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# Beyond sustainability rhetoric: design guidelines for a responsible fashion system

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**Introduction:** The fashion system is under increasing pressure to integrate sustainability across complex and globalized supply chains. However, despite growing commitments, sustainability narratives often rely on reductive solutionism and selective transparency, leading to a misalignment between communication strategies and actual supply chain transformations. This paper critically examines how sustainability rhetoric shapes design briefs and decision-making processes, thereby constraining the potential for systemic innovation. Sustainability rhetoric refers to the recurrent framing of sustainability through simplified narratives, solutionist claims, and selective transparency that prioritize communicability and reputational value over the structural transformation of production systems, governance models, and decision-making processes.

**Methods:** Adopting a qualitative research design that combines discourse analysis with a multi-case study approach, the study identifies alternative pathways emerging from fashion companies and research-driven initiatives that operationalize sustainability through material experimentation, technological innovation, and reconfigured supply chain models. Through cross-case analysis, this study develops an interpretative design-driven framework for reconfiguring sustainability as an integrated system of decisions, rather than a trend-driven, futures-oriented, or purely narrative set of isolated interventions.

**Results:** The findings reveal recurrent rhetorical patterns that limit the scope of sustainable action, alongside evidence of practices that challenge dominant narratives by embedding digital traceability, localized production, circular material flows, and collaborative ecosystem approaches. The framework articulates how sustainability is enacted across different leverage points of the fashion value chain.

**Discussion:** The discussion reframes these findings within a broader systemic perspective, highlighting how sustainability outcomes are shaped by governance structures, economic logics, and cultural and ethical assumptions related to value, speed, and consumption. This research contributes to redefining sustainability in the fashion system by demonstrating how integrating critical design perspectives with supply chain innovation can support a transition toward more transparent, accountable, and transformative models.

## KEYWORDS

circularity and material innovation, design-driven innovation, digital traceability and transparency, strategic governance, sustainability narratives, sustainable fashion supply chains, systemic sustainability

## 1 Introduction

The fashion system, including textile and apparel supply chains, has become one of the main targets of sustainability conversations due to its intensive use of natural resources in production, particularly water, and its significant negative environmental and social impacts. Beyond its material footprint, “fashion is the most complete expression of a post-modern industrial culture (...)” (Fiorani, 2006: 7–8). Being a core cultural industry (Hesmondhalgh, 2007), it expresses the evolution of symbolic, experiential, and cultural content through narrative and marketing strategies, exerting broader influence on consumer behavior and shaping consumption patterns that extend beyond the fashion market (Rathore, 2018). However, communication has been progressively functioning primarily as a mechanism to stimulate demand and accelerate consumption cycles, rather than as a means to articulate or reflect broader cultural and anthropological transformations.

This has led sustainability to emerge as a dominant discursive framework in fashion marketing and branding (Kilbourne, 2004), often driven less by substantive transformation by its growing normative and symbolic value in responding to consumer expectations and market pressures. As a result, sustainability has frequently been articulated through aesthetic and narrative elements—such as visual cues, storytelling, and symbolic references—rather than through transparent representations of structural change (Díaz-Soloaga, 2021). While sustainability is often described as “communication-led,” this condition should not be interpreted merely as a strategic misalignment or managerial failure. Rather, it reflects a structural feature of a market-driven economic paradigm in which symbolic value, branding, and narrative differentiation function as primary competitive assets. Within this context, sustainability narratives are incentivised to operate at a discursive level, where they can generate market advantage without necessarily challenging underlying production volumes, pricing structures, or growth imperatives.

