015; Lee 2015; Solanki 2018; Franklin and Till 2019). The experimentation, development, and proposals of designers for sustainable material alternatives are now stimulating new commitments on the part of both individuals and firms and increasing critical thinking (Migliore 2019; Rognoli, Ayala-Garcia, and Bengo 2017). These activities involve the development of samples, prototypes, and collections that demonstrate the possibility of new material paths and novel sustainable production and consumption models. Fashion and product designers in particular are demonstrating that is possible to go beyond the usual limits of their discipline in testing materials; hybridizing with science, engineering, and biotechnology; and embracing an increasingly transdisciplinary approach (Oxman 2016; Langella 2019; Migliore 2019). If traditional form-focused design previously determined designers' limited knowledge of materials, a change is now taking place through the direct action impelled by the designers themselves. They are engaged in the conceptualization of material, where the material becomes the real project driver (Karana et al. 2015; Bak-Andersen 2018), a shift also noticed among fashion designers (Ribul, Goldsworthy, and Collet 2021).

Key concepts of eco-design and the circular economy, such as design for durability, reparability, and reuse, are increasingly being adopted and integrated into design strategies. The Togolese designer, Amah Ayivi, has created high-fashion clothes to sell to Western consumers that are made from the recovery of clothes destined for charity and secondhand markets.²⁰ Although this approach may seem contradictory, it tackles the problem of tons of garments that cannot be reused (for example, winter suits) and which would otherwise become delocalized waste. Moreover, this operation aims to promote greater space for the African textile sector, which is often overwhelmed by secondhand clothes. Applying the reuse strategy to extend the lifespan of textiles, Ayivi also relies on a valuable esthetic based on luxury collections.

Wastes derived from the most diverse sectors are being used as raw materials (Cleries et al. 2021). Many designers prefer working with bio-based and renewable resources as alternatives to materials that are made of plastic. One example is the project *Repearls*, developed in 2021 by Margherita Grassi to tackle the impacts of embellishments like plastic buttons and beads, for which she developed a pearl-like material from the waste of oyster shells.²¹

Another emerging trend is the involvement of living organisms in the material-fabrication process. Here, the transdisciplinary approach is fundamental, and the prospects for sustainable innovation are

those of biotechnologies and the bioeconomy. More and more case studies are referring to materials, fabrics, and processes derived from fungi, algae, or bacteria. For example, Suzanne Lee, a pioneer in the fashion industry with Biocouture, was the first designer to offer a speculative collection made of bacterial cellulose starting around 2008–2010 and still under development. Her early DIY experimentation with the material (begun in approximately 2004) was the beginning of a long journey that sees her today as Chief Creative Officer at Modern Meadow, one of the biotechnology companies intriguing the fashion sector with exciting offers to seek better standards of sustainability with the help of biology.²²

We are especially keen in this article to highlight the integration of natural agents into materials innovation as one of design community's most disruptive responses. The following section focuses on the design approaches supporting this transition in fashion, defining the materials and organisms involved in this new emerging materiality.

Approaches enabling designers

In parallel with increased attention to the management of materials within the life cycle of products, designers are developing in research labs and startup companies new applications of bio-based materials embedded in circular models. However, in fashion, new materials are usually aimed at replacing or mimicking established fabrics (e.g., there is a big focus on creating leather replacements). Rather than creating novel applications, new materials are often positioned by imitating the characteristics of other materials. It remains challenging to position them through their unique qualities (Karana et al. 2015) and uses, precisely because they still do not have a definite identity and experience with them is limited (Hildebrandt, Thrän, and Bezama 2021).

A focus on the materials experience offers alternatives where designers can be sensitized to the unique qualities of novel materials, potentially leading to meaningful applications. Karana, Pedgley, and Rognoli (2015) build on the proposition by Manzini (1986) that designers need to know what materials are and what they do. They suggest that designers need to ask: What does it express? What does it elicit from us? What does it make us do? These questions help designers go beyond understanding the material and expand into the experiential aspects of what materials can do.

The role of the materials experience in sustainability has already been investigated using the concept of "Materially Yours" (Karana, Giaccardi, and Rognoli 2017) which indicates strategies for using

materials at different experiential levels to assist in the design of longer-lasting products. By expanding the territories of the materials experience, the aim is that it will be possible to improve the ability of designers to address environmental considerations.

The growing impact of human artifacts (and their waste), and the ever-increasing pressure on material resources, requires a change in our relationship with the artifacts themselves, including the materials of which they are made. Considering the expanded territories of materials and design (Pedgley, Rognoli, and Karana 2021), material skills are (re)gaining importance in design. The bodily experience of the material is irreplaceable even if the history of design shows how the very act of designing marked the separation between the materials and the project (Bak-Andersen 2021). In fact, the arrival of industrial design brought a division between intent (design) and making (production). Using the concept of the materials experience (Karana, Pedgley, and Rognoli 2015; Giaccardi and Karana 2015), as well as the Material Driven Design method (Karana et al. 2015), it is possible to design the material by focusing on the experiential dimension.²³ Furthermore, with the DIY-Materials approach (Rognoli et al. 2015; Rognoli, and Ayala-Garcia 2021), experimentation and tinkering restore the physical separation between the designer and the materials.²⁴ Indeed, with DIY-Materials, designers, who are not looking at materials that someone has already designed and developed, are motivated to inquire about and challenge themselves by experimenting and thinking about their own design of materials. From this standpoint, many authors agree that material explorations and material tinkering are no less important than materials selection (Parisi, Rognoli, and Sonneveld 2017; Rognoli, and Parisi 2021; Bak-Andersen 2021). In other words, in the contemporary material atelier, designers and designers-in-training become acquainted with materials in effective ways (Pedgley, Rognoli, and Karana 2021).

A significant motivation for encouraging designers to undertake the DIY-Materials approach is to find more sustainable and eco-friendly material solutions. However, using this methodology does not guarantee a sustainable material outcome at the end of experimentation. Instead, it is necessary to consider that such an approach leads the designers to make decisions that help them improve their sensitivity toward sustainability challenges as they become increasingly aware of their role as facilitators and pursuers of sustainable solutions.

The environmental impact of DIY-Materials has not yet been studied in-depth, and although superficially demonstrated, scholars describe a positive relationship between this approach and

sustainability and identify its potential to find more sustainable material solutions (Rognoli and Ayala-Garcia 2021; Bak-Andersen 2021; Rognoli, Santulli, and Pollini 2017; Fadzli, Aurisicchio, and Baxter 2017; Alarcón and Llorens 2018; Rognoli, Ayala-Garcia, and Pollini 2021; Caliendo, Langella, and Santulli 2019; Karana et al. 2017).

In the fashion sector, several examples of materials developed from waste, bio-based and organic sources, and living organisms testify to the importance of experimentation and tinkering. Furthermore, in these cases, the designer is the one who visualizes, facilitates, and provides the solution (designer as the solution provider, Bak-Andersen 2021; designer as the facilitator, Manzini 2014) in the specific material solutions that can inspire and initiate the development of the material for industrial production.

Given the observed paradigm shift toward the consolidation of bio-fabrication and the cross-fertilization of biology with design (Zhou et al. 2021), the designer can also enable the creation of materials from living organisms. This can bring new sustainable solutions and different forms of expression for design, and specifically for fashion. The following section introduces the bio-fabrication of materials as a possible alternative to the contemporary manufacturing model based on intense consumption of energy and materials. Such a change would be welcome given its alignment with the principles of biology and circularity. Furthermore, as many scholars claim (see, e.g., Collet 2018; Kääriäinen and Niinimäki 2019; Kamiński et al. 2020), bio-fabrication, and bio-based materials in general, could represent a satisfactory response to the environmental and social problems of the fashion sector.

Introducing bio-fabricated materials

Historically, human productions, including textiles, have been deeply connected with the natural world. After decades of industrial models and oil-based materials, a rediscovery of natural resources is being driven by the will to produce within the limits of the planet's capabilities. Today, while the sustainable fashion landscape is dealing with terms and definitions such as slow, ethical, green, and eco-fashion (Brydges et al. 2020), new materials trends are emerging and affecting the fashion sector.

A newfound interest in bio-based resources pushes material designers to develop new and/or rediscovered material solutions from natural resources and to design around material flows. Recently, designers have also begun to perceive organic waste as a source of valuable raw materials to be experimented with to develop new textiles (e.g., Vegea,

Orange Fiber), following a circular and bioeconomy model (Collet 2018).²⁵ Besides newly circular made-from-waste and bio-based textiles, living organisms integrated as functional components in designing new materials offer a new sustainable opportunity.

This trend is associated with the rise of Biodesign (Myers 2014), a radical approach born from the cross-pollination between biology and design, where materials are bio-fabricated and obtained from organisms such as bacteria, enzymes, algae, mycelium, and others. In Biodesign, materials gain a predominant role and they are made of, with, or from living organisms (Ginsberg and Chieza 2018) that engage in morphogenesis: from more passively growing in a given shape to more actively co-designing the final object or material (Collet 2013; Camere and Karana 2018; Karana, Barati, and Giaccardi 2020).

Although the term “bio-fabrication” originated in the medical sector, Mironov and colleagues in 2009 widened its definition to biotechnology and defined it as “the production of complex living and non-living biological products from raw materials such as living cells, molecules, extracellular matrices, and biomaterials” (Mironov et al. 2009). In 2020, the report *Understanding “Bio” Materials Innovations* (Lee et al. 2020) focused on the fashion sector, stating that “bio-fabrication technologies are evolving and extending into application areas, including textiles for fashion.” The potential for the fashion sector derives from the possibility that different organisms can self-grow into fibers, tissues, or dyes, using life-friendly chemistry and processes typical of biological growth. This article focuses on those materials produced by living cells and organisms such as bacteria, yeast, algae, mycelium, and plants, and particularly on their potential application for the fashion sector and textile industry.

The origins of Biodesign are characterized by a DIY approach and open-source philosophy (Elsacker et al. 2020) and the first dedicated study paths have become established. The case studies of bio-designed materials were initially experimental and related to speculative design (Aldersey-Williams et al. 2008; Myers 2014), but it is now not uncommon for a designer’s DIY approach to lead to establishment of a successful company in the biotechnology field such as Ecovative, Mogu, Mycoworks and Modern Meadow.²⁶ The desire of the designers behind these companies (or with similar inclination) for sustainable and radical solutions led to a first-round (primarily speculative) of exploratory research to test the potential of living biological resources to replace oil-based and polluting ones. The visions traced by the first experimental prototypes were then scaled and experimented

with further, leading to today’s first examples of bio-fabricated materials applied to the world of textiles.

With various degrees of biotechnological maturity, today, it is possible to consider the idea of dyeing fabrics with less water and fewer chemicals, using bacteria or producing alternatives to animal leather, such as fungi or bacterial cellulose created by a symbiosis of bacteria and yeasts, reducing environmental and ethical problems related to the tanning of animal leather and animal welfare. For instance, it is possible to weave and dye with algae. In short, what seemed to be highly speculative propositions ten years ago are slowly approaching the market, thanks to advancements in biotechnology.

Bio-fabricated materials are starting to stimulate a highly engaged audience due to the sustainable features associated with their biological origin and underlying techniques. In parallel with the material experiments of designers, and sometimes as a direct consequence of these activities, the biotechnology sector is investing heavily to increase the potential of these organisms as alternative sustainable materials (Matthews et al. 2019).²⁷ Bio-fabrication techniques also contribute to transforming society by limiting the exploitation of child and female labor that is widespread in the traditional production of textiles in the global South. Indeed, bio-manufactured materials could be an excellent opportunity for innovation and renewal from workforce training, making it more advanced and updated (Miehe et al. 2020; Ahmad 2020). Furthermore, the DIY culture, including DIY with biology (thus incorporating DIY bio-fabrication techniques), due to its intrinsic nature, supports the model of distributed micro-production (Bianchini, and Maffei 2013), drawing on local sources and fostering bio-based and circular solutions (Devadas et al. 2021; Meyer et al. 2020; Provin et al. 2021). Moreover, this approach, initiated through DIY-Materials investigations, can foster self-sustaining models in remote places (Palacios et al. 2020).

Biomaterials can empower local production and give rise to new alternative and sustainable production methods that support local producers by creating resilient socio-technical systems based on hybridized social and technological innovation. Such developments are determined by interactions undertaken directly by the interested parties (in a bottom-up approach), and different types of interventions by institutions, civic organizations, and companies (from a top-down approach) often support them (Manzini 2011).

A trigger for designers and a push from the market derives from the prospect that these materials have the potential to create a radical shift to more

sustainable fashion. The speed of growth of these organisms denotes them as rapidly renewable (Camere and Karana 2018). The production processes use life-friendly chemistry, do not require much space compared to plant or animal harvesting (Bhat and Bhat 2011), use less energy than synthetic processes, and require smaller amounts of water and other resources. However, due to the complexity of a product's life cycle, many factors can influence the overall impact of a material or product. In life cycle design, the material must be selected to comply with the design requirements imposed by the functional unit to achieve a minimum impact. Life cycle analysis (LCA) is the most reliable methodology for comparing multiple materials as it can show the different impacts occurring throughout an object's life cycle. The first studies comparing the LCAs of bio-based and bio-fabricated materials highlighted the hidden implications of these alternatives (Hildebrandt et al. 2021). When analysts compared leather-like bio-based and bio-fabricated materials to animal-based leather, the impact of the bio-based alternatives entailed the use of land, water, and chemicals to harvest the vegetable fibers; moreover, the bacterial cellulose impacts were related to the feedstock source and the finishing treatment. These variables need to be thoroughly evaluated with a forward-looking approach when upscaling the production of bio-based and bio-fabricated materials.

Moreover, a study by Hildebrandt et al. (2021) highlights that alternative bio-based leather substitutes can contribute to relative environmental advantages in impact reduction (especially concerning CO₂ emissions), but only if the material substitution is coupled with less frequent product replacement. This means that a profound cultural transformation is needed to achieve sustainability goals. When trying to reduce the impact of human production, behavioral change is significant and influential in terms of economic and design strategies (Ricchetti 2017). This is also true for bio-fabricated materials (Collet 2018; Hildebrandt et al. 2021).

In addition, some of the key impacts of materials highlighted in this article are among the main features influencing users' tendencies to retain their products for longer periods of time, as suggested by the *Materially Yours* concept discussed above. Narratives and identity, among other factors, are important for emotional, long-lasting designs and can be used to develop strategies that increase product attachment (Haines-Gadd et al. 2018).

The product's identity and personality (concepts further addressed in the following sections) can reinforce users' beliefs, including creating connections with communities, for example, if the material

is produced locally and grown on wastes from proximate sources. The narrative behind bio-fabricated materials can evoke a radical idea of sustainability in balancing ancient knowledge (e.g., fermenting processes) and future innovation (e.g., biotechnologies). Moreover, these material narratives can shift the collective imagination about the future of products, systems, and processes as they are based more on biological regeneration than on the depletion of nonrenewable resources (Chapman 2021).

Bio-based and bio-fabricated material cases for fashion

As this article has shown so far, textiles made of bio-based and bio-fabricated materials, following a long-term dominance of well-known synthetic and natural fibers, are currently seen as a novel option for sustainable purposes, despite the development of biosynthetic fibers dating back to the late 1800s (Textile Exchange 2018). This long history, combined with the recent interest of designers, has resulted in a plethora of bio-based and bio-fabricated materials available today with unique qualities and characteristics that are still being explored, comprehended, and defined.

The current understandings and experiences emergent with these novel materials are influenced by applications and communication that help define the social space they will occupy. Given that many of these nascent materials remain niche products and are distant from the public, it is especially crucial to examine them further through a case-study analysis that helps to highlight the opportunities and challenges for the widespread adoption of these materials. Additionally, decisions in terminology need to be balanced, on one hand, between scientific accuracy and, on the other hand, consumers' understanding, market strategies, and brand-positioning opportunities (Lee et al. 2020; Ahmad 2020; D'Olivo and Karana 2021).

To restate the purposes of this article, the objective is to build a panorama of possible alternative bio-based and bio-fabricated materials to favor a lasting and effective transition toward more sustainable fashion. We aim to provide more information on the origin and potential of these emerging materials to improve awareness of the benefits that will likely come through societal acceptance and to further support the design community with new tools to appreciate and apply them in the fashion industry for more sustainable results. Furthermore, the article highlights how these evolving approaches to material design can positively contribute to the proliferation of alternative and sustainable materials for fashion. To serve this purpose, we have developed

the concept of “materials biography,” outlining a set of categories to better define these new materials and to examine their peculiar features by supporting the material narrative and raising awareness among designers about the range of their applications and environmental characteristics.

Methods

We selected 24 material cases to further explore current understandings that have emerged with novel bio-based and bio-fabricated materials. We analyzed them in terms of common and meaningful information that could help generate appreciation and position their materials biographies. These characterizations include a detailed description of each material’s life and highlight the attributes that we consider to be most significant.

This study was carried out through desk research to collect, select, and analyze cases of bio-based and bio-fabricated materials for the fashion sector. Between February and May 2021, we undertook an exhaustive search for new materials through scientific journals using leading academic databases such as Scopus and Google Scholar. In addition, we completed an exploration of grey literature such as fashion and design reports, magazines, blogs, textile manufacturer’s and designer’s websites, and related press releases. The keywords used for the search of materials cases were “bio-fabricated materials,” “growing materials,” “bio-fabrication in fashion,” “bio-based materials in fashion,” and “bio-based materials in apparel.”

Criteria for selection

There were two primary eligibility criteria for the cases: (1) the selected materials had to be at least at a proof-of-concept stage and (2) their main field of application had to be the fashion sector. Biotechnology offers exciting opportunities for novel and more sustainable alternatives for the design and manufacturing of products. One of the most promising approaches is developing materials from living organisms such as fungi and bacteria (Camere and Karana 2018; Collet 2018; Collet 2017). Thus, the research presented here focuses on selected cases that best represent the potential of these bio-based and bio-fabricated materials for future designs that are consistent with humankind’s need for a sustainable transition. As previously mentioned, the definition of “fabrication of materials by living organisms” (Groll et al. 2016) seems the most suitable to frame those materials processes involving living organisms. Thus, all the examples collected for this study have been bio-fabricated by living

organisms. The typology of organisms generating the material was one of the observed characteristics and this feature also helped group the cases, as shown in Figure 1.

The design and development period neither discriminated against the eligibility of cases for this study nor their approach, which is sometimes speculative but aimed at a vision of future feasibility. In the field of bio-fabrication, a considerable amount of research is currently underway to develop new materials. In addition, in the fashion sector, many alternative bio-based materials (for example, leather substitutes) are still in the research stage. Accordingly, we have included those cases that were at least at a proof-of-concept stage but will still require time before they are potentially commercially viable. In contrast, others are already on the market, albeit often with limited production. This study considered materials under development since the early 2000s to ensure that material innovations relevant to the focus of this article were included and to provide an overview of the most important cases.

We need to note that public information about these new materials is oftentimes still limited. Recent academic research in the field also relies heavily on desk research to understand them (D’Olivo and Karana 2021) and many of the sources come directly from the manufacturer or related commercial partners. While having primary sources of data is very valuable, investigating how companies portray these materials for marketing and other business purposes is also critical.

A first analysis of the material cases

A preliminary analysis of the cases proved necessary to bring out some fundamental aspects helpful in developing the findings. Table 1 reports the selected cases, highlighting some criteria employed for our initial analysis. Apart from the name of the material, we collected the following data to further deepen knowledge of these emerging materials. The first step was to group the material cases according to the organism involved in their origin: bacteria, yeast, algae, mycelium, and plants (Figure 1). The bio-based origin cannot be translated into products’ biodegradable end of life because this depends on the manufacturing process which the relevant company does not always declare. For this reason, the second criteria for organizing the data was the end of life of these materials which we found to be unknown in many cases. We also collected the range of applications within the fashion-production processes, distinguishing between textiles, dyeing biotechnologies, application in accessories, and so forth.

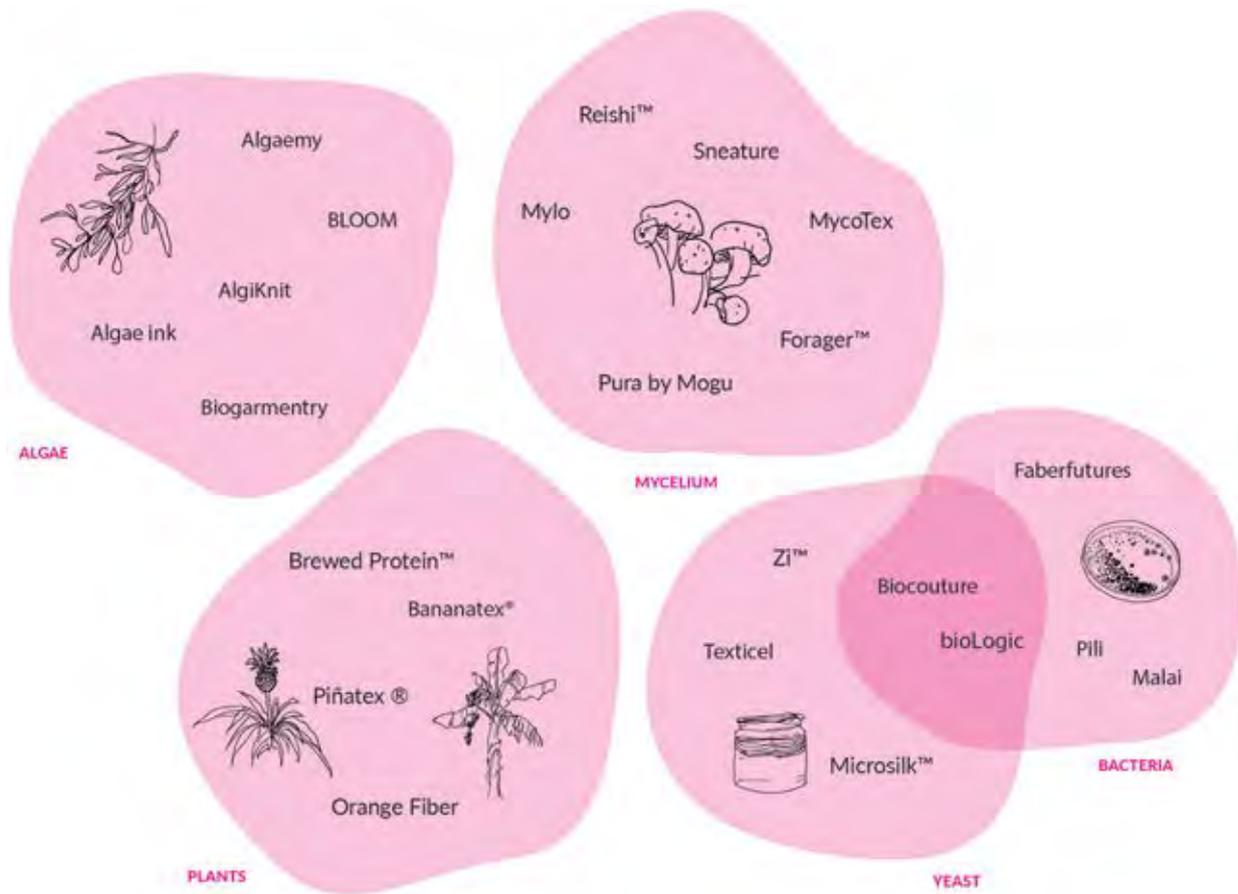


Figure 1. Groups of material cases according to their origin.

The study revealed that many of these novel materials were positioned as potential replacements for common and less sustainable materials currently used in the fashion sector. Therefore, to display the cases we created a cluster named “mimics” (Table 1) aimed at creating parallel comparison with the type of material that the new one is being designed to replace and, in some ways, “imitate” esthetically.

We collected information on the locations of the associated companies to identify the hotspots of this biotechnology revolution in the fashion sector. The study showed significant involvement of firms based in Europe and the United States as well as a few in Brazil, Japan, Thailand, and the Philippines. Finally, we assembled data on the main processes used to produce and bio-fabricate these materials. Many of these materials require a lab environment, while others follow more traditional paths.

The following section provides an in-depth description of each organism in the bio-fabrication process of the selected cases.

Bacteria

Most cases of bio-manufactured materials originating from bacteria are made with bacterial cellulose from various bacterial strains. Acetobacter bacteria which

present favorable physical and mechanical properties for applications in fashion have received the most attention in the design field (Rathinamoorthy and Kiruba 2022). As stated, the pioneer researcher in this domain is Suzanne Lee. In 2004, she started growing bacterial cellulose in a tea and sugar static culture medium and applied it to a leather-like jacket. This process is still the most popular alternative for researchers involved in producing cellulose sheets for fashion applications (Rathinamoorthy, and Kiruba 2022; Da Silva et al. 2021; Domskiene, Sederaviciute, and Simonaityte 2019). The weakness of this process is the drying part which produces a loss of flexibility and breathability generated by structural disintegration (Rathinamoorthy and Kiruba 2022), as well as the difficulty of finding suitable finishes that could counter these problems (Hildebrandt, Thrän, and Bezama 2021). Several researchers are looking for solutions to these obstacles (Sederaviciūtė et al. 2022).

A second approach involves Malai which is a bio-composite material made from bacterial cellulose that is grown on agricultural waste sourced from the coconut industry in Southern India.²⁸ The company collects the waste-coconut water from local farmers and processing units and feeds bacterial cellulose production. One small coconut-processing

Table 1. Final selection of material case studies.

	MATERIAL	END OF LIFE	APPLICATION	MIMICS	LOCATION	PROCESS
 ALGAE	Algae ink™	Compostable	Dye	Conventional dye	United Kingdom	Made from algae pulp
	Algaemy	Unknown	Dye	Conventional dye	Germany	Made from microalgae
	AlgiKnit	Biodegradable	Yarn	Conventional yarn	USA	Unknown
	Biogarmentry	Unknown	Clothes	Conventional fabric	Netherlands	Lab made
	BLOOM	Non-recyclable	Accessories	Rubber	USA	Unknown
 MYCELIUM	Reishi™	Biodegradable	Accessories	Leather	USA	Lab made
	Forager™	Unknown	Accessories	Leather	USA	Lab made
	Pura by Mogu	Unknown	Accessories	Leather	Italy	Lab made
	Mycotec®	Unknown	Accessories/ Clothes	Leather	Netherlands	3D manufacturing
	Mylo™	Non-recyclable	Accessories	Leather	USA	Lab made
 BACTERIA	Malai	Unknown	Accessories	Leather	India	Bacteria grown from coconut water
	Pili	Unknown	Dye	Conventional dye	France	Fermentation
	Faberfutures	Unknown	Dye	Conventional dye	United Kingdom	Fermentation
	Texticel	Compostable	Accessories	Leather	Brazil	Lab made
BACTERIA & YEAST	Biocouture	Compostable	Accessories/ Clothes	Leather	USA	Lab made
	bioLogic	Non-recyclable	Accessories	Leather	USA	Lab made
 YEAST	Microsilks™	Biodegradable	Clothes	Silk	USA	Protein made from yeast
	Texticel	Compostable	Accessories	Leather	Brazil	Lab made
	Biocouture	Compostable	Accessories/ Clothes	Leather	USA	Lab made
 PLANTS	Piñatex®	Partially biodegradable	Accessories	Leather	United Kingdom / Philippines	Coated non-woven fabric
	Brewed Protein™	Testing stage	Clothes	Wool	Japan/ Thailand	Fermentation
	Orange Fiber	Biodegradable	Clothes	Lyocell	Italy	Cellulose extraction
	SweetFoam™	Biodegradable	Accessories/ Footwear	Rubber	Brazil	Cellulose extraction
	Bananatex®	Biodegradable	Accessories	Canvas	Switzerland / Taiwan/ Philippines	Cellulose extraction

unit can collect 4,000 liters of water per day which can produce 320 square meters (m²) of Malai. The resulting material is comparable to leather or paper and is flexible, durable, and water-resistant.

A third route being explored with bacteria entails the creation of dyes. Currently, several companies are using DNA circuits to produce colorants in microorganisms (such as bacteria). These companies include Pili (France), Colorifix (UK), and Ginkgo

Bioworks (United States).²⁹ The technology is challenging and there is often a drastically different pathway for each color. Thus, the technology is only now emerging and the range of colors is minimal.

Yeast

Synthetic biology is the core technology underlying most of the materials that originate from yeast.

Current research involves programming these microorganisms to produce something that they do not usually produce or something in greater quantity. The outputs of such processes are incredibly variable, meaning that the material opportunities are vast through this route. Examples of companies applying this technology in consumer fashion include Bolt Threads (Microsilks) and Modern Meadow (Zi).

Bolt Threads employs genetically modified yeast to produce a silk-like material and aims to scale this approach to make consumer products. Inspired by the properties of spider silk, Microsilks is an attempt to emulate its high tensile strength, elasticity, durability, and softness, creating an enhanced rayon through bio-engineering (i.e., fermentation, using yeast, sugar, and water).³⁰ The company claims that this is achieved with less environmental impact than the usual textile-manufacturing processes with the additional benefit that the material can biodegrade at the end of life.

Modern Meadow, launched in 2012 (Mainwaring 2012), created a range of bio-fabricated materials named Zoa that are design-driven by function and sustainability. The first collection of materials named ZiTM uses proteins (genetically modified yeast) and bio-based polymers that create what the brand calls a Bio-AlloyTM and results in a leather-like material. In terms of performance, the brand declares that ZiTM is resistant to abrasion and water, is durable, and holds shape.³¹

Algae

Edward Stanford first discovered Alginate in 1881. Since being commercialized in 1927, Alginate has become the most abundant marine biopolymer and, next to cellulose, the most popular biopolymer in the world. It is widely used in the medical, food, textile, material, reactive dye, and printing industries because of its water-retaining, gelling, and stabilizing properties. AlgiKnit, Inc. is a biomaterials company integrating science and design into textile production, creating durable yet degradable yarns from kelp (a type of seaweed or macroalgae).³² The yarns can be applied across the fashion industry and in packaging and home furnishing. The company praises the material's associated benefits: it is grown in the ocean (does not use upland, pesticides, or fertilizers), and its CO₂ capture purifies the surrounding water; however, more studies are needed to clarify the environmental and social advantages of such production.

Vollebak makes T-shirts from lyocell (pulped eucalyptus and beech from sustainably managed forests) and the print on them comes from algae grown

in bioreactors which is biodegradable.³³ This garment will decompose in compost or a landfill in twelve weeks. The company emphasizes that this is a regular T-shirt, the only difference being that all the materials going into making it are "grown by nature" and can "go back to nature" at the end of life. Green algae (spirulina) are used for the dyeing, and as it is a plant dye, it does not use other chemicals, only carotenoids and chlorophylls occurring in the algae. It is no longer alive when applied to the T-shirt; its color will change due to oxidation in contact with air (i.e., it is expected that the color will fade with time). Similarly, Blond and Bieber's design studio uses algae to create colorful dyes for textile printing that change color when exposed to sunlight, creating bright and dynamic colors.³⁴

Mycelium

Mycelium constitutes the principal vegetative portion of a fungus. It consists of networks of branching microfilaments containing mixtures of cellulose and chitin. These interlinking branches can form very robust structures. The manufacturing process (mostly for the production of packaging) involves combining waste materials (agricultural/plant-based) with mycelium (vegetative fungus). This mixture is placed in molds and the mycelium grows to occupy the mold to form the desired shape. The process takes about one week (Karana et al. 2018; Arifin, and Yusuf 2013; Collet 2017; Williams and Collet 2021).

Ecovative has emerged as the leader in manufacturing with mycelium (first provisional patent 2006, fulfilled in 2016). The company has developed applications in foam and bulk-material development as well as textiles. The company has formulated applications in foam and bulk-material development as well as textiles. It created MycoFlexTM using pure mycelium foam to produce compositions for diverse applications include leather-like materials. The material is heat resistant, insulating, hydrophobic, breathable, and strong.³⁵

Bolt Threads (founded in 2009) is one of the pioneers in developing a mycelium-based leather substitute. It was first seen in an application in their Mylo Bag, pre-sold on Kickstarter in the summer of 2018.³⁶ The material Mylo has been optimized in the intervening years and applied in different concept pieces by Adidas (Stan Smith MyloTM) and Stella McCartney garments (top and trousers in March 2021).³⁷

Mogu, a European-based company, also developed a Pura Flex leather substitute using mycelium and bio-fabrication technology.³⁸ Mogu employs non-genetically modified organisms (non-GMO)

and non-allergenic fungal strains, which do not release any spores throughout the whole production process. The materials are durable and will only degrade in the right conditions at their final disposal, meaning that the material is biodegradable and can be broken down and re-assimilated back into the natural environment but it requires specific processes for degradation.

Plants

Plant-derived materials rely on growing plants, the agricultural industry, and their byproducts (Shogren et al. 2019). While they can offer more sustainable alternatives to current materials it is essential to consider land use and prioritization of food systems when opting for such alternatives.

Piñatex[®] is a non-woven textile made from waste pineapple-leaf fiber coated with resin to mimic a leather look and feel.³⁹ The leaves are the byproduct of existing agriculture and their use creates an additional income stream for farming communities. Piñatex[®] is a natural, sustainably sourced, cruelty-free material. It first appeared in 2014 and is now being applied to products (e.g., shoes and bags) available to the consumer.

SweetFoam[™] was developed in a partnership between the shoe brand Allbirds and Braskem and launched in 2018. It is a bio-based renewable resin⁴⁰ and Braskem has referred to the product as a “renewable bio-based EVA resin (ethylene-vinyl acetate copolymer)” to communicate the properties and applications of this material.⁴¹ This material is commercially available in Allbirds sports shoes.

Materials biography as a metaphor to strengthen the identity of novel materials

The concept of identity with reference to human beings is a complex and debated notion, especially in the social sciences. Today it acquires an even more significant role since society and technologies allow multiple identities for a single individual (for example, physical and digital identity) which creates more nuances to an already tricky concept.

The identity of materials is strictly connected with their acceptance and, therefore, their adoption by designers, industries, and end-users. Issues pertaining to the identity of materials have already been introduced in the debate on material design; here scholars have tried to improve understanding of and experience with novel materials that have a weak identity by adopting different approaches—e.g., bio-based, bio-fabricated or waste-based materials are still at a proof-of-concept stage (Rognoli, Salvia, and Levi 2011; Veelaert et al. 2020; Du Bois

et al. 2021; Confente, Scarpi, and Russo 2020; Karana 2012).

Furthermore, recent research has highlighted a gap in the literature regarding how these materials can be presented to a broader audience (D’Olivo and Karana 2021). Therefore, this issue is timely and of interest to the practice of design from different points of view. As an example of the concept of identity associated with the material it is crucial to consider that it took humans almost 100 years to have a shared, recognizable, and acceptable idea of plastic derived from petroleum and manufactured into a previously unknown synthetic material. The design practice was fundamental for creating the identity of oil-based plastics: the identity emerged through studying the essential traits and improving the material experience connected to them (Bijker 1995; Rognoli and Santulli 2014; Manzini and Petrillo 1991). The significant characteristics of plastic’s identity that have achieved acceptance and broad applications are mainly connected to its “mutant and versatile” character—such biological associations are based on the material’s ability to mutate in shape, texture, and color due to its biological nature. However, ignoring several fundamental features of plastic materials has overshadowed some aspects that today, with hindsight, have become problematic, most notably its end of life. In studies of material culture within the social sciences, especially anthropology and sociology, the concept of the “object biography” has been defined as an analytical process that examines the life history of an artifact to “address how the social interactions that they involve people and objects create meaning” and to understand how these meanings change and are renegotiated through the life of an object (Gosden and Marshall 1999). Such a biography may include information on the genealogy of an object or its manufacture, use, possession, exchange, alteration, movement, and destruction or storage as obtained from a wide variety of sources. The concept of “object biography” relates to the notion of “product biography.” The notion of “product biography” as advanced by Gregson et al. (2010) is helpful for this conceptualization. The authors suggest defining products not as standalone creations but as “assemblages of materials that are stabilised and then transformed by consumers” (see also Spring and Araujo 2017). This notion of “product biography” encourages reflection on the nature of products, including their role and identity, which tend to be more relevant in a circular economy where materials and products “undergo refurbishment, remanufacturing, dismantling, re-use and recycling, and being subject to new forms of valuation and exchange” and cannot remain anonymous and stable



Figure 2. Material-identity card example showing material-biography categories applied to a material case.

in user experiences in contrast to a linear take-make-dispose model (Spring and Araujo 2017). They, too, become worthy of scrutiny in choice, care during use, and responsibility at the end of life.

In addition, the circular economy literature offers critical insights into individual biographical qualities of materials and leads to the conceptualization of a taxonomy to better frame them in a material-identity card (Figure 2). Two propositions have emerged at the material level for operationalizing important aspects of circular economy principles: “material passport” and “material narratives” or storytelling.

Thomas Rau and Sabine Oberhuber, in their book *Material Matters* (2019), highlight the importance of a “material passport” for the sustainable management of material flows in circular economies, facilitating materials-life extension while keeping their maximum value for as long as possible. They suggest that the collection of data on the material is helpful to have a picture of the physical reality: the material passport that they designed in 2011 records an accurate inventory of all the materials, components, and raw sources used in a product or building, along with information on their location. For them, each identity gives the object/material to which it is connected “a significant, unique, and unrepeatable character... suggesting the idea that it is something that must not be lost and that must be protected.” This is another example of how biographical information can positively contribute to the sustainable management of materials. However, because this is a novel proposition there is not yet an agreed-upon standard determining the requirements for material passports. Importantly, the recent *Proposal for Ecodesign for Sustainable Products Regulation* (EC 2022) released at the end of March 2022 also includes a recommendation to create a digital product passport to electronically register, process, and share product-related information

among supply-chain businesses, governmental authorities, and consumers.⁴²

Also important is the concept of material narratives which is based on storytelling techniques and is critical for materials acceptance (Machgeels 2018; Lambert and Speed 2017). It is used to enable designers, companies, and users to understand the materials before they experience them, given that often material samples are not readily available.

We endorse the concept of a “materials biography” to bring the notion of an “object biography” or “product biography” to the material level and for it to be used as a valuable tool to derive categories of materials biographies, therefore fostering broader and quicker acceptance and application of more sustainable materials in the fashion sector.

While the material passport focuses on traceable data about materials and the material narratives concentrate on communication as a marketing tool, the concept of “materials biography” relies on five material-biography categories that we deem to be more relevant during the early stages of material development. The categories serve primarily as a first acknowledgement of the material origin and main characteristics which we argue are unique to each new material: life cycle, temporality, origin, process, and identity (each of these items is explained in greater detail below). These categories can be explored when developing awareness of these novel materials, especially bio-based and bio-fabricated materials for the fashion industry.

Although we described the pervasiveness of bio-materials earlier in this article, most of the materials reported here are new, and still unfamiliar to the consumer. Therefore, these materials require stronger identities to help shape and develop users’ perception of their value, quality, durability, and desirability. Still, it is critical to acknowledge that storytelling is a central marketing tool in the

“content economy,” that is an economic system where people and organizations produce, distribute, exchange, and consume digital content products and services, as a result of the Internet and Internet-based technologies (González-Romo, García-Medina, and Romero 2017). Because the materials are still in their very early stages of entering the market, all information is attributable to the communication efforts coming from material-manufacturing companies, fashion brands, and their collaborators.

During the course of conducting the current study, we came to realize that the information about many material cases was inconsistent, leaving many blank spaces in the original spreadsheet (Table 1) and making it more challenging to compare materials and discuss them in common groups or categories. It was particularly the case when dealing with information about material production, the current readiness status of products, and their end of life. We could likely have predicted that this would be the case given that most of these materials are at different stages of production and that, even under patents, companies in these phases are generally very vague about the details of their products. We found that even designers and companies who had not yet registered their products were keen to protect their intellectual property and this situation contributed to a lack of detailed technical information. At the same time, companies often compensate for this dearth of data by relying on storytelling to communicate about the properties and potential applications for their materials. As a result, both researchers and users seeking to understand these materials rely primarily on corporate marketing, trying to understand the characteristics of the materials that are, at this stage, often inaccessible in their physical form.

Given the importance of the concept of materials biography, both for the framing of the still undefined identity of novel materials and for understanding their main characteristics and sustainability performance, we further describe the five materials-biography categories previously mentioned to create new biographies for recent bio-based and bio-fabricated materials for the fashion industry.

Material-biography categories

As outlined above, we identify five material-biography categories to describe the nature and history of these innovative materials. At the moment, these categories do not fit with standardized approaches for presenting material information in products, particularly in terms of what is normally included on product labels. There is thus considerable potential to offer users additional relevant details to

Table 2. Material-biography categories.

Material-biography category	Material characteristics or quality highlighted from cases
Life cycle	Livingness, future cycles, end of life
Temporality	Growth rate, durability/degradation
Origin	Crop-based, biomass or waste-based, a biotech-based (organism)
Process	Techniques utilized, social and environmental impact
Identity	Completely novel, mimicking/substitute

support the current information provided in clothing labels (such as care instructions). This type of passport could be a way to improve transparency and to provide further material clarification of aspects that are still unknown, for example in terms of durability. The regulation of these categories could help producers, designers, and users to understand and care more effectively for these materials. There is ample room for furthering the design research around these first five categories (summed up in Table 2 and explained in further detail in the following section) and the concept of materials biography. Such investigations create opportunities to reflect on how we could communicate differently around conventional materials, including the new bio-based ones. Therefore, the categories provide a framework to rethink how to present the qualities and potentialities of materials.

Life Cycle

As outlined earlier, understanding the life cycle of products and materials is a fundamental aspect of a designer’s environmental awareness. We have highlighted in this article how the life cycle becomes a key point of company strategies in the current discourse around biomaterials for fashion.

In a circular economy, the possibility and desirability of engaging with transparency and traceability as well as provenance and design has enabled materials to regain space and become foregrounded in experiences of users. As a material-biography category, these notions can inform the user on the state of the material (inert or still living) and on fundamental aspects that should be considered for its application in sustainable projects, for instance its renewability and end-of-life disposability.

Temporality

Notions about the growth rate and durability of materials are emphasized in the communications of our case studies. In other classes of materials, temporality begins when the material is applied to a product. Instead, in the cases of bio-based and bio-fabricated materials, temporality is considered from the beginning of a product’s life cycle (i.e., when

conceived and developed). We observed through the cases that this category is frequently mentioned in the narratives around materials, although it is still abstract to the general public, especially given the novelty of these materials.

Origin

Origin is the most relevant element in the material narratives of the cases. In the textiles area, the practice of grouping and categorizing materials is common so it is not unusual to have “origin” named as a material category. Although this is a customary practice, it tends to be overlaid in the narratives. Whether a material is crop-based, biomass, waste-based, or biotechnology-based (organism), its origin becomes a critical starting point for bringing users into the stories of the materials. The link to places of origin proved so strong in our cases that it was often difficult to distinguish between the name of the company and the name of the material, which is usually a derivative from the material-source name. Some examples are materials that come from mycelium, the majority having names starting with “My” (as MycoTEX or Mylo), or similarly all the plant-based materials are directly related to the source (as seen in Piñatex or Bananatex).⁴³ In fact, a recent study on the communication of bio-fabricated materials pointed out the different wording and imagery that companies use to create the sense of the “original habitat” where the organisms come from and some of the processes that enable their transformation into usable material (D’Olivo and Karana 2021). In fact, these are instructive insights in helping people imagine these organisms and processes that are still mostly unknown or unfamiliar to them.

Process

By “process” we mean the technologies and practices with which materials are developed, worked, and transformed. In this context, processes are not only applying the material to a product but also, and above all, concern the experimentation and development of the material itself. There are different ways where the understanding of processes appears relevant to our cases. First, the notion of process is apparent in references to how these materials are derived from a collaborative process between nature, humans, and technology. They are generally created with a specific function and certain sustainability criteria in mind. Second, the cases emphasize, an issue that we discussed above, that the boundaries between material production and application are blurred, with designers starting to interact with the making of the materials. These modes of

experimenting and tinkering make the creation and development processes of these materials more visible. As the socio-environmental impacts of the fashion industry become more compelling, this feature, besides facilitating transparency, will create more opportunities for users to understand and potentially be involved in these processes. Finally, users rarely experience these materials in the initial instance in their physical form. Rather, the first points of contact are virtual—via images, recipes, stories—and mediated in the digital environment. This is because these materials are not yet widely available in samples or product applications. Accordingly, the communication around processes helps build a relationship between users and these materials, creates the space for them to enter people’s lives, and forges the contexts for their experience.

Identity

The lack of physical experience presents yet another challenge for bio-based and bio-fabricated materials in the fashion sector concerning identity (Rognoli et al. 2011), namely what they are and their perceived and experiential qualities. Being unfamiliar to most people, many of these materials are often commercially introduced as substitutes for current less sustainable materials. Mimicking the properties of existing materials, but with added functionality and sustainability-related qualities, is a common objective in many of the cases that we observed. This insight emerged above and is described in Table 1. In a smaller number of cases, we noticed that materials are introduced as unique and innovative, presenting opportunities for innovative applications and encouraging practices to emerge around them. An important consideration is how to balance phasing out less sustainable materials and enabling new practices to emerge with these bio-based materials and their unique qualities. For the latter, it is crucial to encourage and nurture tinkering practices and experimentation with materials to reveal their unique potential (Rognoli and Parisi 2021; Barati and Karana 2019; Parisi et al. 2017).

Discussion

To facilitate and speed up the development and adoption of bio-based and bio-fabricated materials in the field of fashion (and perhaps also in other fields), it is necessary to disseminate the associated knowledge to the public, companies, and designers. With respect to designers who want to experiment with these materials and adopt a DIY approach (including tinkering with the materials and then

developing meaningful material experiences), they must intimately know the history of these materials and understand the salient features of their composition. This article has sought to establish a foundation for constructing a repository that emphasizes information related to the biography of these materials and to demonstrate how their unique characteristics differ from traditional alternatives in accordance with material-biography categories.

Given the environmental problems that derive from the fashion sector, it is mandatory to consider new material solutions. Talking about bio-based and bio-fabricated materials is essential. These materials are inspiring a new generation of designers and many of them have emerged by developing experimental practices. However, while the expectation is that new biomaterials will enhance sustainability performance, there is a lack of research that is independent from the manufacturing companies to assess their impacts, especially at scale. As noted above, there is currently a lack of transparency concerning the technical aspects of these materials due to concerns about protecting the intellectual property around the production technologies. We are hopeful that as they enter the market and become more accessible, additional information will be made available to both academic and industrial audiences. From a social standpoint, especially in the case of plant-based materials derived from cellulose extraction, it is important to recognize that reproducing old extractivist models solely focused on supplies of raw materials, as currently takes place in countries of the global South, may not be a sustainable solution despite the ostensibly desirable features of the resultant material. Sustainability efforts would also benefit from further studies measuring the impact of scaled production, gathering data not only on the environmental effects of particular materials, but also their social impacts, especially with respect to the consequences for local artisan and textile communities that have traditionally worked with the same fibers.

Recent experiences concerning bio-based and bio-fabricated materials are biased by the fact that the objective is for many of them to replace other existing counterparts and to mirror many of their qualities. While we recognize the importance of this intentionality to produce alternatives to either animal leather or oil-based fabrics, this focus overlooks the potentials of many of these new materials that are unique or inherent to each organism (Barati and Karana 2019) including liveliness, affectability, and responsiveness. These characteristics are likely to be much more extensively explored and articulated by independent designers and artists who, through their practice, are apt to develop a closer relationship with the materials. Our examination of the communication copy from the established

companies with trademarked materials prompts us to conclude that their apparent strategy is to appeal to the nostalgia of consumers based on their familiarity with customary materials (the ones they are trying to mimic) and to use this feature as the basis for establishing trust (“this will feel like real leather or rubber”) rather than describing the characteristics of the material itself. When companies present the new material, the focus is on storytelling, creating a narrative around the sustainable intentions of developing the technology, using technical descriptors and imagery such as laboratory equipment.

Future research on bio-fabricated materials could take a similar approach that focuses on their experiential qualities and moves beyond initial material-mimicking intentions. We argue that nourishing and supporting artistic sensibilities and DIY approaches is fundamental in allowing these material developments to flourish. Additionally, many regenerated or synthetic fibers were developed to imitate natural fibers and the implications of overlooking their unique material properties and potential impacts have been extremely unfortunate.

This study suggests that a greater understanding of these communication and marketing strategies could assist both users and other stakeholders to further explore the innovative potentials of these materials, hasten their transition to the market, and reduce the environmental burden of the fashion industry. Materials biography-based tools such as the materials-identity card could become helpful instruments to compare case studies and to promote newly developed products. At the same time, we are confident that these categories can be expanded and recognize the need to gather more data about the social and environmental impacts of these new materials.

Conclusion

This article has focused on building a panorama of possible alternative bio-based and bio-fabricated materials to support a lasting and effective transition toward more sustainable fashion. It has provided a comprehensive analysis of the most pressing socio-environmental challenges facing the industry and offered a comprehensive picture of the current actions being undertaken by governments, industry, and designers to transition to more sustainable practices. We also summarized previous literature on how the concept of the materials experience and the DIY Materials approach could positively contribute to the proliferation of alternative and sustainable materials with particular attention devoted to applications pertaining to fashion design.

We furthermore presented 24 cases of bio-based and bio-fabricated materials, grouped according to

their origin and provided details on both the origin and potentials of these emerging materials. The aim here was to raise awareness of the benefits of societal acceptance and to support the design community with new tools to understand and apply these novel materials in the fashion industry to achieve more sustainable results. We also introduced the concept of materials biographies to highlight categories that can be explored by designers, companies, and end-users in introducing these materials. The analysis of cases was fundamental for building the materials-biography categories which can facilitate understanding of the prominent narratives of these new materials, communicating their characteristics and fundamental life traits, namely, life cycle, temporality, origin, process, and identity. These material-biography categories were elaborated by drawing on the circular economy concepts of a material passport and a product biography which emphasize the need for tools to enhance the communication and traceability of such innovative materials.

Notes

1. See <https://www.greenpeace.org/international/act/detox>
2. Sustainable Fashion Summit, ECOSOC Chamber, Friday, 1 February 2019, H. E. Ambassador Inga Rhonda King, President of the United Nations Economic and Social Council. See <http://www.un.org/ecosoc/sites/www.un.org.ecosoc/files/files/en/president/2019/remarks-ecosoc-president-sustainable-fashion-summit-01-feb-2019.pdf>
3. It has been estimated that around half a million tons of microfiber, which is the equivalent of 3 million barrels of oil, is now being dumped into the oceans every year. See <https://news.un.org/en/story/2019/03/1035161>.
4. See <https://unctad.org>.
5. See [https://www.europarl.europa.eu/RegData/etudes/ATAG/2020/656296/EPRS_ATA\(2020\)656296_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/ATAG/2020/656296/EPRS_ATA(2020)656296_EN.pdf)
6. See <https://bangladeshaccord.org>.
7. See <https://www.eea.europa.eu/publications/textiles-in-europes-circular-economy>.
8. See <https://www.circle-economy.com/news/our-world-is-now-only-8-6-circular>.
9. See <https://cfda.com/resources/sustainability-resources>.
10. See <https://apparelcoalition.org/higg-product-tools>.
11. See <https://www.greenstrategy.se/sustainable-fashion-seven-forms-of-sustainable-fashion>.
12. See <https://www.lvmh.com>.
13. See <https://taukodesign.com/pages/textile-recycling>
14. See <https://rapanuclothing.com>.
15. See <https://group.ferragamo.com/en/news/2017/orange+fiber>.
16. See <https://resortecs.com>.
17. See <https://fashionchecker.org>.
18. See <https://cleanclothes.org/fashions-problems>.
19. See <https://knownsupply.com>.
20. See <https://www.instagram.com/marchenoirlomeparis/?hl=it>.
21. See <https://www.re-pearls.com/post/a-day-in-the-life-of-a-textile-designer>.
22. See <https://www.modernmeadow.com>.
23. The Materials Driven Design (MDD) method supports design for meaningful material applications with the material as a point of departure. Designers quality the materials not only for what they are, but also for what they do, what they elicit from us, what they express to us, and what they make us do. The process comprises four main action steps, starts with a material (or a material proposal), and ends with a product and/or further development of materials. See <http://materialexperience.com/material-driven-design-method-mdd>.
24. The DIY movement is expanding beyond artifacts to include the materials from which products are made, namely DIY-Materials. DIY-Materials are created through individual or collective self-production experiences, often by techniques and processes of the designer's own invention, as a result of a process of tinkering with materials. They can be new materials with creative use or other substances as material ingredients, or they can be modified or further developed versions of existing materials. Designers from all over the world are engaged in various experimental journeys in the field of material development, and they consider these experiments as the starting point of their design process which will lead to the creation of new artifacts. The possibility to self-produce their own materials provides designers with a unique tool to combine unusual languages and innovative design solutions with authentic and meaningful materials experiences.
25. See <https://www.vegeacompany.com/> and <https://orangefiber.it/it>.
26. See <https://www.ecovative.com>, <https://mogu.bio>, <https://www.mycoworks.com>, and <https://www.modernmeadow.com>.
27. See <http://www.newstatesman.com/spotlight/emerging-technologies/2020/07/biomanufacturing-path-sustainable-economic-recovery>.
28. See <https://malai.eco>.
29. See <https://www.pili.bio>, <https://colorifix.com>, and <https://www.ginkgobioworks.com>.
30. See <https://bolthead.com/technology/microsilks>.
31. See <https://www.zoamaterials.com/zi>.
32. See <https://www.algiknit.com>.
33. See <https://www.vollebak.com/product/plant-and-algae-t-shirt>.
34. See <https://www.dezeen.com/2014/10/14/blond-and-bieber-algaemy-coloured-dye-algae-lodz-design-festival-2014>.
35. See <https://ecovativedesign.com/mycoflex>.
36. See <https://www.kickstarter.com/projects/boltprojects/the-mylo-driver-bag>.
37. See <https://www.mylo-unleather.com>, <https://www.adidas.co.uk/blog/663481-stan-smith-mylo-tm-made-using-mushrooms>, <https://www.mylo-unleather.com/stories/stella-mccartney-debuts-a-mylo-bustier-top-and-trouser-set/>
38. See <http://pura.mogu.bio/project/pural-materials>.
39. See <https://www.ananas-anam.com>.
40. See <https://www.allbirds.co.uk/pages/our-materials-sugar>.
41. See <https://www.braskem.com.br>.
42. See https://ec.europa.eu/environment/publications/proposal-ecodesign-sustainable-products-regulation_en.