In the academic discourse, the concept of sustainability was initially articulated as “eco-development” by Sachs (1978), defined as “...an approach to development aimed at harmonizing social and economic objectives with ecologically sound management, in a spirit of solidarity with future generations.” The Brundtland Report, formally titled *Our Common Future* (World Commission on Environment and Development, 1987), subsequently expanded this concept, framing sustainable development as the integrated interaction of economic, environmental, and social dimensions. This tripartite framework was reaffirmed at the international policy level during the United Nations (2012), Conference on Sustainable Development in *The Future We Want*, which explicitly recognized that “Sustainable development goals for the development agenda beyond 2015 should integrate all three pillars of sustainable development: economic, social and environmental.”

While in the literature the environmental, social, and economic dimensions of sustainability are widely recognized as interdependent, in practice their integration has remained uneven (D’Itria and Aus, 2023). In particular, environmental and social sustainability have received increasing attention through

regulatory frameworks and operational interventions, whereas economic paradigms have proven more resistance to structural reconsideration (Roy, 2016). This imbalance has limited the overall effectiveness of sustainability initiatives, as efforts within individual pillars tend to be constrained by economic logics that remain largely unaltered, with a general focus on limiting costs.

Within this context, economic performance indicators have continued to play a central role in shaping strategic decision-making across the fashion value chain (Medcalfe and Miralles Miró, 2022) and organizational choices are still predominantly evaluated in relation to their contribution to financial outcomes, positioning communication as a key economic lever within competitive market environments.

As a result, sustainability narratives have often been reframed toward solutions that are readily communicable and economically advantageous, privileging symbolic alignment over substantive specificity. This shift has contributed to the proliferation of ambiguous or partial claims, generating interpretative uncertainty that can support short-term economic objectives (Greco and De Cock, 2021). This tendency should not be understood merely as a communication failure, but as a structural feature of a market-driven and growth-oriented system in which sustainability is often absorbed into competitive logics of branding, differentiation, and value extraction. In this sense, the increasing commodification of sustainability narratives reflects a broader political-economic condition in which environmental responsibility is frequently rearticulated in ways that remain compatible with accumulation and accelerated consumption. The progressive ambiguity of sustainability narratives has also had material implications for product development (Janz et al., 2025). When sustainability claims remain insufficiently specified or contested, product design and production choices tend to be evaluated primarily through financial performance metrics. Under these conditions, investments in product quality, durability, or in the wellbeing of workers involved in the production process risk being deprioritised, if economic performance indicators continue to function as the dominant criteria of success (Buchel et al., 2022).

These dynamics yield two interrelated systemic effects that significantly undermine the transformative potential of sustainability initiatives in the fashion system. The first can be characterized as temporal acceleration and reactive sustainability adoption. While brands and manufacturers increasingly recognize market demand for sustainability-oriented solutions, accelerated production cycles and competitive pressures favor short-term, reactive responses. Under compressed time-to-market conditions, sustainability is frequently operationalised through rapidly assembled interventions designed to maintain alignment with industry trends rather than to address structural needs across the supply chain. This dynamic can be interpreted through the lens of social acceleration (Rosa, 2013), whereby temporal compression constrains organizational capacity to pursue long-term systemic transformation. As a result, sustainability principles are often introduced as initial design inputs without a holistic understanding of their system-wide implications, thereby limiting their ability to generate durable and meaningful outcomes. This reveals a structural paradox within sustainable fashion: while sustainability requires durability, reduced throughput, and

long-term accountability, the fashion system remains dependent on novelty, acceleration, and high turnover as conditions of economic growth. Whereas trend acceleration is acknowledged as a systemic driver of unsustainability, this study focuses instead on the upstream design and governance conditions that structurally enable or counteract acceleration, rather than on forecasting logics.

The second effect pertains to knowledge asymmetry and behavioral spillovers. As sustainability-related practices are predominantly communicated through branding and marketing channels, consumers become structurally dependent on corporate narratives to evaluate sustainability attributes that are otherwise difficult to observe or verify. This condition reflects a form of information asymmetry (Akerlof, 1970), in which access to reliable knowledge about product impacts is unevenly distributed between producers and consumers. While communication plays a critical role in diffusing new practices—such as changes in product use, care, and disposal—it also introduces the risk of misinterpretation when claims are partial or insufficiently contextualized. In such cases, behavioral spillover effects may occur (Thøgersen, 1999), whereby practices perceived as sustainable are replicated across contexts, potentially producing unintended negative outcomes while sustaining the perception of responsible behavior.