43. See https://ec.europa.eu/environment/publications/proposal-ecodesign-sustainable-products-regulation_en.

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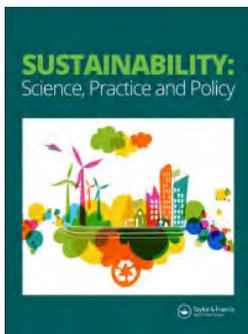
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Recycling technologies for enabling sustainability transitions of the fashion industry: status quo and avenues for increasing post-consumer waste recycling

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ABSTRACT

A major environmental issue of the rise in garment production is a steep increase of textile waste. At the same time, recycling technologies appear to be promising avenues for sustainability transitions of the fashion industry. This article examines the chances and challenges of scaling recycling technologies for textiles and considers the collection and sorting processes as well as the actual reuse. Drawing on case studies and expert interviews, the results indicate current obstacles and opportunities for accelerating diffusion of recycling technologies. Various initiatives are promising, however industry structures, garment designs, and business models need to be re-orientated and re-aligned to accelerate these recycling concepts. Applying the greenwashing notion that acknowledges co-creation by producers and consumers, the article critically argues that the focus on recycled polyester bottles for garments distorts incentives to improve other recycling technologies and masks the true cost of textile-waste recycling. Instead, fashion-brand companies and retailers should leverage their market power to foster sustainability standards in the global recycling industry.

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Introduction

The sizeable increase in garment production over the last decades has generated several benefits in terms of social and economic sustainability. The benefits include economic growth and employment opportunities in low- and middle-income countries, raising the income of many households (Mottaleb and Kalirajan 2014; Uddin 2014; Olds 2009) and expanding availability of affordable garments for low-income households (Taplin 2014). The vast growth, however, has brought enormous negative impacts for the environment and also considerable social costs (Niinimäki et al. 2020). The quest for better environmental practices along the whole life cycle from fiber production to garment disposal and higher labor standards, including living wages and adequate health and safety measures, attests to the downsides of these developments (Biadgo et al. 2021; Steinisch et al. 2013; Peters, Li, and Lenzen 2021).

Transforming the textile and garment sector toward a full-spectrum approach to sustainability will require phasing out and substituting unsustainable manufacturing practices. Among the

environmental issues, with increasing fashion consumption on a global scale, textile waste is becoming a particularly difficult and growing problem (Sandin and Peters 2018; Shirvanimoghaddam et al. 2020). This challenge includes industrial waste such as fibers, yarn, fabric, garment remnants, unsold stock from rejects and overproduction, and post-consumer waste of worn garments. Sustainability transformation as a deliberate socio-technical transition entails both social transformation and technical innovation as well as broad diffusion of sustainable solutions (O'Brien 2018; Geels 2019). While global fiber production has almost tripled from 1975 to 2018 (EEA 2021), many European brands doubled their fashion release from 2001 to 2011 (Remy, Speelman, and Swartz 2016). At the same time, clothing prices dropped in Europe by approximately 30% when corrected for inflation and European textile consumption is estimated to be 26 kilograms (kg) per person (EEA 2021). The COVID-19 pandemic lowered fashion consumption only in its early stages, with brands responding with heavy discounts and purchase incentives that in due course drove sales back up again (Brydges, Retamal, and Hanlon 2020; Dowsett 2020).

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Garments fulfill several functions beyond protecting bodies from the environment. Fashion, in particular, serves to express status and identity (Crane 2000). The fashion industry is built to continuously reinvent and to provide an increasing number of products (Taplin 2014). With slowly reducing poverty worldwide (UNDP and OPHI 2020), and with ethical fashion, slow fashion, and reduced consumption in fashion being only niche phenomena confined mainly to industrialized countries (Joergens 2006; Vladimirova 2021), we can expect a continuing increase in garment production and consumption accompanied by an increase in textile waste in coming decades.

A promising approach for tackling textile waste is recycling. This includes mechanical recycling but also chemical and novel biological recycling technologies of blended fiber-textile products (Navone et al. 2020; Sanchis-Sebastiá et al. 2021; Sandin and Peters 2018). The objective of this article is to contribute to an understanding of the status quo and prospects of recycling for sustainability transitions in the fashion industry by posing the following questions: What are the challenges and chances to increase recycling of garment waste considering the whole process from collecting to actual recycling? Considering the role of consumers, fashion businesses, and collecting and sorting companies, the findings identify specific issues associated with recycling approaches along each stage of the value chain.

The history of technology provides many examples of innovation that aimed to solve one environmental problem and ended up creating another, or came with unexpected and undesirable side effects. A prominent example is the cultivation of agricultural crops for renewable biofuels that adversely impair biodiversity and wildlife (Jager and Kreig 2018). Another instance is sharing-economy concepts such as shared use of automobiles. Instead of reducing overall car dependency, there are indications that the practice leads to additive consumption, discouraging users from more sustainable transportation modes such as bicycles and public transport (Amatuni et al. 2020). Accordingly, this article aims to provide a critical view that also focuses on the drawbacks and downsides of some practices in the fashion- and textile-recycling sector and investigates whether some practices may be little more than greenwashing.

The concepts of circular economy and, in particular, the related notions of closed and open loops, waste streams and recycling, and greenwashing as a co-produced process among fashion brands and consumers are the main concepts used in the analytical part of this article. The study complements a

thorough process of desk research on recycling with qualitative and empirical research: case studies of businesses that conduct recycling of worn garments and expert interviews. The desk research and analysis drew mainly on information and other data pertaining to the textile-waste and recycling situation in Europe. However, the recycling industry is globalized due to used clothes exports for sorting and for secondhand markets. The insights from case studies and expert interviews with representatives of European business and research institutes confirm how the recycling business is part of global value chains. Accordingly, the findings are also relevant to some extent to recycling industries outside of Europe.

Recycling as a circular economy avenue for sustainability transitions of the fashion industry

With non-governmental organizations (NGOs) such as the Ellen McArthur Foundation claiming the fashion industry to be a highly polluting industrial sector (e.g., EMF 2017), many top-down initiatives from policy and bottom-up from industry and NGOs have started over the last two decades to trigger sustainability transitions. Policies have focused on supply-chain responsibility, environmental issues, and waste treatment; notable examples are the European Union's (EU) waste directive that requires member states to collect textile waste as a separate waste stream starting in 2025 and the Circular Economy Action Plan to increase reuse, recycling, and circular design (Jacometti 2019). In addition, industry and NGOs have developed certification systems to create and demonstrate sustainable supply chains (including codes of conduct), formulated plans to reduce overproduction, and launched efforts to improve design for longevity and recyclability (e.g., Brydges, Retamal, and Hanlon 2020; Vladimirova 2021). A promising approach is the extension of the length of the use phase of garments (RISE 2019). However, a longer use phase still does not address the problem of the growing amount of textile waste from overproduction and increasing consumption. Accordingly, politicians and industry representatives consider recycling to be an important part of sustainability transitions of the fashion industry (Sandin and Peters 2018).

A concept with increasing popularity to govern sustainability transitions on a policy and on a firm level is the circular economy (EEA 2021; EMF 2017; van Bahr et al. 2019). After a short introduction to waste streams and recycling processes, this article turns its attention to how circular economy approaches can contribute to converting waste into

new resources through different recycling methods. To provide the basis of a critical view on recycling, the concept of greenwashing as a co-creation process is described.

Types of waste and recycling in the fashion industry

In Europe, the overflowing garment-collection containers during the COVID-19 pandemic brought the textile-waste issue to public attention. Donations increased tremendously, while charity shops could not open to resell secondhand garments (Wearn 2021). The situation also revealed the global interconnectedness of textile-waste streams. Shipments from Europe to African and Asian countries paused during the pandemic, leaving collectors with increased warehouse costs (Bauck 2020).

Textile waste from the fashion industry can be categorized into industrial waste, pre-consumer waste, and post-consumer waste (Wang 2006). First, industrial waste occurs during manufacturing of fibers, yarns, fabrics, and garments. This includes fibers unsuitable for yarns due to length or coarseness, remnants, trimmings, and cutoffs during fabric and garment processing, as well as scraps associated with unmet quality standards. The fiber composition, processing chemicals, dyes, and finishes of industrial waste are usually known, which makes it a better fit for recycling.

Second, pre-consumer waste includes unsold stock and returns in stationary and online sales. Some industry specialists consider unsold stock and returns to also be an industrial waste as the fashion industry is responsible for accurate disposal. According to the EU waste directive (EC 2018), waste should be avoided by any means and can only be discarded in landfills when the products cannot be used anymore. However, according to the German Federal Ministry of Environment, accurate figures on the amount of unsold stock and returns and the type of disposal of these garments are not known in Europe, as brands do not provide these kinds of information (GFME 2019). The garments often contain multi-fiber compositions, prints, buttons, zippers, and trimmings. Outdoor apparel may contain waterproof membranes, coatings, and water repellents. In some countries, products such as curtains and baby clothes, flame-retardant finishes are required (Figure 1).

Finally, post-consumer textile waste contains worn garments and household textiles. These items end up in domestic trash bins or get donated. As used textiles are not considered hazardous waste with special waste-treatment requirements, they are typically not collected by municipalities but by

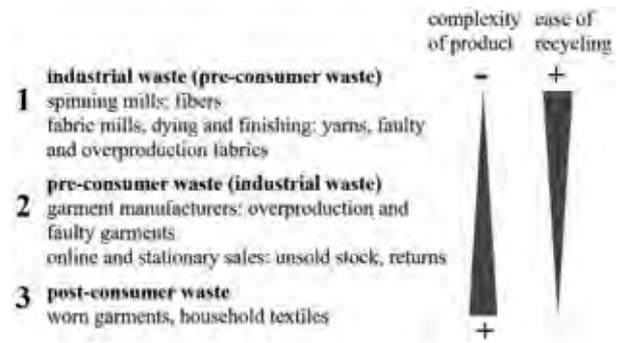


Figure 1. Waste categories in the fashion industry and ease of recyclability.

private firms and charities (Weber, Lynes, and Young 2017). In the EU, consumers discard about 11 kg of textile waste per person per year (EEA 2021). The majority of these materials are incinerated or end up in landfills. A smaller percentage is resold as secondhand garments in Europe or shipped to other countries and sold on secondhand markets. Recent figures show that the EU exported about 1.5 million tons of worn clothing to Asian and African countries in 2018 (Manshoven et al. 2019). Secondhand clothes are also critically discussed by politicians, economists, and NGO representatives. They argue that the large amounts of used clothes that arrive at Asian and African secondhand markets undermine local garment industries (Brooks and Simon 2012).

Only a few countries, such as Germany, have structured textile-waste collection and recycling facilities (Manshoven et al. 2019). Shirvanimoghaddam et al. (2020) estimate that worldwide two-thirds of this material is disposed in landfills and only 15% of textile waste – including pre-consumer and industrial waste – is recycled. Another part of the textile-waste stream gets incinerated in cogeneration facilities used to produce electricity or heat (Schmidt et al. 2016). As synthetic fabrics involve the use of crude oil as a constituent of their manufacture, their properties for energy generation (namely their limiting oxygen index) is better than brown coal that continues to be widely used in some parts of Europe and elsewhere. Although thermal recovery is sometimes included in recycling, in this article it is not considered in recycling methods for textile waste.

The textile waste that gets recycled is usually industrial waste and to a smaller extent post-consumer, domestic waste. Recycling methods are usually distinguished according to the type of process: mechanical, thermal-mechanical, chemical, and biological (Chavan 2014; Robinson 2020). First, mechanical recycling is the most important textile-recycling treatment in terms of quantities. It is also the preprocess for the other three recycling

Table 1. Recycling technologies in the textile industry.

Recycling technologies	Product examples	Advantages	Limitations
Thermal recycling	Energy, heat	No fiber sorting, suitable for all types of waste	Using exhaust-gas treatment, only synthetics have good limiting oxygen index Destroys resources for new garments
Mechanical recycling	Wiping rags, yarns for new fabrics, fabric strips for blankets Nonwovens for insulation mats	All fibers and fiber mixtures Processes readily established Closed and open-loop recycling	Mechanical cutting and ripping of textiles may deteriorate fiber properties High-quality yarns require additional virgin fibers
Thermal-mechanical recycling	Polyester yarns out of Polyester bottles	High-quality fibers and yarns similar to virgin polyester fibers Open-loop recycling	Homogenous fiber inputs Better suited for industrial waste Only few industry-scale processes worldwide
Chemical recycling using chemicals to break up fibers	Cellulosic oligomers and polymers out of worn cotton and other cellulosic fibers, polyester monomers, oligomers out of polyester	High-quality fibers and yarns equivalent to virgin fibers Suitable for closed-loop recycling	Homogenous fiber inputs Better suited for industrial waste Only few industry-scale processes worldwide
Biological recycling using enzymes to break up fibers	Cellulosic oligomers and polymers out of cotton and other cellulosic fibers, polyester monomers, oligomers out of polyester	High-quality fibers and yarns equivalent to virgin fibers Suitable for closed-loop recycling	Homogenous fiber inputs, Better suited for industrial waste Only on laboratory-scale available

technologies. While some researchers (see, e.g., Sandin and Peters 2018) prefer classifications based on the level of disassembly of the recovered material, the distinction according to recycling method is insightful as it reflects the different phases of technological and industry development and the current state of industrial application of these recycling processes (Table 1).

Mechanical recycling is as old as garments because producing new fibers and yarns was traditionally more time consuming than recycling existing textiles. For example, during the late Middle Ages cotton waste became so valuable for paper manufacturing as book printing increased that governments imposed bans on textile-waste exports and cotton cloth became a profitable trafficked good (Craig 2019). As new fiber production became over the centuries more expensive than recycling, mechanical recycling came to be established all over the world and has been continuously improved to efficiently generate fibers for non-wovens and for new fabrics. This development started to slow down with the increase of affordable synthetic fibers in the 1990s.

A typical mechanical recycling product is wiping rags, which are fabric squares cut from mainly cellulosic fibers. The price for wiping rags is higher than reselling used cloth for secondhand markets, but the processing of worn clothes into squares is labor intensive and thus rarely done in high-income countries (Piribauer and Bartl 2019). Other mechanical recycling processes include fiber recovery which involves disentangling the fibers from fabrics through cutting, ripping, and carding. As the fiber properties deteriorate due to the harsh treatment, only about 5% gets used for new yarns in

combination with virgin fibers for new wovens and knits for garment and the majority gets processed into non-wovens (Palme 2017; Wang 2006).

Second, thermal-mechanical recycling refers to processing fibers into granulate for melt spinning. This is only possible for synthetic fibers which can be extruded through this technique. As fibers from the garment industry are often contaminated with additives such as pigments, ultraviolet stabilizers, and flame retardants, the industrial manufacturing of recycled polyester draws mainly on polyester bottles from food packaging as raw material (Chavan 2014; Sandin and Peters 2018). Many brands such as Adidas and H&M are committed to fully replacing virgin polyester with recycled polyester (rPET or recycled polyethylene terephthalate) over the next few years. Accordingly, they strongly advertise the use of rPET which is usually made from used plastic bottles from the food industry as they contain significantly less foreign additives and pigments than polyester garments (Bussé and Van Kruijsdijk 2019; Piribauer and Bartl 2019). While the majority of bottles and other plastic packaging is locally recycled – countries such as Norway, Sweden, Japan, and India achieve recycling rates of more than 80% (Tiseo 2020) – the majority of PET fiber-manufacturing plants are based in China which has a low national recycling rate and banned imports of plastic waste (d'Ambrières 2019).

Third, chemical recycling is possible for both cellulosic fibers such as cotton and viscose and synthetic fibers like polyester. This recycling method breaks down fibers into polymers, oligomers, and monomers which are then used as feedstock for new human-made fibers (Robinson 2020; Sanchis-Sebastiá et al. 2021; Wang 2006). An example of

chemical recycling of cellulosic fibers is the Refibra[®] technology from the Austrian company Lenzing, which uses a certain percentage of industrial waste cotton as feedstock (Palme 2017). Chemical recycling of polyester has been done on an industrial scale for more than a decade by the Japanese company Teijin (Teijin Frontier, Ltd 2021). The Swedish start-up Renew:cell recycles cotton-polyester blends (Renewcell 2021). Chemical recycling is less widespread due to its higher investment costs, skill requirements, and processing costs. The low cost for virgin fibers especially has to date made chemical recycling of polyester on an industrial scale less attractive (Kumar and Joshiba 2020).

Finally, a novel method for handling certain fabrics is biological recycling. Similar to chemical recycling, the fibers are broken down into short polymers, oligomers, and monomers (Navone et al. 2020). The cellulosic fibers are processed with cellulase enzymes and synthetics with enzymes that can hydrolyze the synthetic fibers (Piribauer and Bartl 2019). At present, biological recycling is still only operationalized on a laboratory scale and industrial applications remain to be developed in the future.

Circular economy: open- and closed-loop recycling

Politicians, NGO representatives, and scientists alike consider circular economy business models to be a key element for sustainability transitions of the fashion industry (van Bahr et al. 2019; Pal 2017). Circular economy approaches call for the 6Rs: reduce, redesign, reuse, recover, remanufacture, and recycle (Malek and Desai 2019) for addressing the environmental impact of the production and disposal of fashion items. The current collection and recycling systems are limited to reducing the production of new items by the reuse of used clothes through secondhand markets and to recycle new garments and other textile products.

Circular economy recycling concepts can be designed as closed loops or open loops. The notion of a closed loop refers to processes in which materials are kept in a loop for applications involving the same products (Palme 2017). An example is the recycling of polyester workwear by Teijin that produces new polyester fibers for the garment industry (Teijin Frontier, Ltd 2021). Other examples from the fashion industry include cotton-denim trousers which can be returned to fashion enterprises that then distribute it further to recycling businesses; through mechanical recycling the fibers can be spun into new yarns and woven into new fabrics for denim trousers. Open loop refers to products that are made of materials from other sectors and

products that are recycled for other applications. An example of open-loop recycling is rPET from beverage bottles that are remanufactured into polyester fibers for garments (Park and Kim 2014).

As open-loop recycling can result in less valuable products such as wiping rags or nonwovens for insulation mattings, it is sometimes regarded as a form of downcycling and hence a less attractive alternative (Piribauer and Bartl 2019; Sandin and Peters 2018). But open-loop systems can also incorporate upcycling. Polyester bottles that are upgraded from food packaging to garments are an example of effective upcycling (Palme 2017; Park and Kim 2014).

Greenwashing as co-creation of producers and consumers

The term “greenwashing” was initially coined to refer to practices whereby businesses provide false information about the environmental performance of their products and technologies (Laufer 2003). These dubious activities typically include marketing strategies that aim to improve a company’s ecological appearance through the use of trademarks, certifications, and product names that reference terms such as “green,” “eco,” and “bio.” These claims are not generally legally protected even though trademark law in most European countries prohibits wrong and misleading product information. With the rise of corporate social responsibility (CSR) and sustainability reporting during the 1990s, the term greenwashing was extended to firms that provided erroneous or deceptive information about their sustainability activities (Laufer 2003; Ramus and Montiel 2005). The current understanding of greenwashing judges business communication more strictly by including exaggeration of sustainability activities, vague claims, and misleading imaginaries that suggest environmentally friendly activities to gain market shares and competitive advantage (Dahl 2010; Delmas and Burbano 2011). Accordingly, greenwashing includes clear cases of fraudulent communication as well as subtler, suggestive, and disingenuous information (de Jong et al. 2020).

This conceptualization is challenged by Seele and Gatti (2017) who argue that information can be misinterpreted by consumers and other organizations, especially when business communications contribute to exaggerated expectations by consumers. Seele and Gatti (2017, 239) define greenwashing as “co-creation of an external accusation toward an organization with regard to presenting a misleading green message.” The concept of co-creation is consistent with communication theories that postulate that the meaning of artifacts and concepts cannot be

Table 2. Description of case studies.

Case study	C1	C2	C3
Headquarters location	Europe	Europe	United States
Type of recycling	Mechanical, thermal-mechanical, chemical	Mechanical	Mechanical
Geographical waste stream	Waste input from Europe, North Americas, Asia; processing in Asia and Europe; new products in Europe and North America	Waste input from Europe; processing in Europe and North Africa, new products in Europe and North Africa	Waste input from Europe; mechanical recycling in Europe, new products in North America, Asia, and Europe
Type of business	Large enterprise	Small- and medium-sized enterprise	Small- and medium-sized enterprise

considered without the shaping of the receiver (Torelli, Balluchi, and Lazzini 2020). Accordingly, some accounts of greenwashing may even be unintentional (de Jong et al. 2020). However, the responsibility for accuracy of sustainability claims remains with the sponsoring businesses and should not be imposed on the consumers.

Humanitarian and environmental organizations, NGOs, and others have sharply criticized the fashion industry in recent years for polluting the environment and perpetuating disastrous work conditions including child labor and modern slavery (Clean Cloth Campaign 2021; EMF 2017; Greenpeace 2021). Public attention and industry activities and policies for improving work conditions increased following the tragic accident in Dhaka, Bangladesh in 2013 where 1,134 workers died in the Rana Plaza factory collapse (Ashwin, Kabeer, and Schüßler 2020; Fashion Revolution 2021; Niebank 2018). Consequently, consumers have been turning more and more to sustainable fashion items (Lee et al. 2012) and demonstrating a preference to purchase fashion brands with strong sustainability commitments and for substantiating their own ethical consumer identity (Niinimäki et al. 2020). However, very few fashion consumers have voluntarily changed their purchasing behavior to consuming fewer articles of clothing (Vladimirova 2021).

Given the harsh criticism of the fashion industry and the dilemma of fashion being a key element for consumers' expression of identity, arguably the industry is a cultural domain well fit for the co-creation of greenwashing by businesses and consumers. Applying the concept of co-creation of greenwashing claims to the fashion industry, some consumers evidently want to continue their consumption habits in terms of fashionable items and quantity of purchases. Consumers welcome claims about sustainable products and practices of firms because it provides a way to resolve their own eco-anxieties, but they are reluctant to accept higher prices and less comfortable materials (Joergens 2006; Vladimirova 2021). Accordingly, we can assume that they embrace the sustainability claims of fashion brands and are likely to read them less critically because they benefit from exaggeration of marketing

assertions that enable the guilt-free continuation of problematic consumption habits.

Methods

To investigate the current recycling technologies for various textile-waste streams, I carried out three case studies to collect data through desk research and interviews with business representatives. Applying a targeted sampling strategy, the cases were selected to cover various recycling methods for textile waste and recruited firms needed to have been in business for at least a decade. The desk research was compiled in graphical templates illustrating the development of the businesses, sustainability impact, and the business model including the components of the standard business-model canvas such as value proposition, value delivery, value generation, and value capture (Bocken, Schuit, and Kraaijenhagen 2018). A special focus was devoted to key technologies and relevant intellectual property rights and collaborations. Given the research interest in addressing the growing textile-waste issue of worn garments, all three businesses were selected on the basis that they were active in the recycling of post-consumer waste (Table 2).

For data triangulation (Yin 2018) and to explore the importance and issues around further recycling technologies in-depth, semi-structured expert interviews were conducted (Black and Fennelly 2021). The experts were identified through conferences, reports, publications, and business events. I contacted eighteen people and ten agreed to participate. Five experts were identified from the fashion and recycling industries, three from research institutes, and two from recycling-industry associations. They were asked to share their personal context-specific knowledge instead of providing official company and business-association statements (Bogner, Littig, and Menz 2009). All case-study participants and expert interviewees were granted anonymity and the option to opt-out. The results are anonymized to rule out the identification of businesses and people (Table 3).

The desk-research phase for the case studies and preparation for developing the interview guidelines started in November 2019. The case-research

Table 3. Characterization of interviewed experts.

Experts	Business, business association, research	Knowledge and application: types of recycling	Knowledge and application: geographical coverage
E1	Business: Fashion	Mechanical, thermal-mechanical, chemical	Europe, Asia
E2	Business: Fashion	Mechanical, thermal-mechanical	Europe, Asia
E3	Business: Recycling	Mechanical, thermal-mechanical	Europe, Africa, Asia
E4	Business: Recycling	Mechanical, thermal-mechanical	Europe, Africa
E5	Business: Recycling	Mechanical, chemical	Europe
E6	Business Association	Mechanical, thermal-mechanical	Europe
E7	Business Association	Mechanical, thermal-mechanical, chemical,	Europe
E8	Research Institute	Mechanical, thermal-mechanical, chemical, biological	Europe
E9	Research Institute	Chemical, biological	Europe
E10	Research Institute	Chemical, biological	Europe

interviews and expert interviews were conducted by videoconference or telephone between June 2020 and February 2021. The interviews were recorded, transcribed, and coded using an alternating deductive and inductive approach. The deductive approach used the categories already employed in the interview guidelines such as challenges and opportunities for sustainability specific recycling processes that were based on the literature review. With the inductive process, further categories were developed based on topics and remarks that were brought up by the interviewees.

Results

Following the objective of this article to provide an overview of the status quo and prospects of textile-recycling technologies, the results from the case studies and interviews are presented to correspond with the value chain from collecting to recycling. The coding categories for challenges and opportunities for each step are presented in the following subsections.

Collecting used clothes

The business models differ in terms of which process steps they cover, with some collectors having an integrated sorter. Others are sole collectors that distribute the used clothes further to sorting businesses. Some sorters operate a full or partial mechanical recycling line to process garments. These facilities can include preparation for mechanical recycling, such as removing zippers and buttons and other non-textile attachments. The full mechanical recycling includes cutters to cut garments into small pieces and carding machinery to rip apart and disentangle the fibers out of yarns and fabrics.

To investigate the bottlenecks and opportunities of these different collectors and approaches during the coding of the empirical data two topics crystallized: (1) the revenue streams of professional collectors and sorters and (2) potential increase in

environmental impact when fashion-brand companies and retailers collect garments.

Revenue streams of professional collectors and sorters

The standard business model of textile-waste collectors contains major revenue streams from selling secondhand clothes. The majority of European textile waste is sorted in Eastern European and North African countries. The collected garments get separated into reuse, recycling, and trash. A small percentage of reusable garments is diverted to the market for premium secondhand clothes: luxury and popular brands as well as exceptional fashionable designs and more expensive natural fibers such as wool, linen, and silk in good condition. This clothing gets shipped back to secondhand stores in Europe and these premium fashion items form the most important revenue stream for collectors. Sometimes these desirable items are retained in Europe during a pre-sorting step. The rest – the majority of reusable garments ends up in secondhand markets in African, and to a smaller extent Asian, countries (E7, E8). Garments with stains or holes are sorted for mechanical recycling and sold on to recycling companies where they are processed into wiping rags, strips for rug weaving, and fillings and nonwovens for the building and construction industries and the furniture sector. However, sales to mechanical recycling businesses do not generally generate any significant revenues for collectors as the demand is low compared to the availability (C2, C3, E3, E7).

The interviewees, in particular E3, E4, E6, and E7, described how the current challenge is an overall decline in quality, both in terms of fiber materials and brands. Accompanied by the steep increase in donations due to expanded fashion consumption of lower-quality garments, the amount for resale has declined while the amount for mechanical recycling has increased – a currently less profitable field.

Another issue that is challenging the revenue streams is that some countries have raised taxes for

used-clothing imports or issued complete bans. Notable examples are Nigeria, Tanzania, and Rwanda which have acted to protect local garment industries but also to tackle increased littering involving textile waste. This situation arises from the high quantities; items are sold on secondhand markets but also are informally discarded to the environment or used as fuel for cooking (E5, E6, E8). The interviewees expect that more countries may follow.

The third issue that may disrupt the business model is stricter environmental policies to tackle climate change. Textile-waste collectors expect an increase in shipping costs (E6). Since sorting relies on manual labor, to distinguish resaleable garments from textile waste for recycling, European collectors usually ship the used clothes to lower-wage North African countries for sorting. Accordingly, increased costs for logistics are expected over the next decade, which increases the pressure to either export less or increase other income from textile-waste collection.

A fourth and final problem that challenges the business model of collectors is an increase in online-resale platforms (E7). These websites allow consumers to sort for sizes and brands. Consequently, collectors receive fewer premium garments because consumers sell them online through third-party vendors. Traditional secondhand markets were not generally viewed as under threat as it is not worthwhile for end-use consumers to sell single clothing items and the sale is not targeted at popular brands. The online platforms now compete for premium secondhand clothes.

Take-back systems of fashion brands

Next to the professional collectors and charities, an increasing number of fashion brands have installed take-back systems similar to sellers of consumer electronics, cars, and white goods. This is in line with the waste directive and producer-responsibility directives of many countries that require producers to recover their products at the end of their life and to then organize waste treatment in the most sustainable way. Four different approaches can be distinguished, with fashion businesses using either one of them or a combination: (1) free mail returns to take back used garments, (2) collection of used garments in stores, and (3) donation incentives by providing vouchers for new purchases. Usually, businesses implement these three options in ways that allow consumers to hand back any brand. More upmarket outdoor-clothing brands and ecological brands take a fourth approach that involves (4) purchasing used garments of their own brand and selling them on their online-market platform.

E1 and E2 explained that fashion brands communicate their take-back incentives as part of CSR activities and sustainability reporting as well as a form of advertising to consumers. These programs are also promoted on company websites. Some department stores advertise purchasing vouchers for used clothing donations at special shopping events. C3 highlighted the importance for fashion brands to market sustainability stories. Consumers do not just buy an appealing garment, they purchase a lifestyle promise. Because social media and the Internet have become major marketing platforms, fashion brands are always in search for good sustainability stories to gain the attention of bloggers, influencers, and customers.

According to E1 and E4, the fashion brands and retailers do not implement their own sorting and recycling facilities. They work with large, established sorting and recycling businesses. Only very few and mostly small ecological brands that take back their own products repair and recycle them into new products (C2).

The sorting process: increasing demand and automation technologies

Sorting is a manual process where workers have about 2–3 seconds to decide on the quality of a garment (C2). For some recycling businesses, the clothing gets sorted according to fiber materials; for instance, for some specific applications only cellulosic fibers or synthetic fibers are required. Processing textile waste through mechanical recycling into nonwovens for matting, packing material, and insulation can be done with multi-fiber compositions (E5, E9). Sometimes a pre-sorting step into garments for resale, recycling, and trash is followed by a more detailed sorting into different types of materials for mechanical recycling. As mentioned already, sorting is a labor-intensive manual process and consequently takes place in low-wage countries. It is important for recycling companies to build long-term relationships to guarantee high labor standards. With the expected increase in textile-waste streams due to the EU waste directive that requires member states to collect used textiles as a separate waste stream by 2025, C2 points out that this will lead to enlargement of the number of sorting companies as the increase is too drastic for existing businesses to handle it by expanding operations.

Distinguishing among different human-made cellulosic fibers or between different synthetics is often not possible for sorters. Current chemical-recycling processes require homogenous fibers to be efficient, such as pure polyester or polyester-cotton blends.

Hence, industrial waste is preferred for chemical recycling because collecting standardized textiles is easier (E5). Automation technologies for fiber sorting with near-infrared spectroscopy (NIRS) is already used in the recycling of plastic packaging. Current research projects are further developing it to be suitable for fiber sorting (E9, E10). However, this technology is not expected to replace pre-sorting in the near-term future.

Radio-frequency identification (RFID) tags are sometimes discussed as a promising technology for tracking fiber compositions as labels get cut out or fade (C6, C9). They are used by professional work-wear-service companies that rent and launder the garments for large firms. This is also the area where the majority of chemical recycling of polyester is done, e.g., by Teijin. In the fashion industry, some premium brands use RFID tags to distinguish original products from counterfeits. For ordinary fashion items, the interviewees argued that it would only increase the electronic waste issue as consumers may cut it out and it is a development that will not result in an increase in recycling volumes. Instead, according to E4 and E7, more recycling businesses should first be set up.

The recycling process

All of the actual recycling processes hold potential for further improvements, according to the case studies, each of which registered growth of their recycling activities, and to the interviewees. An open issue is how to inform consumers in order to leverage their sustainability choices and to increase demand for recycled products.

Transparency of recycling to consumers

According to C3, textile recycling has only recently gained momentum as a positive trend in public awareness. Mechanical recycling technologies that were developed due to resource shortages a century ago have been around for the last several decades but stayed under the radar of consumers. New materials for products were more appealing. If insulation fillings – for example for winter coats – were a blend of new and recycled materials this message was not effectively communicated, in part because current modes of textile labeling do not distinguish between virgin fibers and recycled fibers. Fashion brands may choose to add a “r” in front of the abbreviation of fibers to indicate that they originate from recycling. But also innovation in mechanical recycling of post-consumer textile waste slowed down with new fibers becoming cheaper (C2).

According to C1, the cradle-to-cradle (C2C) certificate issued by the Cradle to Cradle Products

Innovation Institute is gaining importance in the fashion and textile industry. Some fashion brands have received certification for cotton products such as t-shirts and denim trousers. The certificate distinguishes between five different levels with the aim of incentivizing producers to reach the next level. A high score at the gold level, however, does not say anything about end-of-life treatment and it does not indicate if the product gets recycled or how cost effective and commercially attractive it is to recycle the item. Other than the C2C label, there are no significant labels on the market to guide consumers. The majority of certificates are for good environmental practices, fair labor standards, or toxic-free products in general (E2).

Comparison of recycling solutions

For mechanical recycling, the garments are cut into pieces then the small cloth fragments are torn apart until single fibers are entangled and carded into new rovings – the mat of fibers that serves as pre-yarn. Because the fiber length deteriorates during mechanical preparation, usually virgin fibers are included to actually spin out new yarns, which are used again for weaving and knitting of the fabrics for new garments (C2, E2, E7, E8). An advantage of mechanical recycling is that the process is much less susceptible to interferences due to multi-fiber compositions. Improvements are still possible with current spinning machines to process mechanically recycled fibers (C2).

According to some of the interviewees, chemical recycling is more promising for large-scale closed-loop recycling to tackle textile waste (E4, E7, E10). Others see mechanical recycling as having larger potential (C2, E3). Biological recycling appears to be interesting for cellulosic fibers, but is not seen as an important building block for a sustainability transitions in the next decade (E9). The interviewees agreed that both recycling methods will coexist and require further improvements to process post-consumer waste more efficiently.

In general, current recycling methods result in more expensive yarns and fabrics (E1, E6). As the garment industry has developed over the years into optimizing mass production, recycled yarns and fabrics need to be available on a larger scale and in a more homogenous quality (E7). Thermal-mechanical recycled polyester from PET bottles is already used, as there is a steady supply available (E1, E2). According to C3, fashion-brand companies have to provide customers with sustainability stories. They embrace initiatives involving fibers made of plastic collected from the oceans and beaches, but the supply of this waste for new garments is limited. Accordingly, rPET from bottles is seen as the next

Table 4. Challenges and opportunities to increase post-consumer waste recycling.

Building block and organization in value chain	Challenges	Opportunities and possible solutions
Collecting -Professional collectors	Revenue streams require change due to fewer premium secondhand donations and increasing waste Increasing import taxes and bans on secondhand garments Expected increase in shipping prices due to increasingly stricter environmental regulations for logistics	True-cost approach to incorporate environmental impact issues in virgin-fiber price Responsibility of fashion businesses for whole value chain including end-of-life solutions could incorporate garment-price increase that goes to recycling businesses, e.g., per item per weight and recyclability
Collecting -Fashion businesses	Vouchers and stationary collection systems may provide purchase incentive for increased consumption Mailing options increase carbon footprint compared to stationary collection systems	Take-back systems should not provide purchase incentives such as vouchers but instead improve consumer education about recycling
Sorting	Increase in waste accompanied by increase in sorting businesses may lower labor standards Automatic sorting technologies do not solve pre-sorting for secondhand markets	Extended producer responsibility could include labor standards at sorting Pre-sorting by consumers: differentiating between good condition and worn such as differentiating between glass colors in Germany Further development of automatic sorting RFID and QR codes helpful for professional workwear-rental businesses
Recycling	Virgin fibers are too inexpensive rPET from PET bottles diverts resources from packaging industry instead of incentivizing recycling of worn clothes	True-cost approach to incorporate environmental impact issues in virgin-fiber price Responsibility of fashion businesses for whole value chain including end-of-life solutions Commitments to recycling of fashion businesses should include worn garments in order to rethink their designs for recyclability Transparency also in terms of labels whether circularity labels include take back and recycling

best alternative as new fibers from textile waste are not available yet in large enough quantities at reasonable prices (E2).

Discussion

The results point toward three discussion points concerning the collectors and sorters and increasing recycling in general. The aspects are elaborated in the following section and summarized in Table 4.

Challenges to revenue streams of professional collectors and sorters

The results confirm an increase in garment donations accompanied by a decrease in the quality of discarded clothing (Brydges, Retamal, and Hanlon 2020). This situation is challenging the business model of established collectors and sorters. Financing the collecting and sorting of used clothes by selling premium secondhand items cannot be sustained as an expansion in premium apparel relative to donations is unlikely and secondhand platforms for consumers will continue to grow. At the same time, the results reinforce the argument that selling worn garments to Asian and African secondhand markets is being challenged by contentions that garment imports hamper local garment-production industries (Manshoven et al. 2019). It has been

difficult to investigate this claim because of the methodological complications of distinguishing whether the decline of domestic clothing manufacturing is due, on one hand, to general globalization trends, lack of infrastructure, inefficient businesses, and cheaper imports or, on the other hand, to used-clothing imports (Brooks and Simon 2012). However, the number of countries that adopt a critical view on used-clothing imports is rising, as the claim seems plausible and textile waste is also littering the environment in developing countries. Even the government of India, one of the top importers of worn clothes, was urged in 2019 by the National Committee on Textiles and Clothing to stop the imports which are mainly from China, Bangladesh, and Indonesia (The Hindu Business Line 2019). Other challenges exposed by this study include increased use of consumer-sales platforms and an expected increase in shipping costs.

Accordingly, collectors are facing a situation where they need to change their revenue streams. Consistent with policy suggestions to provide financial incentives and obligations such as quotas for reuse and recycling (e.g., van Bahr et al. 2019), a solution may be the true-cost approach (Piciu 2014) which asserts that a percentage of the cost of end-of-life treatment of garments should be incorporated into the sales price. Some eco-label companies are practicing this already (Manshoven et al. 2019).

Higher retail prices are unlikely to be a popular strategy, both for consumers and fashion-brand companies and it is doubtful that it will happen on a larger scale without policy intervention.

Consumers certainly need to be educated that sustainability of the fashion industry requires higher prices and that they can reduce the impact of garments if they purchase clothes made of recycled fibers. This could be incorporated already in school curricula as natural science and applied mathematics projects, as garments are objects that everyone wears. Revising textile labeling to clearly indicate recycled fiber materials and recycling labels may help only very few consumers to guide their purchase decisions, as they hardly consult labels.

Leverage in collecting garments: charities and fashion businesses

As textile waste is increasing, the number of sorting businesses in low-income countries grows as well. When the EU directive goes into effect in 2025 to collect used clothes as a separate waste stream, established collectors and sorters may have difficulties keeping up. Rapid growth in sorting demand poses a threat to labor standards that is similar to other waste-sorting industries such as consumer electronics (Bauck 2020). According to the results from this study, automation in sorting is unlikely to solve this issue, as pre-sorting in resale, recycling, and trash will continue to be performed by manual labor for the foreseeable future. Consequently, clear policy measures are necessary to limit the social costs associated with growing textile waste. On a policy level, extended producer responsibility and waste directives should encompass requirements for labor standards in the sorting sector.

Charity organizations that license their names to collectors could require that the authorization includes obligations to provide responsible labor standards throughout the recycling value chain and, in particular, for the sorters. It is questionable whether consumers are aware that charity organizations simply license their names. I argue that they have a moral obligation with respect to consumers to leverage their power if they provide their names for garment donations. I assume that this may contribute to drive recycling without increasing social costs.

Is rPET from plastic bottles and take-back systems with purchase incentives sustainable action or greenwashing?

Fashion-brand companies and retailers as collectors could have a positive impact but their activities

could also backfire on the environment. According to the results of this study, there are three issues associated with the collection of used clothing by brands. First, customers might assume that fashion-brand companies and retailers know the fiber composition of their products and recycle them more efficiently. Such circumstances could lead to presumptions that these businesses have better performance in terms of sustainability and CSR than they actually do. The second issue is when fashion brands and retailers provide purchase incentives for new clothes in exchange for used clothes. Implementation of this strategy very likely increases fashion consumption. A third open question is the sustainability impact of returning used clothes by mail. The environmental impact of small parcels as compared to stationary collection boxes is estimated to be higher (Escursell, Llorach-Massana, and Roncero 2021). As long as fashion-brand companies and retailers simply transfer the used clothing to collectors and sorters, it adds little value. On the contrary, I argue that it is more of a marketing strategy to improve customer relations and to add to sustainability activities in CSR and sustainability reporting. Accordingly, even though it is a legal responsibility of fashion retailers in many countries to take back products at the end of their life (EC 2018), advertising it as sustainable action has a flavor of exaggeration and could be deemed greenwashing as defined by its subtler expression (de Jong, Huluba, and Beldad 2020). Instead, fashion-brand companies and retailers could also use their power – equivalent to charity organizations – to assure that sorting and recycling is done in accordance with responsible labor practices and environmental standards.

While all recycling methods have further potential to grow, the results indicate that new fibers and garment manufacturing is still too inexpensive for recycled fibers to be competitive. Recycling polyester bottles into fibers diverts resources from the packaging industry and de-incentivizes recycling technology advancements for used clothing. Accordingly, the strong focus of fashion-brand companies on rPET from plastic bottles as a raw material for sustainable products – the cheapest recycled fiber with the lowest environmental benefit from all recycling approaches – overcomes consumers' reluctance to change fashion-purchasing habits that are rationalized on the basis of a greenwashing co-creation process. Instead of using rPET from plastic bottles, fashion businesses would improve their environmental impact by focusing on design for circularity, as already suggested for instance by Ho and Choi (2012).

Conclusion

The results of this study reveal that various initiatives are promising, such as chemical recycling of cotton and polyester, and take-back systems by denim brands that convert used garments into new fabrics. However, industry structures and business models need to be re-orientated to boost these recycling concepts as to date they have failed to continuously finance collection and sorting systems. The current investigation revealed that collectors will not cope with an increase in worn garments if they do not change their revenue model. At least in the EU, this situation encourages policy action to support smooth implementation of the new requirements to collect textile waste as a separate waste stream. The results can also be read as a need to further improve the current waste directive of the EU (2018), to really compel producers and sellers to take responsibility for recycling, and to incorporate the associated costs into the retail price of garments. In particular, fashion-brand companies and retailers, as well as charity organizations, should use their market leverage to enforce high environmental and labor standards in sorting and recycling and waste policies could require the industry to provide collection and recycling options that do not incentivize an increase in consumption. Here, further research is necessary to explore suitable collection options that may even entail pre-sorting by consumers.

Also, further technological advancements are required for all recycling processes to become competitive for new fibers. While chemical and biological recycling are being promoted as ways to produce high-quality fibers, the findings indicate that mechanical recycling holds potential as well for further improvements and has the advantage that it is less susceptible to impurities and is already broadly established. This trend can be accelerated if the cost for virgin fibers increases. As market-pull mechanisms, educated customers are important to increase demand. They could potentially be reached by labeling that acknowledges actual recycling instead of recyclability.

To drive recycling as part of sustainability transitions, along with further innovation of recycling methods, research needs to focus on how to build adequate industry structures. This should not be limited to the collectors, sorters, and recycling businesses. The roles of consumers, fashion-brand companies, and retailers need to be considered as parts of this value network. Incentives for fashion businesses to design for recycling and to actively take responsibility for the end of life of their products merits further investigation. It is also important to note that recycling may slow down more fundamental changes toward sustainability in the fashion

industry. As an end-of-life solution, it may contribute to the perpetuation of trends of increasing material consumption. An in-depth analysis of the sustainability benefits of recycling also provides an important avenue for further research of high societal relevance.

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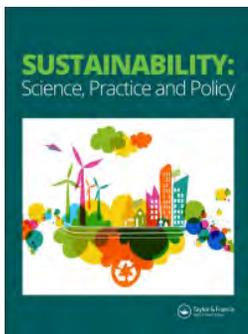
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Cultural sustainability in fashion: reflections on craft and sustainable development models

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ABSTRACT

The overcoming of outdated values embedded within the system of fashion requires a complete revamping of its very foundation toward a concept of cultural sustainability and preservation of material culture. Discussion about cultural sustainability and heritage preservation requires conservation and regeneration of the cultural beliefs and symbolic meanings embedded within the traditional processes and practices of craft. With meaning tied to place, and the evolution of ideas, attitudes, and practices, local knowledge of traditional handcrafts can be considered as a sustainable repository of culture. The purpose of this study is to interpret the most developed craft-based strategies in the field of fashion to promote positive and sustainable change and to disassociate from the practice of cultural appropriation. Through the presentation of selected case studies in the fields of fashion, design, and craftsmanship, this article provides an interpretative model for cultural sustainability through traditional craft. With a focus on the incorporation and valorization of material practices and knowledge in fashion, the proposition for design to act as a promoter of innovative processes and the nurturing and retaining of craft can ensue. This speculative model is built on case studies on cultural sustainability through traditional craft. It is focused on experimentation, innovation, and sustainability through the design and creative process expressed through cultural heritage strategies. The result is a range of possible outcomes, aligned with existing craft practices, that highlight opportunities for design to support traditional craft through innovative processes while maintaining their embedded codes.

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Cultural sustainability: an introduction

The United Nations Educational, Scientific, and Cultural Organization (UNESCO) (2015) describes culture as a powerful driver for development that has communitywide social, economic, and environmental impacts. Related to this point, the FashionSEEDS project (Williams et al. 2019) defines cultural sustainability as

Tolerant systems that recognise and cultivate diversity. This includes diversity in the fashion and sustainability discourse to reflect a range of communities, locations, and belief systems. It includes the use of various strategies to preserve First Nations cultural heritage, beliefs, practices, and histories. It seeks to safeguard the existence of these communities in ways that honour their integrity.

Cultural sustainability is thus a response to a shift in our values that seeks to rectify the biases of the past by recognizing the importance of diversity, inclusion, representation, and respect for other people, communities, and their representative material

cultures, as well as the role that craftsmanship plays in expressing traditional culture.

Originally, the term sustainability was conveyed predominately from an environmental perspective. The expansion of the concept of sustainability in “sustainable development” has been ongoing since publication of the Brundtland Commission’s report (WCED 1987) introducing three dimensions: economic growth, social inclusion, and environmental balance. The inclusion of a social and economic dimension in this framework was further validated in 1992 in the United Nation’s Agenda 21. In the same year, the Swiss project “Monitoring of Sustainable Development (MONET)” outlined a paradigm for sustainable development that incorporated three pillars, one each for environmental conservation, economic growth, and social equity (Keiner 2005a, 2005b). In 1994, the World Bank’s “capital stocks” model of sustainable development consolidated this paradigm by evaluating society as equal to the economy and the environment. This approach was based on the banking theory of

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ecological capital, that if you can live off the interest of your investment, you can maintain prosperity.

This formulation was further amended in 2001 by UNESCO's Universal Declaration on Cultural Diversity by adding cultural diversity as an integral component in the form of a bridge connecting the other three pillars, rather than adding a pillar in its own right. The organization explained cultural diversity as a dynamic process within which cultural change can best be managed with intercultural dialogue and sensitivity to cultural contexts. However, it was not until 2010 that the United Cities and Local Governments (UCLG) published a policy statement arguing for culture as the fourth pillar of sustainable development. Axelsson, Angelstam, and Degerman (2013) view the long debate about the need for the inclusion of a fourth pillar that expands upon previous expressions of social inclusion as encompassing a cultural perspective. Decoupling culture from the social pillar demonstrated a specific focus on cultural diversity as a set of shared values within a specific local community that are considered important levers to drive sustainable development and are on par with the environment, economy, and society, as shown by its promotion by the UCLG and adoption by the United Nations. The introduction of this fourth pillar has had profound implications when analyzed in a fashion context, particularly in relation to traditional craftsmanship.

As Boia-Moisin (2017) argues, cultural sustainability in the fashion and interrelated textile field means supporting and sharing knowledge of traditional know-how, competencies, and skills of fashion and textile cultures with future generations. Therefore, cultural sustainability in fashion requires that we address the history of cultural appropriation (Kangas, Nancy, and Beukelaer 2017). Central to the problem of appropriation are the issues of ownership, authorship, respect, and power imbalances with brands too often utilizing unique cultural expressions and processes for commercial gain, sometimes in a disrespectful manner (Anderson 2010; Vezina 2019). Susan Scafidi, an expert in fashion law and author of *Who Owns Culture?* (2015), cites cultural appropriation as one of the main reasons why some cultures and their material representations are threatened. She sees the commercial exploitation of traditional craft as having devastating implications for indigenous communities, with tradition distributed by brands without gratitude or economic benefit to the original creators.

Scafidi (2015) cites the vast gulf between *cultural appropriation*, *cultural appreciation*, and *cultural exchange*. First, *cultural appropriation* is commonly mentioned as contributing to the loss and devaluation of cultural heritage and its material

representation through unsolicited use and misuse. Second, *cultural appreciation* generally refers to the admiration for "another" culture and an interest in learning about it. Finally, *cultural exchange* is a sharing of skills and knowledge. UNESCO's report on Intangible Cultural Heritage (2018) documents hundreds of different forms of intangible cultural heritage from around the world. The interactive listing offers insight into the major contributing factors to the loss of tradition worldwide, citing cultural appropriation as one of many threats to continued viability.

There are currently few to no legal protections in place to safeguard indigenous material culture, allowing brands to continue to raid cultural heritage as a source of inspiration, despite being publicly shamed in social media for doing so. With multiple indigenous communities in the process of trying to expand upon intellectual property law to include collective material culture under its protection, the time will soon pass when a designer can dip into another culture for inspiration and produce designs without recompense to the community that inspired their work. Despite the progress of several initiatives including the Maasai Intellectual Property Initiative, the National Mayan Weavers Movement, the Mexican government's public commitment to developing legislation, the Lao Traditional Arts and Ethnology Centre's efforts, the overarching work of the World Intellectual Property Organization (WIPO), and the Cultural Intellectual Property Rights Initiative (CIPRI), most protections remain aspirational. Collectively these proposals seek to safeguard the traditional knowledge and the custodians of traditional cultural expressions with protection against misappropriation under law. However, until these legal protections are implemented within comprehensive frameworks, brands will continue to "copy and borrow" indigenous material culture with impunity (Vézina 2019).