Against this backdrop, the present research conducts a critical analysis of alternative design approaches emerging from selected case studies within the fashion system. The cases span multiple levels of intervention, including sustainability-oriented practices developed by start-up brands, systemic innovations within manufacturing supply chains, the adoption of technologies that address specific environmental or social needs, and the introduction of novel materials into production processes. The analysis examines how these interventions negotiate the tensions between communicative logics and structural transformation and considers their implications for achieving substantive sustainability outcomes. At the same time, these tensions are not only industrial and organizational, but also cultural and ethical, as they are shaped by dominant assumptions about value, speed, desirability, and consumption that underpin the fashion system.

## 1.1 Historical and systemic emergence of sustainability in fashion

The conceptual origins of sustainability in fashion can be traced to the second half of the 19th Century, when concerns related to anti-consumerism, waste reduction, the use of natural fibers, and the promotion of durable products first emerged. Although these ideas were not framed within a contemporary sustainability paradigm, they reflected early apprehensions regarding resource efficiency, product longevity, and the social consequences of industrial production.

During the 1960s and 1970s, sustainability evolved into a more explicit form of environmental and social awareness, mirroring the broader ecological debates that characterized the period. A pivotal contribution to this shift was Rachel

Carson's *Carson (1962)*, which documented the environmental harms associated with the indiscriminate use of pesticides in agriculture. The book played a significant role in shaping public environmental consciousness and contributed to regulatory responses such as the ban on DDT and the establishment of the Environmental Protection Agency in the United States in 1970.

In the late 1980s, environmental scandals associated with global supply chains, involving the extensive use of hazardous substances and the discharge of untreated waste from dyeing processes into rivers in Asia, Eastern Europe, and Latin America, highlighted the significant environmental footprint of textile production (Piccolo, 2022). At the same time, the public uncovering of labor exploitation practices by major global brands raised concerns about respect for human rights within the fashion industry, extending the sustainability discourse beyond environmental preservation to social responsibility (Ross, 1997). The emergence of such environmental and social crises within the fashion industry led to the explicit codification of the concept of "sustainable fashion."

From the early 2000s onward, sustainability increasingly became a governance and institutionalization issue, particularly after the publication, in 2004, of the report *Who Cares Wins*, issued as part of a joint initiative of the United Nations and major financial institutions which introduced the Environmental, Social, and Governance (ESG) framework. Within the ESG framework, which was meant to integrate sustainability into corporate strategy and financial decision-making (Vigolo et al., 2025), corporate governance is configured as the set of structures and processes through which companies are directed and controlled, defining their purpose, power relations, accountability mechanisms, and decision-making processes. Virtuous approaches such as Stella McCartney's development of alternatives to animal-derived materials and Patagonia's early adoption of recycled polyester contributed to legitimizing sustainability as a normative reference within the industry (Gwilt, 2020), shaping public expectations and accelerating the diffusion of sustainability discourse across brands and supply chains, not so much as voluntary choice as a structural requirement. From the 2010s onward, the transition toward a systemic approach to sustainability started to be operationalised in a market characterized by the extreme overconsumption of globalized production and entrenched consumerism, making the mainstreaming of sustainability in fashion discourse relatively late. Moreover, the institutionalization of sustainability occurred within a system already structured around growth-oriented economic paradigms (D'Itria and Aus, 2023). While regulatory frameworks, operational interventions, and reporting obligations increasingly addressed the environmental and social dimensions, the economic system underpinning fashion production remained largely unrevised, continuing to push for infinite growth through rising volumes and financial targets. Governance practices have continued to prioritize monitoring, documentation, and compliance, rather than questioning the structural conditions that define production, consumption, and value creation. This asymmetry has limited the transformative capacity of ESG implementation. Environmental and social initiatives have often been pursued independently of a substantive

reconsideration of cost–margin structures, investment logics, and performance indicators.