Multiple examples of blatant cultural appropriation litter Western fashion history, from Victoria's Secret's 2012 fashion show with Karlie Kloss strutting down the catwalk wearing a traditional First Nations war bonnet and turquoise jewelry to Carolina Herrera's Resort 2020 collection (Friedman 2019). Herrera's collection, naïvely intended as a homage to Latin America, resulted in the Mexican government accusing her of plagiarizing several indigenous communities and setting in motion the development of legal protections for the country's intangible cultural heritage. Isabel Marant's Spring/Summer 2015 collection, which copied a traditional Mexican blouse from Oaxaca, resulted in the designer being sued in a French court (Larson 2015). Dior's direct copy of a traditional Romanian

vest resulted in the launch of an online platform called Bihor Couture selling original Romanian artisan-made versions while publicly shaming Dior for the theft (Bihor Couture 2018). This is a long conversation, punctuated with periods of dormancy and outrage, reminiscent as it is of colonialism, fueled anew with activism in defense of threatened tribal peoples and traditions from around the world.

A virtuous example of cultural appreciation followed by cultural exchange, in line with Scafidi's argument, is represented by Oskar Metsavaht, the Creative Director of Osken and the Ashaninka collection. Metsavaht collaborated with the Ashaninka people from the rainforests of Amazonia for his Spring 2016 collection. The collection was a collaboration and an exchange, with Metsavaht working directly with elders from the community to ensure that no symbols, colors, or patterns were utilized inappropriately. He developed a logo for community use and effectively treated the relationship as an artistic collaboration, with the tribe benefitting from royalties from every sale and their accreditation in all communication as the source of inspiration (Quartz 2015). Metsavaht showed that by using the vehicles of traceability, transparency, provenance, and authorship, material culture and craftsmanship can be reclaimed and honored.

In the following sections, we discuss how design accesses craft culture through a knowledge exchange of practices and techniques in order to reconfigure processes and to encode different meanings into new narratives rooted in the appreciation of a specific culture.

Intangible cultural heritage in the fashion system

Given the challenges of craft retention, a design-oriented approach offers a strategic option for solution-oriented implementation of artisan knowledge. This strategy would redefine directions in support of the development of territory and community through the conservation of culture. Artisans would be provided with the tools for self-evaluation, enabling them to better articulate the intrinsic qualities of their work. A methodological process of product development can be designed through successive phases of knowledge, reflection, activation, and preservation of specific know-how, thereby informing the continuous enhancement of craft-knowledge from a design-oriented perspective. As Fry (2009) argues, design participates in the planning of culture through the introduction of an object into the world. Therefore, the history of designed objects is the history of culture. Design is never culturally neutral, but always transports socio-cultural values,

with the value dependent upon the “the symbolic, emotional and identification of meaning it embodies” (Rullani 2004, 13). According to Oppenheimer (2019), craft is not a finished product, or even a set of refined technical skills, but a means of understanding the material world. By producing handicrafts that strengthen and valorize local culture, meaning transcends simple income generation, allowing people to act in line with their values and to create new means to overcome their circumstances. This concept is called platforming by Fry (2009) and described as a strategy that maintains existing and traditional economic activity and work culture, while building a new direction with new products.

LVMH, one of the largest luxury conglomerates in the world with over seventy brands to its name, understands the need to maintain the renowned French metiers that luxury fashion relies upon as a means to retain and retrain young people for the longevity of luxury craftsmanship. For the company, preserving know-how has become an increasing concern (Hope 2015). In an effort to maintain tradition, LVMH developed an initiative called *L'institut des Métiers d'Excellence* (IME) (The Institute for the Professions of Excellence) in 2014. The IME provides training for young people to learn these skilled trades while providing long-term investment and support for their most valued suppliers (LVMH n.d.). The loss of traditional craft skills in France has been magnified by the loss of global craftsmanship, which is disparate, splintered, and exacerbated by modernization and globalization (Murphy 2018).

Other examples of retention exist in the educational space, with some universities fostering collaborations between students and artisanal communities. While these examples are limited, they represent a realization of the importance of retaining these endangered crafts. One example is *Officina Borbonese* which is a collaboration between The New School's Parsons Paris campus and the craft cooperative *Su Trobasciu* in Mogoro, Italy. This small Sardinian village plays host to an innovative project that reinterprets the iconic tapestries and carpets typical of the region. A specific initiative called *Savoy Faire* focuses on sustainability by enhancing local culture and operating a traceable and transparent supply chain. The idea was founded on the identity and values of the Borbonese and reinterpreted through the material culture of Sardinian craftswomen and fashion-design students. This venture is further supported by students from programs in strategic design and management and they created the marketing and communication strategy for a Fall/Winter 2021 capsule collection.

Handcraft and artisan production is estimated to be the second largest employer in the developing

world (Alliance for Artisan Enterprise 2016), with women representing the overwhelming majority of garment workers and artisans. Globally, the artisan market is valued at approximately US\$34 billion with 65% of this activity taking place in developing economies (Kerry 2015). UNESCO (2018) lists a number of specific threats to the retention of tradition with both globalization and mass production featuring prominently in addition to the higher costs and the investment of time required to perform hand-crafted labor, the inability of artisans to adapt to market needs, the environmental pressures, and the loss of access to raw materials. A further factor is the lack of interest from the next generation to learn the requisite skills. Global craftsmanship does not enjoy the benefits of one of the world's largest luxury conglomerates to protect it and to ensure its longevity, retention, and relevance (Black 2016). Moreover, the cultural and creative sectors have been disproportionately affected by the global pandemic (OECD 2020).

Research methodology: cultural sustainability through craft

In accordance with the definition of cultural sustainability, material culture consists of practices, techniques, and processes that are curated constantly by human capital. In many cases that capital has enabled the preservation of unique and distinctive knowledge and expertise within specific territorial contexts (Faro Convention 2005). These cultural heritage resources are facing major challenges today because of resource depletion, cultural appropriation (Pham 2014; Scafidi 2015), and globalization which

has reduced the diversity and uniqueness of practices and knowledge. However, the distinctive practices and knowledge of authentic craft production have sparked renewed interest (Castells 2004; Kapferer and Bastien 2009; Mazzarella et al. 2015; Walker 2018) and these developments have led the fashion system to rediscover “cultural capital” (Throsby 1999) at a time when local communities and their material culture are suffering from impoverishment of meaning and value. Craftsmanship can support the codification of a new cultural language and, at the same time, target consumers who are increasingly attentive to the exclusivity and personalization of particular products (Sennett 2008). The interaction of craft and design can generate real value through the transfer of knowledge among stakeholders (EFI n.d.). In this way, a craft-design approach can reconfigure the traditional codes and languages and outline a process of continuous innovation that can be replicated over time and is able to penetrate and compete in globalized markets, thereby valuing cultural diversity as a form of evolved creativity (Vacca 2013).

This study explored emerging design scenarios in the field of fashion and craftsmanship. It is oriented toward combining and consolidating the design disciplines with experimentation, innovation, sustainability, and inclusive processes and tools consistent with the four pillars of sustainability (UCLG 2010): (1) environment as biological diversity and resource preservation; (2) society as people and social inclusion; (3) culture as cultural values and heritage preservation, and (4) economy as circular and performance-based (Figure 1). Through a holistic vision of the combined themes of sustainable

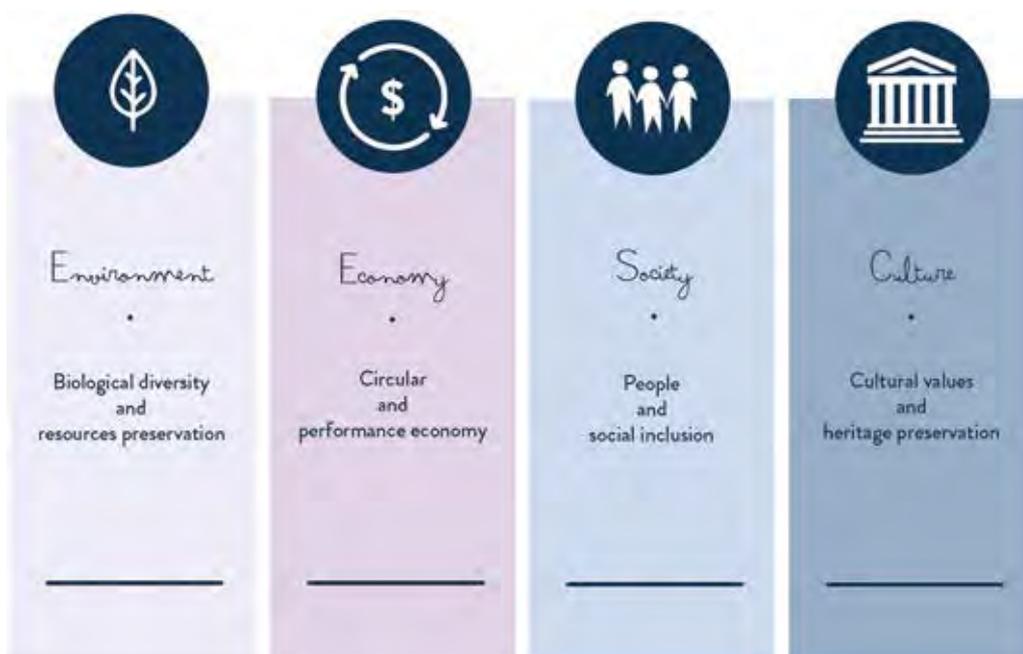


Figure 1. The four pillars of sustainability (adapted from UCLG 2010).

development (WCED 1987) and sustainable fashion (Williams et al. 2019), the model attempts to identify strategic assets to deploy in the fashion system to address the challenges of sustainable transformation by enhancing, preserving, and integrating material culture. Accordingly, this study has four objectives. First, we sought to interpret, through the identification of significant and recurring trends, the most developed craft-based strategies in the field of fashion. Second, the work reported here was designed to highlight the dynamics and evolution that the craft and fashion sectors are experiencing currently to promote positive and sustainable changes within the cultural dimension. Finally, we strove to overcome the dynamics of cultural appropriation and misappropriation that have been carried out to the detriment of territories and communities that possess cultural heritage.

To design this speculative model, we drew on the results of several of our studies related to the phenomenon of cultural sustainability through traditional craft, with an emphasis on the cultural potential of processes oriented toward the valorization and incorporation of material practices and expertise in fashion (Brown 2021; Vacca 2013). In the past decade, we have developed personal research paths related to the themes of craftsmanship and cultural sustainability. In this context, we have analyzed skills, practices, methods, processes, materials, tools, relations, communities, and territories. Through these projects, we have come into contact with both micro-scale communities of autonomous and independent artisans and artisanal businesses that are larger and structured and organized more extensively. This study is based upon a global sample of 105 cases of crafting initiatives, each of which we evaluated through preliminary desk research and then developed a map based upon their characteristics. This was followed by a case study that allowed us to study complex phenomena within their contexts (Nixon and Blakley 2012). Then, we identified ten case studies and conducted semi-structured interviews with key respondents in each of them to gain deeper insight into their values, processes, approaches, and methodologies. These entities represent excellence in cultural sustainability practices, oriented toward the recovery and enhancement of fashion-design approaches to material culture. We refer to these examples as “culture-intensive artefacts” (Bertola et al. 2016). The semi-structured interviews were conducted to enable us to study the techniques, traditions, and customs behind these ancient producers. We identified their connections with the contemporary world, the products they produce, the means through which they communicate and distribute their work,

and the nature of their collaborations—whether occasional or continuous—with brands and/or independent designers. Some of the cases were explored through participatory, co-design, and social innovation projects, while others were documented through observation and other modes of investigation. This feature of the project initiated the applied dimension of this research, which allowed us to experiment with models of preservation and the sustainable development of cultural heritage (Bertola, Colombi, and Vacca 2014). The expertise that we gained over several years and the sharing of corresponding studies, reflections, and results with us, has provided the data on which our model is based.

We conducted a comparative analysis, examining all of the interview data to identify common themes that came up repeatedly with an inductive approach. Then we clustered the cases to generate themes and to track the directions and behaviors of similar initiatives (Brown 2021; Vacca 2013). The model was then built with the goal to construct a detailed panorama that relates to contemporary craft dimensions and their implications with respect to fashion design-driven cultural sustainability. We wished to focus on charting trajectories and scenarios for cultural sustainability in fashion through design-led actions, practices, and methodologies that could generate positive transformation that alters the status quo. The research design was qualitative because of its ability to offer an unlimited range of inquiry into the cultural dimensions of the research (Denzin and Lincoln 2005). A qualitative approach, while not measurable or quantifiable, is more appropriate to present a broader, more extensive description and allows the researcher to make inductive observations, generate theories, and draw conclusions. However, this approach has three limitations: (1) It is impossible to discuss all of the case studies presented in the article comprehensively; (2) The conclusions cannot be generalized because they are based upon a limited number of observations, and (3) The interpretation of the data is based upon the researchers’ experience and expertise.

Cultural sustainability through craft: an interpretative model

To fulfill the purpose of this study, the model (Figure 2) assesses the different approaches to craft sustainability that emerged from the case studies that we investigated. The two axes of the model are expressed as the polarities identified in the study.

The horizontal axis defines craft-based strategies that consider craft as content. Through design and the creative process, it highlights, on one hand, the distinctive qualities, values, and meanings from a

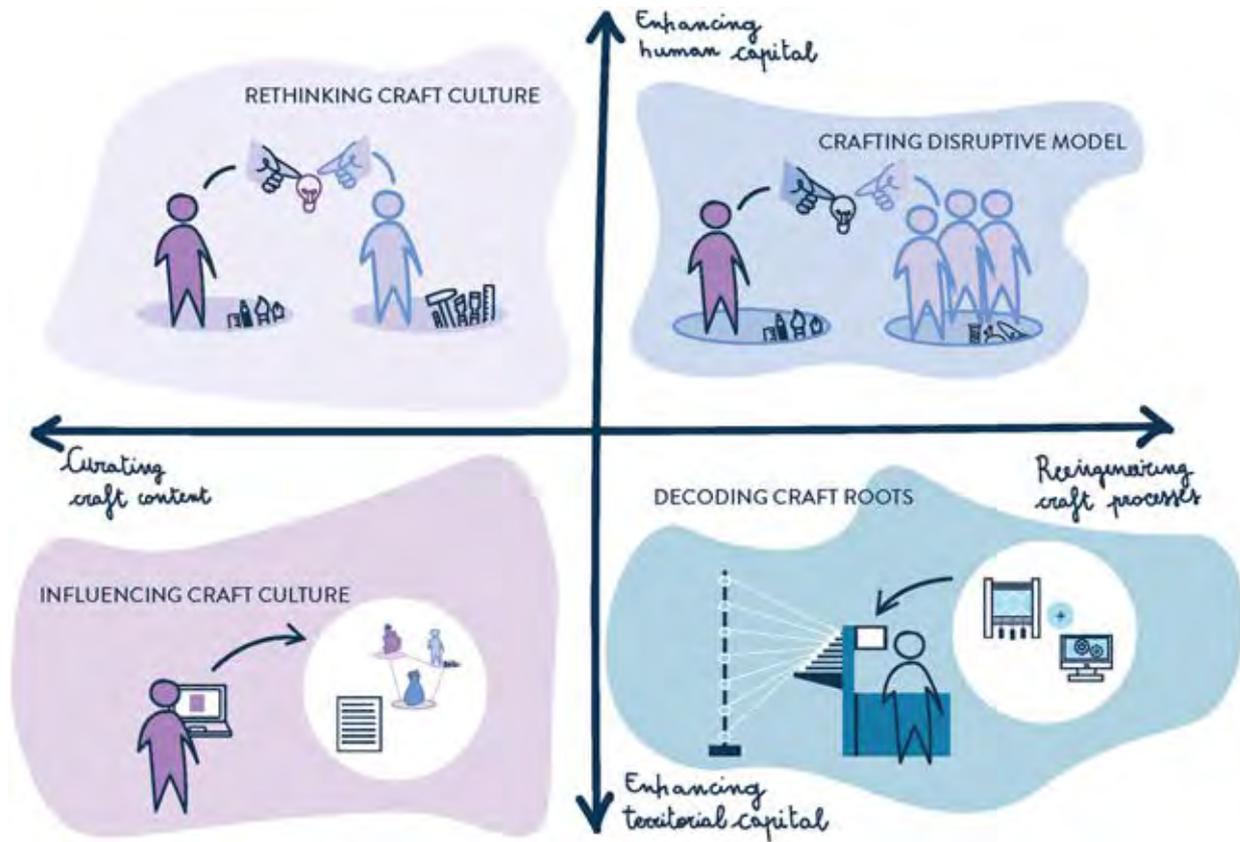


Figure 2. Cultural sustainability through craft: an interpretative model.

curated, preserved, reactivated, and revalued perspective (curating craft content). On the other hand, craft-based strategies draw attention to the traditional skills, abilities, and technical capabilities that need to be decoded and re-engineered to reactivate and generate new and positive approaches to development (re-engineering craft processes).

The vertical axis identifies the methods and tools used to activate craft-based strategies through the enhancement of cultural heritage. Expressed through the empowerment of the socio-cultural dimension (enhancing human capital), its focus is the improvement of quality of life through community development. The sustainable development of local identity (enhancing territorial capital) to preserve natural resources while producing goods and services with traditional approaches is conducted to support and promote territorial cultural diversity.

By interpreting the polarities of cultural sustainability through craftsmanship, and after positioning the cases investigated in the model, four different scenarios emerged that represent different expressions of living cultural craft and highlight future design opportunities in the fashion field: *Rethinking Craft Knowledge*, *Crafting Disruptive Models*, *Decoding Craft Roots*, and *Influencing Craft Culture*. Each scenario was traced to identify analogies and similarities in behavior, practices, and methodologies. What emerged within each scenario is a vision

of a plurality of meanings and values that each case study incorporates.

Scenario 1: rethinking craft knowledge

This craft-based scenario is oriented toward valorizing and reactivating material culture (curating craft content) through a design-driven approach that enhances artisan communities that hold a specific cultural heritage (enhancing human capital). The craft-design relation is one of continuous exchange and knowledge transfer of techniques and expertise intended to redesign and redefine the expressive codes and processes that combine ancient traditions with symbolic cultural innovation approaches. Artisan communities are not involved merely in production, but are an integral part of the design process, as they provide their skills and creative intelligence in design development. The designer explores generative actions in the design of unique and singular objects (Kopytoff 1986; Vacca 2013) to preserve the embedded meanings and expressions of heritage that the re-signified artifact expresses.

This scenario is exemplified by designers such as Stella Jean and Swati Kalsi who foster cultural exchange through the integration of artisan communities with the goal to alleviate poverty and contribute to social and creative emancipation through the dignity of work. Although similar, the two

designers use two different models of collaboration. Beginning from the paradigms of cultural contamination, *creolization* and *métissage* (Glissant 1996; Gnisci 1998), the Italian/Haitian designer, Stella Jean, created a sustainable development platform called “Laboratorio delle Nazioni (Laboratory of Nations)” that supports her work with artisan communities. The designer’s international cooperation projects stem from her desire to study traditional textile processes and techniques which, hybridized with a design vision, become esthetic overlaps of great fascination within her collections. Each collaboration is a form of cultural exchange and “permissive appropriation” (Scafidi 2015) that results in positive interactions with artisan communities. In this scenario, the artisans’ work is not only recognized, communicated, and valued, but also emancipated through the development of a sustainable business model that empowers communities through the dignity of work.

Alternatively, the Indian designer, Swati Kalsi, is a spokesperson for a specific cultural heritage within India (Brown 2021). She works in a highly collaborative process to explore the technique and tradition of Sujani that pushes the boundaries and elicits the artist and creator within the women artisans which results in the repositioning of tradition. Kalsi’s collections are distinguished by the intersection of design, craftsmanship, and art. They consist of unique garments embellished elaborately with Sujani embroidery from the Bihar region. The designs are produced entirely outside of the seasonal fashion calendar and honor instead the time, skill, and labor required to achieve their intensive craftsmanship. The designer’s contribution is to conceive through ongoing dialogue and shared vision timeless garments that preserve, sustain, and tell the stories of women artisans, because, as Harrison (1978, 1) argued, “Making items is part of a constructive cultural activity and is a part of the fabric of society.”

Scenario 2: crafting disruptive models

The second scenario proposes the reactivation of techniques and processes related to crafts (re-engineering craft processes) that embody capacity-building actions as the determinants of improved standards of living (enhancing human capital). Local production based upon traditional techniques becomes the vector with which to recontextualize, revalue, and revitalize material culture through participatory and co-designed innovative processes. Investment in human capital promotes new processes of value generation that result in products, as well as disruptive business models oriented toward

the reconstruction of local communities as the means to promote cultural sustainability and ethics.

This scenario presents a plurality of actions that can be grouped into two main approaches. The first requires the commitment to work with disadvantaged social communities (Krippendorff 2006) with the intended outcome of social redemption. The second promotes the enhancement of a specific community’s cultural capital by rediscovering and redesigning distinctive craft practices to create new cultural and production models (Vacca 2013).

The first approach includes the social innovation projects that fashion companies and independent designers have promoted to emancipate specific communities. It targets fragile communities, not holders of a predefined cultural heritage such as prisoners, migrants, and the unemployed. The investment in cultural capital is expressed through the involvement of master craftspeople of distinctive techniques and processes rooted in territory. Programs are focused on the development of training that supports social development and positive growth to achieve better standards of living and opportunities for self-affirmation through dignified work. Examples of the cultural capital investment are expressed in such projects as “Made in Prison” by Carmina Campus, Tod’s collaboration with a recovery community for drug addicts in San Patrignano, Italy, and the ethical Italian fashion brand, Progetto Quid.

This second approach is characterized by the development of innovative and disruptive business models that invest in cultural heritage and knowledge to ensure the historical continuity of codes and meanings. Donna Karan’s Urban Zen Foundation exemplifies this scenario and represents a philosophical paradigm rooted in the preservation of culture and support of health and education. As an approach, its goal is to uphold community and to maintain identity and diversity through projects that preserve cultural and spiritual values, as well as facilitate the development of artisanal entrepreneurship through an educational commitment to the next generation. As a disruptive model based upon craft it is inspired by the theories of Amartya Sen (2000), who advocates for social welfare based upon human rights, and the concept that people should reach their potential in doing and being, thereby becoming capable in the sense of learning and knowing the way to do things.

Scenario 3: decoding craft roots

The third scenario focuses on craft-based actions intended to decode manufacturing processes (re-engineering craft processes) to foster a local,

territorial dimension (enhancing territorial capital). This concept of craftsmanship represents a departure from a simple definition of “handmade” with its emphasis on a master craftsman’s manual skills (Adamson 2007). While it does embrace the broader meaning of craft knowledge and expertise as an expression of a specific territory, it is in constant evolution because of the embedded nature of the material culture (Sennett 2008; Vacca 2013). Therefore, this approach focuses on the recovery of production processes that have been forgotten in part or have become outdated because of obsolete technologies in which there is little interest or generational knowledge transfer. There are no predefined hierarchies of value between craftsmanship, industry, and technology, which thereby gives form to an advanced concept of authenticity. Enzo Mari (2011, 67–68) explained this idea eloquently: “When you make a serial product... the heart, the cleverness of the factory is located in the department of prototypes, where the work of everyone, from the top designer to the last technician, is still artisanal, regardless of whether it is processed with the help of a computer or a pencil.”

The recognition of the cultural potential of manufacturing heritage and the construction of territorially specific models for the preservation of practices and methodologies form the basis of the philosophy of Bonotto’s “Fabbrica Lenta (Slow Factory).” Based in Molvena, Italy, Bonotto offers products rooted in the heritage of craftsmanship, combined with research, creativity, and innovation, and in opposition to the industrial standardization of production. The company has recovered proto-industrial machinery and technologies to develop highly limited and experimental production. The research process that Bonotto uses is focused on the overlap between design thinking and design methods. Fabbrica Lenta’s products are made through a hybrid process that combines the slowness and knowledge of craftsmanship produced on old looms with the speed of technological processes that give new meaning and importance to new products.

An interesting characteristic of this scenario is exemplified by many emerging startups that recognize the strong potential of cultural heritage expressed through manufacturing, skills, and expertise. Brands such as Wrad, Rifò, and Wuuls have developed their own identity precisely through re-engineering and regenerating manufacturing processes and techniques. They recontextualize methods and practices and thereby realign the value system to which they belong. The brands apply unconventional technologies and cutting-edge processes to traditional handicraft culture to envision contemporary archetypes with a renewed local authenticity.

Thus, the application of advanced design practices oriented to identify future perspectives through the creation of innovative products and processes (Celi 2015) helps visualize future scenarios for artisans without the loss of the legacy, local identity, or artisanal expertise. Moreover, decoding the pairing of technology and craftsmanship amplifies the application and encourages positive social and cultural change.

Scenario 4: influencing craft culture

The fourth and final scenario is contextualized in valorization of the territorial capital of a specific socio-cultural and productive system (enhancing territorial capital) through a design methodology that is editorial and curatorial in nature (curating craft content). The main objective of this scenario is to valorize the traditional archetypes of the most important handicrafts and transport them uncontaminated into the contemporary world. Abandoning the patina of time typical of ancient workmanship, it offers visibility and transparency in its stead as a new expression of respect. As a curatorial approach, it favors a dialogue and exchange between producer and consumer in the creation of cultural content. It fosters the ability to interact and experiment with personalized ways of using and means of understanding heritage. Design serves as the activator of socio-cultural networks between small, historically significant artisanal realities and the broader context. It is not bound by territory or local boundaries in an effort to access a wider market. It exploits the integration and hybridization of media, both with respect to diffusion through new media’s social platforms and through increased interaction with fashion’s meanings, techniques, processes, and culture with the user’s involvement and transmedia narratives as a way to reach the diverse fashion community. In this context, the production dimension is shown, told, and presented through storytelling that enhances technique as well as tangible memories, and the objects that represent the places and experiences behind them.

This scenario aspires to raise the visibility of local culture through awareness of the specificities preserved within that constitute heritage’s capability to bring economic development to local communities. Territorial storytelling serves as a route to “cultural appreciation” (Scafidi 2015) addressed to an increasingly attentive and aware public. It is a way to support a territory’s material culture by telling the stories of the craft. Further, it is a means of breaking established patterns related to territory through a complex narrative system that defines the limitations between plagiarism and inspiration, homage

and appreciation, and includes the implicit denunciation of appropriation. The ability to tell stories effectively can give sense and meaning to lives and experiences. As Benjamin (1968) argues, storytelling is therefore not only a way to see more deeply, but also an action of ethics and responsibility because of its ability to preserve and transfer knowledge, experiences, and traditions in a recognizable way.

Best practices in this field are represented by Bihor Couture which is transforming the way that “shared dialogic heritage” (Härkönen, Huhmarniemi, and Jokela 2018) is transferred radically through the creation of a physical as well as virtual space to showcase the various facets that local culture has to offer. Through provocation and cultural promotion, they offer an intelligent campaign born from collaboration between the magazine *Beau Monde* and the community of Bihor in Romania. After deciding not to suffer French Maison Dior’s misappropriation of their heritage for their pre-fall 2017 couture collection passively, they instead claimed proudly the ownership of the traditional embroideries handed down through generations that Dior copied. The denunciation project highlighted creatively the act of cultural misappropriation that characterizes increasingly the fashion industry’s ongoing failure to recognize the original holders of knowledge who are left all too often unprotected from the inappropriate and disparaging use of their cultural heritage (Boïa-Moisin 2017). Bihor Couture was conceived as a website dedicated to the typical creations of the region. Through video interviews with local artisans, they describe the distinctive techniques that represent the region’s culture and customs and offer their traditional products for distribution through an e-commerce site that benefits the Bihor community. This offers an example of cutting-edge cultural experimentation in an era in which cultural appropriation is commonplace. Through the power of evocative storytelling, Bihor Couture seeks to restore authenticity to the territory in the form of cultural values and meanings linked to ideas, people, and place.

Conclusion

From this proposition, craftsmanship emerges as an “open knowledge system” (Sennett 2008) that by its nature evolves over time. Through continuous transformation, it becomes the core of community identity (Adamson 2007) and a differentiating factor in material culture (Miller 1987) through the deep connections that craftsmanship has with culture, memory, and tradition. Therefore, discussion about cultural sustainability as craft knowledge with deep historical roots entails approaching the issue of

sustainable development by strengthening cultural identity (Friedman 1994; Matahaere-Atariki 2017) and revitalizing local cultural heritage through continuous investment in territory-specific human and cultural capital (Auclair and Fairclough 2015). This proposition highlights an increasing need for the legal protection of material culture supported by systemic change in the way fashion is taught in academia to eliminate the practice of cultural appropriation in design development. Although some universities have embarked on decolonization of the curriculum (The Fashion and Race Database 2017; FashionSEEDS 2019), many institutions continue to train designers as autocratic decision makers in product development regardless of context, leading to the belief that it is appropriate in all settings (Johnson 2018, 190).

The interpretative model proposed highlights the different opportunities for design to assume the role of promoter of continuously innovative processes that favor traditional activities and crafts without distorting the meanings or impoverishing the identity of the culture they represent. Exchanging practices and sharing methodologies between design and craft are the tools with which to bring different communities closer to the 17 Sustainable Development Goals (SDGs), provided by the 2030 Agenda for Sustainable Development (UN 2015). Archetypal productions that embody the customs, relations, knowledge, and techniques handed down from generation to generation in a localized context (Friedman 1994) are regenerated through a range of design-led processes of translation and exchange. Experimentation with increasingly innovative visions, approaches, and methods supports the consolidation and linkage of culture and territory. The relentless advancement of technological and digital resources, which are increasingly accessible, has led craftspeople to question how to integrate new and advanced processes without losing uniqueness and heritage. At the same time, this paradigm shift does not imply the passive adoption of specific technologies, but instead a path of re-engineering, exchanging, and sharing visions, practices, knowledge, meanings, and values through the process of similarity and contrast, of preservation and innovation, of typicality and novelty (Vacca 2013).

Disclosure statement

No potential conflict of interest was reported by the authors.

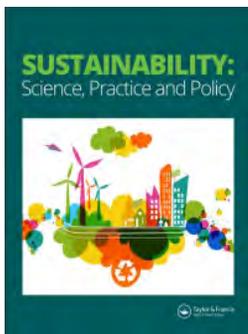
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“What is to be sustained?”: Perpetuating systemic injustices through sustainable fashion

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ABSTRACT

There seems to be a consensus across both the fashion system and academia that “fast fashion” has a problem with sustainability. An increase in consumption of cheap and accessible clothing is behind the rise in extraction and pollution across the world seems obvious, and often the solutions offered span from material and technical solutions to awareness-raising and ethical education of consumers. But most of these interventions either implicitly or explicitly push blame on the consumers of cheap goods. It is “they” who consume too much, the consumers of cheap garments. While goods and behaviors readily available to the upper strata of society are deemed sustainable, it is the aspirational consumption of less affluent consumers that needs to be rectified. This article examines how the general discourse on sustainable fashion strikes unevenly at the lower rungs of social hierarchies, amplifying differences in privilege and wealth while also moralizing, preaching down to, and denigrating the desires of the poor. Using Felix Guattari’s framework of the three ecologies, the discussion examines some familiar tropes in sustainability discourse, focusing on three lines: the emphasis on industrial and technological solutionism, the undermining of democratic principles, and the emotional besmirching of aspirations. These three tendencies add up to a contemporary equivalent of sumptuary laws aiming to hold back the social mobility and lowly desires of the masses. While this may not be the intent of the promoters of sustainable fashion, a thoughtless and single-minded critique of fast fashion impacts the dissemination of agency and blame across the definitions of sustainability. The article calls for practitioners to examine the premises of sustainable fashion more closely. Any serious discussion around fashion must start with the question: *What is to be sustained?*

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Introduction

There is a specter haunting the fashion industry today, a phantom quest of “solving” sustainability, especially the troubling issue of “fast” fashion. As defined within the sector’s scope, the problem is the waste and pollution from current production and consumption volumes. The connection seems obvious, “If a person buys more than he wears,” Roland Barthes (1983, 298) famously pointed out, “there is Fashion.” Thus, excess defines fashion, making waste and pollution the bastard sibling of fashion consumerism. The consensus is that “fast fashion” needs to be addressed (Cline 2012; Thomas 2019), while a more extensive and systemic perspective is often left unconsidered. In sustainability discourse, the fashion industry is the new technology to be “fixed” by recasting complex social phenomena as neatly defined problems that technological approaches can fix (Wang et al. 2020). For example, by innovative industrial processes and materials, or

“ethical consumption” that emphasizes transparency and teaches the masses to be better consumers, the idea seems to be that sustainability can be cut clear from socio-cultural conflicts. Under the current socio-economic landscape, it may be tempting to equate luxury with sustainable and ethical fashion (Joy et al. 2012; Mohr, Fuxman, and Mahmoud 2021).

The emphasis on industrial solutions and ethical awareness effectively bypasses fashion’s entanglement in more complex and contested issues, such as globalization, social conflict, the politics of identity and community, labor organization, precarious work, and the imperative to achieve, and not least public and mental health. The hope appears to be of “fixing” sustainability without questioning the systemic impact of fashion in current societies. Before finding solutions, perhaps one should first ask: What do we want to sustain in fashion?

Such a question may at first seem abstract and idealist. But without questioning the basic

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framework under which the work toward sustainability occurs, the risk is of sustaining *unintended dynamics* in fashion. Sustainability risks becoming a cloak under which to hide how injustices are made permanent, suffering made invisible, while maintaining social conflict and systemic inequities, rather than boosting the democratic principles the industry suggests it desires to sustain (von Busch 2018). Much everyday brand-initiated discourse on sustainable fashion is an excuse for keeping up the status quo, implementing surveillance regimes on goods and labor, and effectively blaming the poor for their aspirations and consumption.

To offer a framework through which to examine the dynamics of justice in sustainable fashion, this article suggests three domains of conflict in sustainable fashion, built on the model of Felix Guattari's (2000) *The Three Ecologies*. In Guattari's model, each of the three ecologies frames a systemic level: (1) the environmental, (2) the social, and (3) the mental realms. As will be seen, the discourse on sustainable fashion suggests changes of a broad scope across the fashion system. Yet, these adjustments all tilt against poor and marginalized communities, making each level a vista for unresolved conflicts. On the *environmental* (or techno-organizational) level, there is a conflict between the aims to fix fashion through industrial, organizational, and material solutionism, while disregarding labor organization and global inequalities. On the *social* level, the fashion system uses discourse praising "democratic" fashion while simultaneously blaming the poor for their aspirations and consumption. On the mental, or *individual* level, the discourse on sustainability pushes a moralizing and classist agenda under the guise of "ethical fashion." The aim of changing user behaviors and values comes to discriminate against and punish low-income consumer cultures, effectively suggesting the values and principles of the poor are not up to par.

The article's organization is as follows. The first section lays out the basis of Guattari's model of the three ecologies and explains how it can be applied to map out the current strategies of sustainable fashion. In the second section, we look at sustainability approaches within the first ecology of environment and techno-organizational solutionism and consider how they affect issues of distribution and justice. The third section examines the social ecology where principles of consumerism and democracy clash and current models of sustainable fashion come to stifle aspirations and possibilities for the poor. The fourth section investigates the mental or individual ecology of values and ethical consumption and how systemic inequalities are multiplied by focusing on cultural principles unattainable to the poor. Finally, the fifth

section suggests a possible path toward more inclusive and constructive practices of sustainability in fashion that could affirm the aspirations of populations with fewer means.

Tensions across sustainable fashion and the three ecologies

While aspiring for sustainability in fashion is a worthy goal, it is also an uphill struggle, if not a paradox per definition (Clark 2008). Various approaches work across several fields to map out scenarios and practices in design, production, consumption, policies, and user behavior, to push for significant systemic change (Fletcher and Grose 2012; Niinimäki et al. 2020). However, many conflicting agendas are present that seldom get the attention that they deserve. One of the most obvious lapses is the conflict between praising "democratic" fashion and its impact on planetary systems.

The taxonomy of Felix Guattari's *The Three Ecologies* (2000) can be useful for framing how these tensions appear across discourses and practices of sustainable fashion. Guattari laid out a model of three transversally connected dimensions or ecological registers: the environment (nature), human relations (social), and human subjectivity (mental). Guattari's model spotlights how the currently unsustainable industrial paradigm ravages across all three ecologies. Guattari calls this paradigm the "Integrated World Capitalism" (IWC), a decentralized force that models the world according to the culturally seductive "American Way of Life," of competitive individualism, medialization, and consumption, where the self-esteem of the individual is tied to lifestyle industries and fueled by norms around productivity, health, well-being, and meaning.

The typology of Guattari's ecologies is organized from the outside in. First, the environmental ecology concerns the planet, environment, natural resources, and industries. Second, society, social relations, hierarchies, our modes of human relations, and togetherness belong to the social ecology. Finally, and in our heads, the mental ecology signifies the realm of psychology and desire, self-knowledge, self-esteem, and inner capabilities.

Through Guattari's model, we can see three systemic dimensions tied together. The *environmental dimension* focuses on pollution and labor in global ecological sacrifice zones, with disposable environments, populations, and species. The *dimension of human relations* is the domain of the Western-centric colonial heritage of appropriation and exploitation through wealth, standards of beauty, and the equation of health and virtue in life practices. The

dimension of subjectivity is the entanglement of fashion and self-knowledge and self-esteem, undermined by judgment, envy, and exclusion. In short, IWC is not merely exploiting the resources of the planet and labor, but eroding social relations and penetrating the attitudes, sensibilities, and minds of consumers (Guattari and Negri 1990, 53). IWC stimulates the multitudes of desires in the unconscious ecologies to propel consumer capitalism to continuous demand for more and more. As they are systemic, Guattari highlights that “fixing” one level, in isolation from the others, is not possible; *they must all be addressed simultaneously*.

It is not hard to draw immediate relations between Guattari’s model of IWC and the current dominance of a specific type of consumerist fashion system. The three ecologies that nourish IWC feed the fashion system as well. As Guattari points out, the three interlinked ecologies all signify social and collective dimensions of injustice; that is, while The American Way of Life suggests individual responsibility, it effectively hides systemic imbalances. Parallels can effectively be drawn to consumers’ responsibility for sustainable fashion consumption. Even if more innovation is currently taking place in more service-oriented business models (Stål and Jansson 2017; Lang and Armstrong 2018), fashion still faces an asymmetrically distributed agency. Primarily aimed to satisfy the needs of the privileged, this betrays the potential to be available as a means for social mobility for populations on the lower rungs of the social strata. Looking more closely, we can find similar systemic injustices entangled across all three ecologies of fashion.

Recommendations for more sustainable consumption are tainted by top-down preaching to the less educated and the poor. While advice on sustainability may seem neutral in general, these guidelines often take certain social positions for granted and appear as preaching from the top down. For example, the influential organization Global Fashion Agenda (2021) advises consumers to “[t]reasure what you own to extend the longevity of your clothing... Repair clothes if they break... Shop less and buy smarter by shopping vintage, second-hand and ethical,” and finally to “invest in high quality and timeless pieces.” While these are praise-worthy suggestions, questions must be raised: To whom is this advice written? Who should treasure their possessions – the rich or the poor? Those surrounded by luxury or heritage goods or those who are in need? Who has the means and status to “invest” in quality? What type of goods are made to last, and what designs are timeless? Who has quality clothes to repair? Who can maintain a professional persona in vintage, repaired clothes, or obvious hand-me-

downs? To put it more bluntly, whose behaviors do we need to adjust? Unpacking sustainability discourse across the three ecologies helps recognize some of the issues at stake.

Environmental ecology: between solutionism and regulating the poor

The first ecology concerns the natural environment and material goods, and thus sustainability often takes the form of industry-oriented fixes. These are the images consumers most often see as urgent production issues, from rivers polluted due to dying processes and toxic chemicals used in agriculture to microplastics in the oceans and the mountains of used and discarded clothes that end up in landfills. To address such polluting elements, the fashion industry is coming to the rescue with technological fixes, from special laundry processes (e.g., ionized water), less caustic chemicals and materials, and compostable and biodegradable textile materials. Consumers are meant to praise the industry as it starts to clean up its mess.

Overall, too little attention is paid to how the emergence of these issues plays out across double standards; what is considered wrong in one setting does not apply when others become victims of the same behavior. Many polluting production moments were established in former colonial countries as environmental regulations became stricter in the consumerist West. Thus, the issue of pollution is not seen in the same way across countries and regions. While this is perhaps most obviously happening in production, we see it as well under the umbrella of “circularity,” in recycling and waste management. It is also inherent in the label of “recycling” or “reuse” as garments are dumped in developing countries (Brooks and Simon 2012; Sandin and Peters 2018).

While the incremental fixes of the industry are not useless, they distort the overall picture. As production and consumption keep increasing, the industry’s improvements are not keeping up, and overall levels of extraction and pollution become worse still. As a larger proportion of the global population is seduced and led toward the pipelines of IWC fashion, the number of garments sold keeps increasing, and the wardrobes get bigger.

The small incremental changes across the industry easily fall into the trap of “solutionism,” which dominates sustainable fashion. Evgeny Morozov (2013) defines solutionism as the cyber-utopian lens of breaking down complex societal issues into technological fixes, which ultimately misses or even increases the initial troubles. As Morozov has it, technological solutionism is a perspective favored by

cyber-utopians, who always see technology through a lens of liberatory potential. It ties into design, as solutionism believes in the inevitable emancipatory prospects of innovation. Solutionism breaks down socio-political contestations into “neatly defined problems with definite, computable solutions or as transparent and self-evident processes that can be easily optimized” (Morozov 2013, 5). It is not about denying the effectiveness of quantification and cybernetic technologies, but how the thinking behind them comes to guide the approach to complex and contested issues; “it colonizes entire theories and domains, imposing its values – openness, transparency, disruption – on whatever it touches” (Morozov 2013, 33).

Solutionism is a “problem-solving infrastructure” going beyond optimization based on engineering principles. Technological solutionism is based on a worldview where sensors and actuators make every process a cybernetic feedback loop to be adjusted and tuned. With individualized solutions, systemic reform is bypassed for “smarter” systems that keep reproducing consumerism. It is an approach that overrides conflict by “promoting efficiency, transparency, certitude, and perfection – and, by extension, eliminating their evil twins of friction, opacity, ambiguity, and imperfection” (Morozov 2013, xiii). It sees every problem as something that optics and quantification can address. Any issue is managed by the same data-processed means – through transparency, surveillance, and choice architecture. Quantification through “fact-checking” or surveillance through “transparency” fuels a data-as-truth mindset where merely measuring is “seemingly objective and consensus boosting” (Morozov 2013, 245).

Focusing primarily on technological, material, logistical, and behavioral tweaks, the general discourse on sustainable fashion becomes overall fashion solutionism. It speaks a language that fits well with default organizational structures and business plans through quantification and transparency. Subjected to these parameters, the promise of sustainable solutionism in fashion is to reach *ethical efficiency*. As a matter of incremental fixes, it translates strategies to be adopted, assessed, and reported within existing corporate structures and supply chains. The challenges to sustainability are cut down to manageable size, and they get framed as problems with defined stakes and solutions. Pollution is reduced to ecologically friendly fibers, transparency is a street address to a factory on the product website, and ethics is a collection labeled “conscious.”

However, the central tension of the solutionist paradigm in sustainable fashion is *what* is seen as

the problem, and even more so, *who* has a problem with fashion that should get solved.

Over the last decades, Main Street brands have implemented increasingly efficient integration of design, marketing, and supply-chain management to radically increase the turnover of items. This has been labeled as “fast fashion.” Fashion editor Michele Lee (2003) called it “McFashion,” a type of fashion consumption just as unsatisfying, commonplace, and utterly forgettable as the fast-food equivalent. On-demand consumption is not limited only to food, fashion, or a socio-economic segment of the market; we have “fast” books in bestsellers, “fast” streaming of music and movies. In addition, consumers expect same-day delivery of goods and the list goes on.

A hypocritical paradox emerges; vast amounts of goods consumed by the upper strata of society are seldom labeled “fast,” even though their practical use and lifespan may be as short as that of the cheap goods accessible to the broader market. This translation between terms becomes even more apparent when fast fashion is put parallel to fast food (Schlosser 2001). As with fast food, the habits of the poor need to get fixed, while the rich and the enlightened elite eat well and eat *nutritiously*. Solving nutrition in fast food is the technological approach to regulating the consumption of the poor – controlling the quality of what the poor should eat while still blaming them for not doing nutritious home cooking. Like in fast food, a larger systemic perspective is missing in the discussion. Poor hands in poor labor conditions feed the poor mouths under poor circumstances and constraints. As with fast fashion, fast food is equated with “bad,” whereas slow and artisanal directly translates to nutritious and healthy.

The technological approach to quality also effectively distinguishes who has, and who does not have, a problem. Luxury goods do not need to get “fixed,” while the versions consumed by the poor do. Luxury goods can get artisanal repairs, and this is promoted, while the actual *repairing habits* traditionally practiced by the poor are willfully ignored. By continuously returning to the virtues of craft and slowness, mass production, and serving larger populations with fashionable goods that they can access, the industrial tweaks let the consumption habits of the wealthy off the hook. As long as you buy quality and craft, you can consume as much as you like because now you support the right hands and heritage. Even if the working conditions of artisans in developing countries may be as bad as those in the factories, slowness and hands still count as better or more sustainable. However, artisans have a more challenging time organizing their labor and

protesting for better treatment. At the same time, their working conditions are harder to measure and quantify when paying living wages. When industrial labor gets domesticated, working at home means living in your factory, which affects family, health, and the possibility to organize labor struggles.

The technological solutionism in fashion boils down to quantification, regulation, and surveillance. Transparency gets easily mistaken for power. While it may be an ethical opportunity to see a photo of who works in a factory and know its address, it gives little agency to consumers to change the conditions of the workers. Instead, the same regime of transparency is used to hide abuse, shift blame, and increase surveillance of laborers and consumers while bypassing the systemic responsibilities of corporations and international trade negotiations.

An example of this being revealed to a consumer in the West can be the documentary *True Cost* (2015). Here, at the film's climax, to the music of an emotional pop song, images are shifted between seductive catwalks, factory workers disabled by labor abuse, and western consumers storming into Black Friday sales, tearing at the goods on sale. The sad song highlights the desperation of all involved; the hunger for affirmation of models, the desperate conditions of laborers in developing economies, and the insatiable appetite for consumption among the poor in the West. However, the scene misses the political games of trade and globalization, the corporate C-suites, the growth of capital and stocks, and all systems of power promoting and profiting from the current paradigm. All, except the powerful, are to blame for the catastrophe we witness in the movie.

Under such narratives, solutionism seems like the only evident approach to realizing a more sustainable fashion industry. Still, by default, it also concludes that clamping down on the consumption of "fast fashion" is the best way forward, effectively regulating the behaviors of the poor. Simultaneously, the consumption of the rich becomes invisible, if not celebrated as more technologically sophisticated. Those who can afford to do so can enjoy splurging on more goods, as these are now from biomaterials, eco-friendly fibers, and artisanal labor. In the end, all goods end up in landfills. The desires and aspirations of the rich are labeled sustainable, while promoting "democratic" consumerism aimed to fulfill the same desires on the part of the needy is considered pollution.

Social ecology: between democratic principles and the pollution of the masses

Fashion is a social phenomenon. It exists between people, and replicates through mimetics and

imitation. As such, it thrives in differences and tensions between groups and styles (Barthes 1983; Lipovetsky 1994; Kaiser 2012). When approached through the lens of critical theory, fashion does not necessarily claim much praise (Barnard 2002). Its deep entanglements with commerce and capitalism signify inequality and class dynamics, if not outright patriarchal, colonial, extractive, and exploitative processes (Paulicelli, Manlow, and Wissinger 2021). If you are a designer, it is seldom uplifting to read an analysis of your professional field. Peek into most academic discussions, and the consensus seems to be that fashion does not bring much good to the table. It is a momentous question for fashion: What is worthy to sustain?

If we take a step back, perhaps there may be some things worth salvaging from fashion on the social and societal levels. Political scientist Joshua Miller (2005) connects fashion to fundamental democratic principles compared with political systems that have repressed both civil rights and fashion. From tee shirts with political slogans to veiling and revealing skin, clothes make suggestions and statements about life practices that speak of contestations and controversies. Clothes take place in societal deliberations. By taking place in public discourse and signifying living practices, clothes can become litmus tests of how democratic ideals are implemented; between citizens who "share approximately equal political power, status, and wealth" (Miller 2005, 6). The democratic ideals of personal freedom, mutual respect, and common action are often in tension in clothing and appearance. Similarly, the principled ideal is not uncontested, as liberties sought by the individual often come into conflict with traditions, solidarity, and community. This also comes to the forefront through fashion; "the pursuit of perpetual change in fashion is destructive to tradition and common ties, but fashion in the broader sense can also be useful to democratic movements" (Miller 2005, 9).

As Miller suggests, fashion supports the possibility of individual voice and political expression, solidarity between groups, and respect for difference. As much as it furthers the expression of the individual, "clothes can encourage a fellow feeling, and that feeling is crucial to democratic community and common action" (Miller 2005, 14). Nevertheless, Miller also warns, the democratic principles of fashion are corrupted in many ways under consumerism – reducing their potential for enhancing democratic capacities. Whether based on style or on class, when fashion helps to establish social hierarchies, it undermines the possibility of a democratic community" (Miller 2005, 13). We must thus not

see fashion as a pure success story of equality and social mobility.

To Miller's democratic principles could be added values central to the dynamics of liberal societies, how fashion supports individual expression, promotes social mobility, and fosters tolerance between different individuals and communities. As Gilles Lipovetsky (1994, 9) similarly argues, fashion "is an ambiguous but effective vector of human autonomy, even though it functions via the heteronomy of mass culture."

Seen from a perspective of societal agency, and like its food equivalent, fast fashion serves a large population across consumer societies that have little agency to change the conditions of their existence outside of cheap and on-trend consumption. Purchasing fashion becomes an accessible means of gaining subjective agency, shaping one's sense of selfhood, and participating in, or even manipulating, social hierarchies. Undoubtedly, fashion as an agency for self-authorship has always been played out with an unjust distribution of means, leaving groups excluded or silenced. We must not simply equate cheap and accessible fashion as the principles of democracy made tangible in goods as "democratic fashion." Still, nevertheless, cheap consumer goods make some of Miller's democratic principles of fashion available for the masses. However, it is essential to notice that the very notion that affordable and accessible garments represent "democratic fashion" highlights how there has been an implicit principle across the industry that fashion is not meant to be democratic in the first place. Fashion consumption is intended to be undemocratic from the start, and the consuming hordes should be grateful for the social advances cheap consumerism has afforded them. As Elizabeth Anderson (1999) posits, selling consumerist tokens of inclusion while keeping most of the population excluded from setting the norms makes the consumer economy cover and patch up an inherently unjust system.

Equating "democratic" with "fast" and "unsustainable" fashion is a common misnomer yet prevalent across much fashion discourse. Lecturing to the hoi polloi that anything "fast" is terrible disguises how Miller's democratic fashion principles are effectively undermined for the consumers of cheap and accessible goods. At the same time, it celebrates and preserves privilege for those with means. This becomes clearer when we examine some of the most common tropes in sustainable fashion as advised to the poor: (1) defining fast fashion as the problem, which undermines the democratic principle of solidarity; (2) suggesting buying less and keeping garments long, which undermines the

principle of individual expression; and (3) urging people to invest in emotionally lasting pieces, which undermines the potential of social mobility. Let us investigate these sustainable tropes more in detail.

While we have discussed the definition of fast fashion as the problem earlier in this article, it is also moralizing the aspirations of the poor. Luxury fashion, by contrast, is deemed essential to the top strata of society and thus more sustainable. Even more so, luxury consumption is no longer considered excessive and unnecessary, and therefore unethical, but instead the epitome of quality, heritage, ethics, and sustainability (Woodside and Fine 2019; Cappellieri, Tenuta, and Testa 2020). With their longing for "democratic" tokens of inclusion, the masses' desires quickly accumulate to unsustainable amounts of goods. More so, with their cheap copies, their goods do not support the cultural values of heritage brands or artisanal crafts. Their copies undermine the actual value of fashion. Thus, the consumption of the poor can only be shallow and vain. Through trickle-down, the poor are to blame for imitating the rich. They need to be lectured to and be made "aware" of the vanity of their fleeting and lowly desires. In contrast, the consumption of the rich serves as the cornerstones of a cultured society.

Getting the masses of consumers to buy less is thus a struggle. When not physically limiting the number of pieces people can buy, the sustainability discourse tries to make consumers "buy classic pieces." But there appears to be little concern about who can afford the quality of such items. It is much easier to buy a classic piece when one is in a social position that cements this social standing, making it last over time. A classic piece must also fit into the rest of one's status environment. It is easy to do this if I am higher in the social strata, but less so if I am poor or marginalized. The imperative to "buy classic" basically tells the needy; buy only what you can afford, stay at the low rung, and do not aspire to be one of us.

The second suggested method translates to something similar, like "buy things your kids can inherit." That is easy to say if you live in a castle and want your kids to inherit your status, but less so if you are poor. Most people want to inherit a vintage Chanel bag, but less so the cheap copy. Inheritance is an idea that favors those with assets to inherit; it petrifies socio-economic hierarchies and shuts down avenues of social mobility.

Both approaches above, to buy classic and to inherit pieces, hampers the democratic potential of individual and political expression toward styles that signify the lasting values already established by social stratification. Expressions are aligned with

those in power, sanctifying their quality pieces with permanent signification, while social climbers are hindered from introducing usurping expressions.

Finally, the third suggested approach is the rhetoric around what is often called “emotional durability.” It is a theme that takes for granted the idea that clothes can embody pleasant memories, stirring affective recollections of the rustic values of the past. Here, it is assumed that memories are good and the past worth conserving, again a perspective that favors the privileged. With this approach, using fashion for social mobility is hampered. The focus on emotional durability impedes the possibility of the needy to use fashion as a model for moving on, forgetting, and celebrating new accomplishments. To populations emerging from poverty, fashion can be a tool to transgress being downtrodden and move toward new possibilities emotionally. This is the radical emancipatory and pragmatic potential of democracy; societal positions are open to question and not set by fate. In the bitter defeats in life, fashion allows us to desire change, however shallow this agency may be. Social mobility is again aligned to favor the privileged and well-off by emphasizing emotional durability.

All these approaches above are essentially contemporary sumptuary laws disguised under the overarching virtue of “sustainability.” They foster elitist judgment rather than tolerance, effectively highlighting how sustainability is something the poor must practice while suggesting the rich are already doing it and turning away the spotlight from their walk-in-wardrobes. As we have seen so far, the main consequence of this discourse is that it *sustains systemic injustices* while effectively *blaming the poor* for their aspirations to consume and be “democratic” in the ways the rich are.

Mental ecology: between virtue and vice

In the mental ecology, sustainability is promoted through the modification and dissemination of correct values. Familiar tropes suggest shifting values from desire, greed, and vanity to virtues such as authenticity, honesty, and the yearnings for a good life, beautiful as much as ethical. Beauty, purity, and perfection can even become interchangeable values mirrored in the perfected self (Widdows 2018). The wealthy set these standards with the modeling of the perfect life, while the poor are excluded and later cursed if they aspire for these same standards beyond their means. With a shift toward a discourse driven by values and inner qualities across the mental ecology, sustainability also has consequences for the discourse around the inner values and cultures of the consuming masses.

If discussing values, one may need to take a step back and ask: Can fashion promote any ethical values in the first place? It is a question not commonly appearing in academic inquiries. Karen Hanson (1990) suggested three decades ago that fashion stands in contrast to many of the foundational values and virtues of social reality that philosophers have examined over the ages. Across social organization, permanence is favored over continuous change, the profound over the inessential, the soul over the body, agency over passivity. To philosophers, Hanson suggests, the truth of life stands in the inevitability of death, and one must thus face death to see the truth, not like fashion, which denies or seeks to escape our final destination. In a search for truth, fashion is at best insignificant, at worst a conspiracy and outright lie. Examine the values of fashion, and philosophers find mainly vanity and the work of illusions.

When it comes to the values of consumerism, they are cursed in everything from religions and ethicists to psychologists and Marxists. Examples can be found in Theodore Adorno’s famous critiques of subjecthood under consumerism and *The American Way of Life in Minima Moralia* (2005), which exposes troubling shifts in the cultural transformation toward the individualist subjecthood and its dire consequences for sociality. It is a theme also approached in Christopher Lasch’s bestselling book *The Culture of Narcissism* (1979), and the diagnosis of cultural self-absorption has been prolific across critics of consumerism. Under these settings, Lasch argues, the hedonistic need to acquire the symbols of affluence and status undermines the liberal possibilities of society and only comes to serve competitive consumption. Following Lipovetsky (1994), fashion is a movement that finally helps consumer society to overcome the old virtue of thrift and to make vanity not only acceptable but a precious cornerstone of contemporary identity production. This is only intensified with social media exposure and the need to achieve and perform (Han 2015). These forces emphasize the individual subject as the moral center of gravity aligned with what and how it consumes, or as Zygmunt Bauman has it, consumers “are, simultaneously, promoters of commodities and the commodities they promote” (Bauman 2007, 6). This move has shattering consequences for the discourse around sustainable fashion and how the issue is addressed as a call for ethical and virtuous behavior.

As noted above, the current discourse around sustainable fashion is mainly driven by consumers’ choice, and blame for the unsustainable conditions of fashion is generally assigned to “overconsumption.” This leads to the conclusion

that the desires and habits of the masses become painted as the planetary villain. Only by changing *their culture* can sustainability come about. This focus on changing cultures partly emerges from a cynical or limited reading of ecologist and systems thinker Donella Meadows (1999) model of “levers for systemic change.” Meadows famously argued that to find leverage for systemic change, one must intervene at points that shift the whole system. In Meadows’ line of thought, intervening at the level of parameters, standards, or taxes has a low impact factor, whereas changing incentives, values, and goals has a higher impact on systemic change. For increasing effectiveness, one must go for the “deeper” leverage points; cultures must change, and in this case, the cultures of the poor.

Meadows’ argument for culture and paradigm change, the parameters that have the most significant systemic impact, is a poignant critique against minor fixes and also against technological solutionism. Tweaking with materials and supply chains only offers so much leverage for change. As Meadows posits, even taxes and policies have limited applicability compared to changes in behaviors and incitements. In Meadow’s model, the most significant changes come from changes in values.

This focus on values and culture has profound consequences when applied in conjunction with individualism and consumer mindsets. If there is a problem with overconsumption and the values and culture must change, this affects the populations who let their unsustainable values and cultures guide their behaviors. As pointed out earlier, in the general discourse, the poor have a “problem” with their consumption of fast fashion. But now, it is not merely a matter of technological fixes or changing behaviors; it is the values and cultures of the needy that are to be corrected.

The moralization of consumption becomes increasingly apparent as the discourse turns toward “value-driven” branding, where companies strive to create deep, meaningful relationships with consumers, not merely selling goods (Bereman et al. 2020). In these settings, fashion is more than just cool stuff. Focusing on values, a customer buys a product that suggests something about their deeply held beliefs. As brands are “creating value for customers,” these values help define customers’ lives. When the buyer comes to identify with these values, brands are in the business of designating the importance and worth of people and their inner lives, esteem, and self-worth. Put bluntly, good consumers are good people, virtuous and worthy of respect, while bad consumers are rightfully condemned for their wickedness and vice. This becomes especially prominent when applied to the virtues of sustainability.

With value-driven sustainability, brands embrace a discourse to again speak down to the poor. Now the needy lack means and desirable assets, and they are supposedly also *devoid of sustainable and ethical values*. They are not aware, at least not like the enlightened consumers of sustainable fashion. Or worse, being deplorable, they are part of an inferior culture. The civilized (and prosperous) consumer, by contrast, can keep on buying couture or vintage undisturbed, and this is virtuous, civilized, and cultured.

Consequently, with superior style and morality, this sustainable consumer can now look down at the riffraff that rushes the sales on Black Friday. They lack exquisite taste, and more importantly, they lack the ethical, refined, and cultured values of the sustainable consumer. This light of virtue saturates the discussion around goods; brands take climate action, promote equitability, restitution, and work close to their communities. By contrast, the poor are so wicked that they cannot even access the tokens of righteousness.

While the sustainability discourse explicitly celebrates the values of the rich, suggesting the moral codes of ethical consumption are equally distributed, it punishes the poor for their social condition. Brands sell their more ethical offerings at high prices, while blame is cast on the poor’s inferior and polluting values and culture. The standard of virtue, of *purchasing virtuous goods*, is set on the terms and wealth of those with privilege, while brands simultaneously withdraw avenues for the poor to aspire and reach these standards. It must be noted that fashion is not equitable to start with, as it is played out on an unfair field of appearance, race, abilities, and affluence. The way sustainability is frequently framed vilifies the poor for their lack of means, and under a consumerist framework, equates this with a flawed character. While it may not have been its aim, the discourse around sustainability has become a new Victorian morale to regulate and harass those on the breadline.

Concluding discussion: sustainability beyond maintaining social stratification

In each of the ecologies examined above, the values promoted through the current discourse on sustainability hampers the possibility of the poor using fashion to move beyond their precarious condition. In each of the three ecologies, surveillance is promoted, barriers are erected, and moralizing discourse limits how fashion can act as a vector for liberation for the needy. In the everyday workings, the democratic potential of fashion is preserved only for the rich or those with social status. On one

hand, the top strata need fashion the least for social mobility or a sense of control over their lives. Populations on the lower rungs of social hierarchies, on the other hand, are blamed for their unsustainable consumption; their behavior is seen as a problem to be fixed while their values and cultures must become “aware” and rectified.

So how can sustainable fashion discourse take these unintended aspects into account? A first step would be to emphasize and support sustainable *practices* with clothes, more than selling sustainable *products* (Fletcher 2016). Such a perspective would reveal that large populations already practice sustainability by caring for their clothes, making them last, and not binding sustainability to purchasing expensive or symbolic goods. As pointed out by Smelik (2021), a new materialist perspective of shared agency between producers, garments, and users, could open up and contribute to a more nuanced understanding of care practices beyond the objects themselves.

To fully embrace the democratic potential of fashion, a more socially beneficial aspect of democratic fashion could be to emphasize the experimentalism combined with limitations to power at the core of democracy. In doing this, the discourse on democratic fashion could build on the ideas of political philosopher Roberto Unger. As Unger (2007) points out, democracy is a form of radical experimentalism, not preserving the status quo. It leaves the future open for rearrangements by the people. Its purpose must be to make its people take part in *socio-political rearrangements*. This interest in the shape of society is essential to democracy, as Unger (2007, 242) suggests:

Under democracy, this interest becomes paramount, for democracy grants the ordinary men and women the power to reimagine and to remake the social order. That is why under democracy prophecy speaks louder than memory. That is why democrats discover that the roots of a human being lie in the future rather than in the past. In a democracy, the school should speak for the future, not for the state or for the family, giving the child the instruments with which to rescue itself from the biases of its family, the interests of its class, and the illusions of its epoch.

Instead of a single-minded focus on fashionable products, both industry and researchers could widen the scope to examine *the vital dynamics* and social engagements with fashion (von Busch 2021). This would mean not limiting fashion to goods and clothing items that embody sustainable ideals but instead unpacking fashion as a *social practice beyond consumerism* and identity reproduction. Instead of the knee-jerk reaction to blame fast fashion, the discourse on sustainability needs a more holistic

approach involving all three ecologies, where injustices across the three dimensions target intersectional redesign without stifling its democratic potential for agency. Mapping these suggestions back on the three ecologies means interlinking the many initiatives of sustainability across all three ecologies. The initiatives in the *environmental dimension*, such as industry change and circularity, must be linked with mitigation of social conflict in the *dimension of human relations*, decolonial practices, and affect-based perspectives on fashion. These initiatives, in turn, could align with the remodeling of fashion in the *dimension of subjectivity*, by the promotion of user agency, self-esteem, and “fashion-abilities” (von Busch 2008, 2020).

In the end, sustainable fashion must be more than a means for maintaining social stratification through covert sumptuary laws. While it is undeniable that increasing numbers of fashion items being sold is a global challenge for the industry to tackle, promoters of sustainability must be aware of the hypocrisy of luxury producers and be careful not to systematically punish the poor for their aspirations. Sustainability in fashion must *enhance* fashion’s democratic, dynamic, and vital principles while staying within planetary carrying capacities.

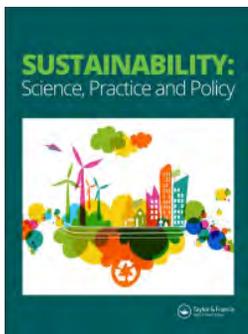
Disclosure statement

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Selling sustainability: investigating how Swedish fashion brands communicate sustainability to consumers

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ABSTRACT

Over the last thirty years, sustainability has become a growing concern in the fashion industry. While there is agreement among a growing range of actors regarding the need to engage with the social and environmental challenges created by the fashion industry, there is less consent regarding what sustainability entails. Although “sustainability” may be intuitively understood, it has different meanings, depending on how it is applied, and who it is applied by. Without a clear-cut definition, sustainability becomes subjective. In this context, there is a need for research at the intersection of brand-sustainability initiatives and their communication to consumers, who play a vital role in this transition. Drawing on a case study of the Swedish fashion industry, we explore how evolving industrial business models and emerging best practices are informed by a robust understanding of sustainability. We evaluate how brands communicate sustainability to consumers across three key sites: brand websites (including corporate social responsibility reports), social media platforms, and in-store campaigns. We found that not only do brands use a range of practices to define sustainability differently, but furthermore, these definitions vary depending on the context. Considering the industry’s ongoing history with greenwashing, it is vital to address and confront this issue head on. We argue that there is a need to determine what constitutes sustainability in the fashion industry and, in turn, hold businesses to that standard. As COVID-19 has only magnified and intensified these challenges, the article explores the implications of a more robust approach for both theory and practice.

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Introduction

The twenty-first century is increasingly defined by a focus on sustainability, of which the fashion industry is no exception (Brydges et al. 2021; Mukendi et al. 2020). The fashion industry has longstanding sustainability concerns, whether that be around the environmental impact of production and consumption (Henninger, Alevizou, and Oates 2016; Athwal et al. 2019), the anti-sweatshop movements of the 1990s (Klein 2010), or more recently through modern-day slavery allegations (Dickson and Warren 2020) and growing concerns regarding the overproduction and overconsumption of garments (Brydges et al. 2021). The popularity and dominance of fast fashion—a business model which marries rapid-paced production of trendy designs with low-cost production—has fueled both the overconsumption and underutilization of garments and challenged working conditions in garment-producing countries (e.g., Bangladesh) (Iran and Schrader 2017; Brydges

and Hanlon 2020; Kabeer, Huq, and Sulaiman 2020). Indeed, much of the industry is locked into this lucrative yet exploitative and unsustainable business model (Niinimäki 2018).

In response, from the annual Copenhagen Fashion Summit, the 2019 G7 Summit, the Fashion Industry Charter for Climate Action, and the United Nations Sustainable Development Goals (SDGs) Partnership Platform “SDGs for Better Fashion,” both industrial and (non-) governmental bodies have advocated for the fashion industry to develop and implement practices that not only protect the environment, but also align with broader climate-action guidelines. Many are also calling for greater social sustainability regulations to prevent tragedies such as Rana Plaza, a disaster that saw 1,134 garment workers lose their lives in Bangladesh (Reinecke and Donaghey 2015). Across the industry, there are also growing calls for *systemic change*, and the need to overcome challenges highlighted in and

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across fashion/textile supply chains, such as the Rewiring Fashion campaign initiated by the Business of Fashion or the Manifesto for a Fashion Revolution by Fashion Revolution.

While the magnitude of the sustainability crises facing the industry may appear to be well understood, questions, such as “Can fashion ever be sustainable?” (Ro 2020) or “Sustainable fashion? There is no such thing” (Indvik 2020) remain commonplace. Here, a critical challenge relates to the meaning of the word, as notions of sustainability are subjective. Terminology used to unpack a brand’s sustainability varies across “the ecofashion lexicon” (Thomas 2008, 530). Indeed, there are important distinctions between various terms in play, and these may be understood, and operationalized, variously by different stakeholders working to address social and environmental challenges associated with the global fashion and apparel industry.

Although “sustainability” may be intuitively understood, without a clear-cut definition it can have different meanings, which is mirrored when discussing sustainable fashion (e.g., Fletcher and Tham 2019; Mukendi et al. 2020). Thus, there is a need to explore how newly established “best practices” can be underpinned by a robust understanding of sustainability. In this article, we turn to “sustainability” as an umbrella concept to not only signal the ever-expanding breadth of issues found within and across the sector—from animal rights and deforestation to worker rights and gender-based violence—but also to capture the interconnected nature of the issues at hand. Each does not exist in isolation from the other. Rather, the social and environmental challenges facing clothing production and consumption are systemic, intricately woven together, and connected to structural inequalities.

There is a need for research at the intersection of brand-sustainability initiatives and the communication of these initiatives to consumers across retail environments. In the current economic environment, in which fashion brands have had to close operations and move to online platforms in response to COVID-19 safety protocols, communicating sustainability and associated best practices becomes ever more challenging. Not only do brands have to deal with the ongoing and unpredictable conditions surrounding their pivot from in-person targeted messaging to an online environment, but they also have had to deal with increased media fragmentation. Social media platforms (e.g., Facebook, Instagram, Snapchat, TikTok) have changed the way brands communicate to and with the public (e.g., Bürklin, Henninger, and Boardman 2019). Brands must now engage in real time, dialogic interactions.

Using online platforms, consumers have the (digital) space to publicly endorse companies, acting in a best-case scenario as ambassadors, or, in a worst-case scenario, expose brands for practices they deem as unsustainable. Mapping knowledge-dissemination strategies from brands related to sustainability provides critical insight into the opportunities and challenges they face in the transition to a more sustainable fashion industry (Henninger, Alevizou, and Oates 2017). Reputation management related to corporate social responsibility (CSR) must move beyond the confines of an annual report (e.g., Wells et al. 2021), buried on the brand website, to instead be woven within and across digital communication strategies.

We turn to practices of CSR to consider the various strategies brands employ to mitigate their social and environmental footprints, including partnerships with nongovernmental organizations (NGOs) and other stakeholder groups. CSR has come to represent the policies and practices used by companies to demonstrate engagement and commitments within and across their supply chains—whether by pledges, for example, for climate action through a reduction in greenhouse gas (GHG) emissions (UNCC 2021), decreasing use of toxic chemicals (Greenpeace 2018), assurances in forest stewardship (Canopy n.d.), or support for labor rights (AFBSB 2021).

Thus, we pose the following research questions:

1. To what degree are evolving business models and emerging best practices informed by a *robust understanding of sustainability*?
2. How is sustainability articulated to consumers in terms of facts and overall narrative (best practices)?

We draw on a case study of the Swedish fashion industry to investigate how the country’s fashion brands communicate sustainability to consumers. The Swedish context was chosen purposefully for three main reasons. First, Sweden is ranked as the second most sustainable country globally (Robeco 2021). Second, the Stockholm fashion show has been deemed to “demonstrate leadership in sustainability” (Robinson 2021). Finally, the Swedish government has pledged to move away from a linear economy to support circular alternatives (Sweden.se 2021).

Literature review

What is sustainable fashion?

Sustainable fashion is a vast and highly contested terrain with countless definitions and interpretations, as well as terminology that has often been used interchangeably including green, eco, organic,

or slow fashion (e.g., Joergens 2006; Henninger et al. 2017; Blazquez et al. 2020). Mukendi et al. (2020) argue that sustainable fashion cannot be defined in absolute terms, given that “what sustainability is” is subject to change, depending on “needs” and technological innovations, and thus, emerges either as a result of pragmatic or radical changes. For example, Hur and Cassidy (2019) found that designers emphasized environmental, rather than social, dimensions of sustainability, while Gurova and Morozova (2018) define sustainable fashion as items that are produced locally and in low quantities, using eco-friendly, quality materials, which are designed for longevity. Clark’s (2008) definition of slow fashion emphasizes that this idea is about more than simply reducing production and consumption cycles; it is a philosophy and way of creating fashion.

For others sustainable fashion is a combination of (1) sustainable development and (2) fashion (Lundblad and Davies 2016). The former is defined as meeting the needs of current generation without compromising the needs of future generations (WCED 1987). Although heavily criticized and part of a political doctrine, the definition alludes to ensuring that life is preserved, and that social and environmental challenges are intrinsically connected. This links to Fletcher and Tham’s (2019) notion of Earth Logic which focuses on two issues: (1) developing new practices and understandings to look after the health and survival of the planet and (2) knowledge generation and dissemination. Elkington (2006) visualizes sustainability as overlapping circles, whereby sustainability is represented as the interchange between social, environmental, and economic aspects, with culture having been added more recently to the mix.

These definitions bear similarity to related terms such as *ethical* and *slow* fashion, found within a seemingly ever growing “eco-fashion lexicon” (Thomas 2008, 530). Ethical fashion focuses more on the social angle and promotes “fair trade principles with sweatshop-free labor conditions while not harming the environment or workers by using biodegradable and organic cotton” (Joergens 2006, 361), while slow fashion is “about designing, producing, consuming and living better ... [It is] a different approach in which designers, buyers, retailers and consumers are more aware of the impacts of products on workers, communities and ecosystems” (Fletcher 2007).

While definitions may vary, understandings of what it means to be sustainable surround issues of social justice and environmental security, in relation to systems and processes of production, consumption, and disposal. A key consequence of these

different terms and notions of sustainability is also linked to brand communication, in that claims about sustainability could be made, which may be difficult to prove, through a lack of transparency and common definition (Granskog et al. 2020; Hughes 2020). Market insights highlight that “shoppers don’t trust fashion brands’ sustainability claims” (Pinnock 2021) due to a fear of greenwashing (Harris, Roby, and Dibb 2016; Granskog et al. 2020; Hughes 2020), and rather see sustainability increasingly as being synonymous with expensive (Ritch and Schröder 2012).

More recently, the concept of circular fashion has also joined the ranks. The circular economy is an influential concept, applied to a growing array of industries to maximize resource use and minimize waste (Geissdoerfer et al. 2017). The circular economy is generally understood to have three key principles: design out waste and pollution, keep products and materials in use, and regenerate natural systems (Niinimäki 2018). There is a growing body of literature investigating the implementation of circular economy principles in the fashion industry such as take-back initiatives (Hvass and Pedersen 2019), secondhand fashion (Hur 2020), and textile recycling (Sandvik and Stubbs 2019).

In summary, there is an expanding range of terms and definitions of sustainability in the fashion industry which are accompanied by a variety of practices and activities.

Sustainability communications

The previous section outlined various definitions of sustainability that while similar in nature can also differ in terms of their focus. Thus, unsurprisingly, communicating what sustainability means and also how these messages and initiatives conform with consumers’ demands, is challenging. Communicating sustainability refers to brands seeking to raise awareness about how their products and/or services align with social, economic, and environmental sustainability. The aim of sustainability communication is not to simply broadcast targeted, one-way messages, but rather to encourage dialogic communication between brands and their respective stakeholders (Henninger and Oates 2018).

This article focuses on organizational communication, which deals with public relations, including CSR, media, investor relations, and environmental communications (Henninger and Oates 2018; Luo et al. 2021). When brands communicate with their stakeholders, they encode their message and forward it to a transmitter (e.g., brand website, social media) which is then picked up by the receiver (audience/stakeholders). The receiver decodes the message and

makes sense of it (Fill 2009; Boardman and McCormick 2021). Transmitting messages that have social and environmental sustainability cues can indicate to consumers that brands produce garments that have a reduced impact on the environment compared to their counterparts. Brands that use sustainability communications seek to (ideally) alter their consumers' consumption patterns to be more environmentally and socially conscious, as such, communication can be a powerful tool (Henninger, Alevizou, and Oates 2017) that may also support *systemic transformation* and disseminate best practices that are informed by a robust understanding of sustainability.

The twenty-first century has seen increased media fragmentation fostered by the development of social media platforms that allow for messages to spread instantaneously, 24 hours per day and seven days per week, with a global reach, and to facilitate dialogues between brands and consumers, and among consumers (Bürklin, Henninger, and Boardman 2019). The emergence of digital communication implies it is “easy, ... convenient and ... incredibly powerful; not because of technology, but because of how that technology nurtures the connection between people” (Ryan and Jones 2012, 153).

Brands can no longer hide, and are often scrutinized for their actions, which can spread like wildfire once in motion. Recent examples where this has happened include scandals, such as burning unsold products (Shannon 2020), or association with modern slavery issues in fashion-supply chains in developed countries (Duncan 2020). Such media reports have shaken consumer trust, with conscious consumers increasingly being aware of issues relating to greenwashing, whereby consumers feel that certain broadcasted messages may not tell the entire truth or are misleadingly written. Moreover, CSR practices have been seen to amplify tensions between brands and their suppliers, as companies attempt to balance conflicting interests and demands from stakeholders and conscious consumers alike (Kabeer, Huq, and Sulaiman 2020).

Turunen and Halme (2021) indicated that although brands are increasingly communicating sustainability messages, one of the key challenges that remains is making these actionable and thus, consumer-oriented. For example, to overcome issues related to greenwashing, brands have started acquiring third-party accreditations (e.g., Öko-Tex, GOTS) which highlight that companies use, for example, less harmful chemicals in their production processes or generally more environmentally friendly materials (Testa et al. 2015). Implementing codes of conduct to be audited and certified by a third party is

another approach to measure and communicate accountability (LeBaron and Lister 2015).

A key benefit for consumers is that they can easily identify whether a brand has a label or not and as such is third-party accredited. Yet, there are drawbacks associated with these labels, in that they may only cover certain aspects (e.g., use of chemicals), are costly and often unaffordable for smaller brands, or not recognized by consumers (Turunen and Halme 2021). However, code-of-conduct audits are not necessarily effective at flagging issues beyond the surface (see, for example, LeBaron and Lister 2015). This was illustrated in a recent investigation by *The New York Times* which suggests that the amount of certified organic cotton sold in India far exceeds what is actually grown in the country (Wicker et al. 2022). This is an example of a situation that can have implications not only for certification organizations but for the brands that rely on these certifications as key pillars of their sustainability commitments.

Company approaches may be limited when it comes to notions of transparency, however, not least with respect to certification standards (LeBaron, Lister, and Dauvergne 2017) and models of economic growth (Fletcher and Tham 2019). Where CSR practices may include standards in corporate governance, these provisions are tied to an “ethical audit regime” (LeBaron, Lister, and Dauvergne 2017). Standards carried out through CSR “from above” are not value neutral but are established and enforced by elite stakeholders imposing “new social regimes of power and inequality” (De Neve 2009, 63). Even with audits in place, practices of benchmarking brands based on compliance with corporate-led standards work to support what LeBaron, Lister, and Dauvergne (2017) have understood as “the industry-led privatization of global governance” (2017, 958).

When we understand knowledge as situated (Dengler and Seebacher 2019; see also Haraway 1988), critical reflection on social location and positionality must be part of the work to be done. If calls for degrowth seek to challenge structural inequalities embedded within the “colonial global economy” (Bhambra 2021) researchers must devote attention to dynamics of power. For Dengler and Seebacher (2019), “[a] feminist decolonial degrowth approach is needed to avoid the unintended reproduction of patriarchal and colonial continuities” (Dengler and Seebacher 2019, 247). Challenges related to “sustainability” are thus vast, diverse, and divergent as brands are tasked to consider social and environmental impact(s) differently, and in tandem, across multiple spaces, contexts, and temporalities.

Table 1. Data summary.

Brand	Category	Role
Brand 1	Children's clothing	Sourcing and sales manager
Brand 2	Children's clothing	Sustainability manager
Brand 3	Children's clothing	Product manager
Brand 4	Denim	Sustainability coordinator
Brand 5	Designer bags/accessories	Sustainability manager
Brand 6	Designer menswear	Co-founder
Brand 7	Designer menswear/womenswear	Sustainability specialist
Brand 8	Designer womenswear	Founder
Brand 9	Fast fashion	Sourcing manager
Brand 10	Fast fashion (womenswear)	CSR and quality manager
Brand 11	Independent fashion	Founder
Brand 12	Independent fashion	Founder
Brand 13	Independent fashion (upcycled)	Co-founder
Brand 14	Outdoor apparel	CEO
Brand 15	Outdoor apparel	Founder and CEO
Brand 16	Secondhand retailer	Sourcing manager
Brand 17	Sustainable basic apparel	Co-founder
Brand 18	Sustainable menswear	Founder and CEO
Brand 19	Womenswear accessories	Sustainability and brand manager

Free-form sustainability communication is a further way to communicate sustainability messages to consumers (Peattie and Crane 2005). Free-form implies that these messages are not verified by third-party organizations but rather are claims made by the organizations themselves about their own products (Henninger 2015; Turunen and Halme 2021). The International Standards Organization (ISO) defines these claims as falling into their Type II category, outlining that they are one-sided (e.g., from the organization or manufacturer) and self-declared. Thus, free-form sustainability communication seeks to appeal to consumer emotions by discussing aspects of transparency and traceability along the production process and more generally along the entire supply chain (Alevizou 2020). While this free-form communication is more accessible to companies, as it is self-declared content, it does not have “costs” associated with it (unlike eco-labels). Yet, it could foster distrust, as the information provided is based on claims made by the company that may be written in vague and ambiguous language (Alevizou 2020; Turunen and Halme 2021). A vicious cycle emerges in which third-party accreditations may be more reliable, yet costly, while free-form information, although truthful, may be seen as less reliable and biased. One key issue that neither form of communication addresses is how messages that are communicated can be actioned by consumers, which is an aspect addressed in this research.

Methodology

This qualitative research draws on 19 semi-structured interviews conducted with small, medium, and large fashion-design brands based in Sweden between January and December 2019. Prior to conducting this research, we created a database of Swedish fashion brands communicating about sustainability either in stores, on their website, or through their social media accounts. A total of 85

brands were contacted, for a response rate of 22% (Table 1).

As also outlined in Table 1, the fashion brands included in this study represent a broad range of categories that were purposely chosen to gain a better understanding as to what sustainability messages are communicated and how emerging best practices could inform a robust understanding of sustainability. We interviewed different sized brands to gain a better feel for the status quo in terms of sustainable fashion communication and what our respondents felt might influence consumer behavior over the long term.

Semi-structured interviews enabled us to develop a protocol that covered themes of interest while also allowing for conversations to expand on topics or to explore new ones that were of interest. The range of questions that we asked covered aspects of the history and motivations behind the brand; the business structure, sourcing and design decisions; and the critical challenges and opportunities related to sustainability and the circular economy. Emphasis was placed on exploring where and how sustainability policies and initiatives are communicated to consumers. While we are not able to generalize from this study's findings, this study can foster insights into current best practices and how these may be communicated. This is especially important because different segments of the fashion industry often prioritize different strategies. For instance, promotion of children's clothing may focus to a greater degree on materials as parents are inclined to be more conscious of what their children wear. By contrast, denim manufactures might be apt to emphasize supply-chain issues related to dyeing and finishing jeans or other items.

Interviews were recorded, transcribed, and sent to the respondents to review (Valentine 2005). We then coded the transcripts according to dominant themes and analyzed and used these categories for

theory-building (Cope 2005). To achieve inter-coder reliability, we independently coded parts of the data before we discussed the results and resolved any discrepancies. All respondents have been strictly anonymized to protect the identity of participating brands.

Results

Communicating sustainability on brand websites

Most of the brand representatives that we interviewed work for a business with a company website which has a dedicated sustainability section. On each fashion brand's landing page, sustainability is typically presented along the header or the footer of the homepage, alongside other company details including "about us," "careers," and "terms and conditions" (e.g., Luo et al. 2021). In addition to sustainability, terms such as "corporate social responsibility," "codes of conduct," or "social rights" are used and these features reflect the complexities associated with sustainability as an intuitively understood concept. Approaches to sustainability vary across businesses, in that some had either a stronger focus on social sustainability through *social rights* or *corporate social responsibility* as opposed to an environmental focus.

Moreover, in addition to the focus of their sustainability efforts, brands take different approaches in deciding how to showcase this information. For example,

We need to create desire for the products that we sell by getting into the hearts and minds of the customers. We don't want to stigmatize the brand and run the risk of being too niche by putting sustainability front and center. But, we do make sure that all of the information that you ever could possibly want is available: traceability, labor aspects, certificates of organic cotton, and whatnot (Interview, Brand 7).

This approach demonstrates that one way of sharing sustainability information and communicating with stakeholders is via a "one-stop-shop" approach whereby it is up to the "receiver" to decipher the message and pick out elements that are of interest. How these sustainability-related messages are portrayed to the audience can differ depending on the brand. For instance, childrens-wear brands seem to focus more on imagery and emotional appeal to parents while outdoor brands center on nature, wildlife, and ultimately the harmony between the brand and the natural environment (Fletcher and Tham 2019).

Websites of brands within this research relied on a combination of free-form communication processes and third-party certifications. Thus, audiences,

on one hand, need to evaluate whether they trust the free-form communication aspects and/or if they are put at ease through third-party certifications. In both instances, consumers (or other stakeholders) rely on the brand to disclose accurate information that is traceable and reliable (e.g., Henninger 2015; Turunen and Halme 2021).

Brands also risk alienating consumers that may not be interested in sustainability or are more skeptical of brands that have a sustainable angle. This is a risk which aligns with key challenges associated with free-form communication: the trustworthiness of the messages provided and the assumption that the receiver can understand them (Alevizou 2020; Turunen and Halme 2021). Yan et al. (2020) highlight that consumers may also not always have the necessary level of sustainability knowledge to translate willingness into actual action and this lapse is partially due to the sheer volume and overwhelming scale of information available on websites.

To make the communication of sustainability more manageable or reader-friendly, sustainability-related information on the brands' websites tends to be organized into several sections that move across production networks. For example, a brand might begin with information pertaining to fabrics and raw materials, progressing on to discussions about manufacturing and commitments to garment workers, and finally considering garment care (i.e., washing, recycling, mending). This growing focus on care seems to be aligned with circular economy discussions around how to extend the life of a garment, although most brands do not use language pertaining to circularity in their sustainability messaging.

While sustainability is not new, communicating sustainability messages on websites remains a relatively recent phenomenon, which has gained popularity in the last decade (Luo et al. 2021). This is seen in the case of Brand 8:

[Our] brand sustainability page has been there for four or five years now, but as it looks today is actually pretty new. The new content has been there for about a year and a half, but the design is only three months old. We have been constantly trying to improve the site and make it better.

We also found that various brands actively withheld communications related to sustainability. For example, Brand 10 insists:

[F]or much of our brand's history, we took an active decision to not shout out what we do in terms of sustainability in order to minimize the number of discussions from the media and NGOs.

This was especially the case for fast fashion brands. For instance, Brand 10 noted that "the more

we spoke, the more issues we got.” In other words, the more information they provided, the more they were to be scrutinized. The respondent went on to remark:

Despite it all, because we are a fast fashion brand, this is a conversation we need to have. We just need to do our homework, share how we are working with sustainability and tackle the hard questions when they come up.

While our interviewees recognized a clear need to communicate how they engaged with sustainability, they also understood that being too transparent could invite negative attention.

This observation links to Kolb and Kozlowski (2019) observations about “honesty” and provides an opportunity for systemic transformation. Rather than seeing sustainability as an ultimate state, it should be interpreted as a “way of work” or philosophical approach (Clark 2008; Fletcher and Tham 2019) that challenges the status quo and continuously improves current practices by learning from identified shortcomings. Yet, for this to become a reality, it is vital for thought processes surrounding sustainability to also include tangible examples for how sustainability can be enacted.

In response to growing consumer expectations, many brand websites have developed highly interactive tools, which include incorporating a range of infographics, images, and videos to try, in the words of our respondent from Brand 9, to:

[E]ducate the consumer through videos we have created. For example, telling the consumer to wash their clothing less or how to repair a garment. We are encouraging customers to shop as they say in Swedish *klimatsmart*, so climate-smart.

This observation links to a key issue highlighted in the previous section in that there is generally a lack of actionable, customer-oriented messaging available (Turunen and Halme 2021). Although Brand 9 provided actionable information, whether it is feasible to act upon it is a different question. Washing clothes less often may not be an option, especially if we think of certain market segments, such as children’s clothing. Similarly, if there are no detailed instructions on how to repair garments, it is questionable if consumers can do so on their own. Not only would mending require a certain skill set, but it also suggests a potential need for tools (e.g., sewing machine, thread, needles), which may no longer be part of household essentials. Thus, whether the consumer engages in the care and repair practices promoted by the brand or not will depend on individual dispositions.

Communication theory suggests that fashion brands should communicate their sustainability messages in a way that is easily understood by their

recipients. Some brands also use the sustainability section of their website to showcase their CSR reports. These reports have become more comprehensive over time, incorporating broader definitions of sustainability and a wider range of metrics. However, a more accessible communication approach can be achieved through using platforms such as Instagram or TikTok, which consist of gaining short, snappy messages accompanying photos or videos, which are more easily digestible and often more engaging.

Thus, finding a balance on how much to communicate is essential, as too much information is overwhelming, yet too little can be seen as holding back and leading to distrust, especially when related to free-form communication.

Free-form communication is not the only way to communicate. Brands can also turn to a growing range of third-party accreditations as a potentially more trustworthy alternative. For example, several of our participants partner with the Fair Wear Foundation, a nonprofit organization that conducts independent, third-party verification of member brands’ factories and this information is then made available online. These reports are generally highly detailed and can add credibility and transparency to a brand’s sustainability reporting.

With certifications, brands hope to showcase their capacity to measure up against certain industry-benchmark standards. However, third-party endorsements are limited in their capacity to capture and communicate the dynamic nature of a company’s supply chain (LeBaron and Lister 2015). Similar to third-party accreditation, which we found was predominantly held by large organizations, firms also produced CSR reports that were readily available on their websites. This was a feature that smaller companies did not generally have.

An explanation for this difference could be that larger brands typically have more robust teams of dedicated staff working on issues pertaining to sustainability and smaller counterparts lack the resources (financial or otherwise) to produce formal in-house reports and also are less likely to be able to afford the services of sustainability consultancies that could prepare such information on their behalf. However, smaller brands (including outerwear, children’s clothing, and independent fashion brands) were still active in sharing sustainability-related information, albeit typically in a less thorough manner. This lack of detail and/or third-party reporting could pose a challenge for smaller brands, as consumers could perceive these brands as “hiding” information, even though it is more likely the outcome of limited resources to produce or commission such reports.

Finally, not all of the fashion brands that we interviewed are using sustainability as part of their online marketing. While some are highlighting sustainability as a source of distinction, there are others that do not want to be known as a sustainable or eco-labeled brand. This was clearly the case for the respondent for Brand 7 who noted:

For customers who want to know more about sustainability, we put that information on our website. But, it's not part of our marketing to consumers. We try to be transparent but are not working toward being a "green" company or something like that.

Our reading of Swedish fashion-brand websites is that while they do not bring us closer to a definition, they provide an insight into how sustainability-related messages are disseminated. Fashion brands are using their websites to support transparency and to communicate a broad range of sustainability initiatives. However, what sustainability entails varies considerably from brand to brand and at times may be more inferred than explicitly stated.

Social media

Social media platforms (e.g., Facebook, Twitter, Instagram) are popular, highly visual, and increasingly lucrative branding tools and they are used as informal channels to communicate CSR practices (Reilly and Larya 2018). Instagram was the most widely used platform among the brands that we interviewed for this study. It allows brands to share images (typically with short text captions and hashtags) as well as videos (or "stories") with their customers. While images remain on the profile of their account, stories last 24 hours before disappearing. Brands can also "go live" in videos, and both stories and live videos can be saved to the brand's profile, curating information for visitors to view later.

Contrary to websites, Instagram fosters dialogic communication and customer engagement, which is important for these brands. For example,

There are a lot of downsides of social media, but one upside is the fact that you have direct access to your customer. We do a lot of brand building and teaching and education directly toward the end consumer, through social media. And it's not only us telling them but a two-way discussion about what is sustainability and what's important for them, how they make their choices, and how we can be a better choice for them (Brand 9).

Instagram is also where a desirable demographic lives, namely young consumers (Moatti and Abecassis-Moedas 2018). As the respondent for Brand 10 remarked, "We are on social media because we want to reach out to our young consumers on the platforms they are engaging with." This interviewee also insisted,

[I]t is still a challenge to articulate our sustainability policies to consumers on social media. Talking about chemicals and the like is not sexy. It's quite serious. It is a challenge to communicate what we are doing in a way that consumers can understand and also be interested in.

Here again, brands are challenged to strike a balance between educating consumers on best practices related to sustainability without turning them away.

One way of overcoming this challenge is through the video-story feature. For instance, the respondent for Brand 19 noted, "we can go to a factory and begin to live stream what we are working on. It doesn't matter if the video is unfiltered or unedited. It is an experience that is meant to be that way." Brands reported that online communication is not only cheaper than, for example, in-person communication but also allows for more creativity, in that videos can be unedited and experimental, yet shared globally within seconds.

Nonetheless, while social media is appealing to customers, brands have faced hesitation from stakeholders who are wary of participating in this form of communication.

We have had to explain to our suppliers and manufacturers that we want to document and photograph everything for our website and our social media. To some factories it was quite odd, but once they realized that it was about appreciating the craft and having the average consumer understand what goes into their clothing and value the garment that they're making more, they just felt an enormous sense of pride in being photographed and documented (Brand 6).

Although there has been a move from brands to go beyond their corporate websites and develop new ways of communicating their sustainability efforts to consumers (Reilly and Larya 2018), key challenges remain. Social media platforms offer quick and easy access to consumers, and act as the "cheerful" companion to broadcasting messages, as such "it can still be difficult to add sustainability information to social media because it can be quite... heavy" (Brand 10). With more brands using Instagram, it can be challenging to stand out from the crowd and to develop content that is engaging.

I follow a lot of different companies on Instagram and everyone is screaming about different things. About the environment or animals or what have you. It feels like a short-term trend. That's why I think you really should concentrate on doing good things. Not screaming about them all the time, just do it (Brand 14).

As this quote highlights, if everyone celebrates, it can be hard for a consumer to decipher what makes an individual brand stand out and what systemic transformation may actually have taken place. Reflecting on the "honesty" approach (Kolb and

Kozlowski 2019), this is not to say that brands should hide what they do and not celebrate their achievements, but rather be transparent and honest about the sustainability actions they have taken.

While social media can prove to be a valuable tool for brands to engage in sustainability-related conversations with their customers, it is also important to keep in mind that brands do not have control over those conversations. For example, one interviewee shared an experience about posting on Instagram a series of images featuring garments that were produced using eco-friendly textiles. Rather than steering a discussion regarding the quality of the textiles, consumers instead began criticizing the brand for using images that had been shot on-location on the other side of the world and the carbon emissions associated with flying to the location to photograph the collection. What had been designed as a consumer-awareness campaign about the brand's use of new textiles instead turned into a social media scandal.

In summary, social media platforms, and Instagram in particular, are enablers of dialogic communication, which creates opportunities and challenges for brands. While these interactions may be more dynamic when compared to those available through a brand's website, risks related to navigating transparency remain. We found brands using discretion to showcase their efforts, all the while engaging in conversations related to sustainability.

In-store

Leslie et al. (2015) and Brydges (2018) have found that retail stores can be an important site for brands to communicate sustainability initiatives, alongside other information, to consumers. Much of this research focuses on independent and/or slow fashion brands that stake much of their reputation on being sustainable. For brands in these industry segments, sharing sustainability information with consumers is central to their story and is something they sincerely want to do (Leslie et al. 2015; Brydges 2018). However, it is also important to consider how other segments of the industry, including fast fashion brands that may not necessarily put sustainability front and center, communicate about such issues using in-store resources.

For larger, fast fashion brands, it was found that while style and trends are the key communication priorities, these brands are also looking for ways to begin to introduce sustainability into the conversation.

We try to communicate our sustainability mandate to customers through our employees in store. They are our best ambassadors. They are with the customer all the time, but we try to do it in a

simple way. For example, when you are standing in line to try on a garment, maybe we can say something about care for the garment or talk about the fabric, such as if it is organic cotton (Brand 8).

However, these brands also identified employee education as a challenge in disseminating information around sustainability.

We do training two to three times a year on the topic, but we also try to think of our staff. We know how hard it is to keep everyone up to date. That is why sustainability information we have on the website will always be more advanced in terms of what staff in the shop can give the consumer (Brand 9).

Communicating sustainability to consumers in retail locations becomes even more of a challenge in instances where a brand sells their garments through multi-brand retailers because they not only have limited control over the in-store experience, but also their definition of sustainability might not align with that of their retailer.

We communicate our sustainability mandate through our own channels. When we sell in department stores, like [name], we also give them all our sustainability information. But, I don't think they share it widely. We have chosen to offer a high-quality product because that supports a longer garment life. To us, that is sustainability. However, sometimes it is hard for bigger retailers to accept that as a sustainable idea (Brand 14).

Thus, we found that brands are more likely to provide detailed sustainability information online and to offer smaller "snippets" of information about sustainability practices in person.

Finally, while the ongoing COVID-19 crisis has amplified issues relating to sustainability (cf. Brydges and Hanlon 2020), access to some brand-related information (in particular, in-stores) has been restricted. As consumers transition to online shopping, this may only serve to increase the importance of digital modes of communication. Although the pandemic has highlighted structural inequalities across the global fashion and apparel industry, there may be light on the horizon: with a new wave of consumer consciousness, fashion brands are challenged with an opportunity to cater to consumers' increasing demand for more sustainable fashion alternatives (Brydges and Hanlon 2020; Brydges et al., 2021). Further research is needed to examine the ways in which these crises continue to intersect.

Challenges in communicating sustainability

Henninger, Alevizou, and Oates (2017) argue that mapping the sustainability knowledge-dissemination strategies of fashion brands provides critical insights

into the opportunities and challenges brands face in the transition to a more sustainable fashion industry. Comparing and contrasting these strategies and practices across sites, our research has identified several challenges in communicating sustainability.

To address the scale and scope of the sustainability challenges facing the industry, brands must work strategically and flexibly across a range of sites to communicate their sustainability initiatives to consumers. We found that different modes of communication have relative strengths and weaknesses. For example, Instagram can allow a brand to share real-time and behind-the-scenes content with consumers in a way that a website or CSR report cannot achieve. At the same time, social media or brief in-person conversations are not the place to communicate detailed processes that go into sustainability reporting and auditing with which brands are engaging.

However, regardless of the site, engaging in the communication of sustainability activities is still something that brands are hesitant to do. For example,

We have been afraid of talking about sustainability because we are not 100% sustainable. We were afraid that we would be seen as failing. We feel it is more important to just be transparent and honest, to talk about what is good and what is still a challenge... We have a responsibility to educate them, whether that is in stores, on social media or through talking to journalists. We have a responsibility to keep those conversations going (Brand 8).

Yet, given the magnitude of the sustainability crises facing the industry, brands are aware that these are issues they can no longer ignore:

Brands need to take responsibility for their actions. We're the ones ordering the products, designing the products and putting them out there. We need to actually be transparent, not just saying one thing and doing another. So long as there is greenwashing, consumers are never going to understand the complexity and the whole picture of what we are dealing with (Brand 17).

This relates to a second challenge: the role of consumers. There is growing evidence that consumers are concerned with environmental and social sustainability challenges facing the fashion industry. However, it is important to keep in mind consumers are not a monolith. While some consumers actively engage with brands on sustainability, whether that be through reading CSR reports, or through asking questions of a brand via email or direct message, others are largely unaware of the issues facing the sector. Interviewees consistently commented on the challenges that they face in reaching new audiences. As the respondent for Brand 2 remarked, "much of

our sustainability material is for the already enlightened. Finding consumers who have no interest in sustainability is very difficult."

While brands are often quick to assign blame to consumers, it is also important to keep in mind that not all brands are vocal about their sustainability practices. Consistently, this research found that brand websites are the place that have the largest amount of information, where it is the most detailed and transparent. It is also the "safest" place for brands to put that material because it is quite discreet.

It is also important to keep in mind that transparency is not the same as sustainability. For example, in the context of labor rights, notions of "transparency" tend to focus on conditions at supplier factories, drawing attention to particular locations, such as Bangladesh. As Kabeer, Huq, and Sulaiman (2020, 1391) have shown, approaches which single out specific contexts are insufficient: "[W]e need to move from a narrow 'spotlight' perspective which confines our gaze to the locus of production to a 'floodlight' approach which illuminates the broader political economy of supply chain capitalism within which these production processes are located." While calls for, and efforts in support of, transparency may be effective at drawing attention to the complex nature of systems of production, those that focus only on a particular issue or context fail to capture the full picture.

For instance, there are brands that view it as necessary to share as much information with consumers as possible, which in turn, will inspire consumers to modify their practices. Brands have highlighted that

[W]e believe we can change people's habits and behaviors, where they buy fewer and better items, through very high levels of transparency. If people have the information and are educated, they can make better decisions (Brand 4).

However, this causal link has yet to be demonstrated. Consumers can in theory make better or different decisions, but the reality of the situation remains unclear. This also relates to the previously mentioned challenge of whether or not brands are reaching new consumers or are confined to communicating to consumers with an existing interest in sustainability.

While some brands are increasingly transparent about how they are working to address environmental and social sustainability challenges in their supply chains, this does not necessarily mean brands are becoming more sustainable. Brands also run the risk of being open about challenges that they cannot—or will not—address, which further contradicts their efforts in this space. This posture also exposes

brands to the growing risk of greenwashing and consumers becoming even more cynical about industry-sustainability efforts. For example,

I think it is very, very risky for a brand to say there is something as sustainable fashion. Every brand that makes a claim of sustainability is eventually going to get shot down because it is too big of a term. There's only so much that you are accountable for. Brands need to tread carefully when it comes to their terminology and we need to really scrutinize when someone makes a sustainability claim: what does what they are saying actually mean and what are they actually doing? (Brand 18).

These challenges have left us to wonder if sustainability will be a guiding concept for the fashion industry moving forward. As the respondent for Brand 17 observed,

Sustainability is such a broad term and is not a word we've been inspired by. Clothing is not sustainable. Consumption is not sustainable. There's no such thing as sustainable consumption or sustainable fashion. We are a responsible company that holds itself accountable for the impact of our actions.

If performing—or selling—sustainability is more important than action, has the concept lost its meaning? Or, if we are to continue to invoke the notion, is a practice-based approach more useful than continually trying to pin down a definition? These are ongoing questions that remain.

Conclusion

We set out in this article to consider two key issues: (1) to explore the degree to which evolving business models and emerging practices in the fashion industry are informed by a robust understanding of sustainability and (2) to gain insights into how fashion brands communicate sustainability to consumers.

In exploring these matters, we found that Swedish fashion brands employ a range of approaches to sustainability depending on the context. Definitions of sustainability are not static but are shaped by the mode of communication (online and in-person) and whether that is a one-way or two-way flow of communication. Definitions of sustainability continue to be contested in the same way as sustainability communication is subject to varying interpretations. Despite these circumstances, however, we have seen how sustainability is performative, as brands are tasked to navigate challenges of securing consumer trust through their dynamic communication strategies, as social and environmental issues remain ever shifting. We demonstrated that while being transparent about sustainability practices is vital, being too open and

honest can also pose obstacles, as consumers will criticize companies for either failing to deliver what they have promised or be seen to be greenwashing. Moreover, the channels utilized to broadcast sustainability-related messages can be size-dependent, in that large companies may have more resources to deliver CSR reports, while smaller counterparts need to make do with what they have. Brands are engaged in a balancing act, curating content with their consumers in mind. They are also actively co-constructing knowledge with customers. Thus, definitions of sustainability remain in motion, operationalized differently and uniquely through various communication strategies, in interaction with the context of the brand and its relationship with consumers, real or imagined. A key challenge here for brands, however, is that as consumers look to them for insight and perspective, they must be prepared with answers.

As a result, we contend that a *robust understanding of sustainability* should be participatory, informed by a practice-based approach that further outlines actionable tasks and is linked to consumer-centered strategies. Rather than calling on brands for static definitions of sustainability, we argue that it is necessary to engage with prevailing understandings and interventions need to reflect on-the-ground complexities. This approach also appreciates that organizations target a specific market segment which in itself may not be homogenous. Thus, utilizing a combination of different channels and approaches is vital to reach as many consumers as possible.

When it comes to understanding how messages are communicated to a target audience and, in light of new opportunities for building relationships with consumers, we have shown how brands are tasked to determine how best to share the ways in which their values align with the strategies and interventions that have been operationalized in support of social and environmental challenges. From the analysis it becomes apparent that “being actionable” is vital, in that consumers need to be able to take responsibility and actively make a difference. As demonstrated, sustainability is a complex phenomenon, thus, it is essential to carry customers and not only inspire their interest in the relevant issues, but also be part of them. Concepts that are too far removed from public sensibilities often lose their appeal very quickly. Thus, to keep sustainability a top priority consumers need to be integrated into change strategies by allowing them to share in responsibility. Using visuals and social media accounts further attracts “younger consumers” who also express inclinations of being more conscious of

the impacts that the fashion industry has on the natural and social environments.

Here we have presented a single case study, geographically bound to one country, and yet the importance of Sweden as a center for sustainable fashion was justified. Seeing as the fashion industry is not confined to a single nation, but rather operates as a truly global industry, with supply chains often spanning multiple countries and continents, the same issues emerge in numerous places. Findings relating to sustainability and its communication are thus not only relevant to this case, but to any context where stakeholders are working through communications to address social and environmental issues related to the global fashion industry. Whether the exact same issues emerge in different contexts remains an area of further investigation, inviting opportunities for researchers to conduct cross-country comparisons.”

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