## 1.2 Environmental dominance and cost–margin governance

Within the fashion supply chain, the environmental dimension of sustainability has become the most visible and operationalised pillar (D'Itria, 2025). This predominance is closely linked to the widespread adoption of environmental certifications and standards, which are comparatively easier to communicate, rely on shared and standardized parameters, and are issued by qualified third-party organizations. Certifications provide brands with a clear and recognizable signal of sustainability performance, while often transferring the responsibility for compliance, monitoring, and implementation to material suppliers and manufacturers (Grant and Shaw, 2019).

The growing reliance on environmental certifications has contributed to a marked concentration of sustainability efforts in the upstream segments of the fashion and textile supply chain. While this trend has facilitated measurable improvements in areas such as chemical management, wastewater treatment, and raw material sourcing, it has simultaneously reinforced asymmetries in the distribution of costs, responsibilities, and innovation efforts. Environmentally responsible alternatives typically entail higher production costs, requiring significant investments from suppliers, more complex sourcing strategies for brands, and increased coordination across multi-tiered production networks (Mazzanti and Zoboli, 2009).

These dynamics have substantial implications for design and creative processes. Designers are increasingly required to operate within constrained material palettes, as not all fibers, fabric constructions, or finishing techniques are available in certified or otherwise “responsible” forms. Consequently, decisions concerning aesthetics, construction methods, and material performance are frequently subordinated to considerations of availability, cost, and certification requirements (Osborne, 2023). At the same time, the governance of cost–margin structures has remained largely unchanged. Brands continue to adhere to accelerated fashion calendars and reduced lead times, placing sustained pressure on suppliers to lower prices to preserve margins while simultaneously absorbing the additional costs associated with compliance with environmental standards (Kiran, 2025; Brooks and K. Fletcher, 2017; Farrer and Fraser, 2011).

This configuration has effectively shifted the burden of innovation and transition onto suppliers, without a corresponding reconfiguration of the economic models governing brand-level operations. Suppliers are expected to invest in cleaner technologies, certification processes, and responsible materials, while also accommodating reduced prices and compressed production timelines (Talay et al., 2020). In the absence of structural adjustments to cost–margin governance and development cycles, environmental sustainability initiatives risk remaining confined within existing production logics (Patora-Wysocka and Sułkowski, 2019). As a result, their capacity to generate systemic transformation is limited, as

sustainability becomes operationalised primarily through incremental adaptation rather than through the restructuring of economic and organizational frameworks (Bertola and Colombi, 2024).

## 1.3 Traceability, transparency, and structural contradictions

Within the ESG framework, the governance pillar has also placed increasing importance on traceability, intended not as a mere technical or logistical function but as a systemic capacity to reconstruct and communicate, and potentially disclose publicly, the sequence of processes a fashion item undergoes throughout its entire lifecycle (Garcia-Torres et al., 2022). Therefore, traceability encompasses the sourcing of raw materials, the manufacturing and assembly phases, the measurement and verification of product and process performances, the definition and respect of life-cycle assessment indicators, and the development of end-of-life strategies, impacting the whole supply chain of a fashion brand. From this perspective, traceability has increasingly been framed as a critical tool for enhancing transparency and strengthening accountability across supply chains, and for fostering consumer trust in global, fragmented production systems (Cura et al., 2022).

Despite its relevance, the practical operationalisation of traceability reveals several structural issues. Historically, competitive advantage in the fashion system has been closely dependent on the protection of proprietary knowledge, particularly in relation to sourcing strategies, manufacturing processes, and material and process innovation (Jha, 2024). As a result, brands and suppliers have traditionally operated within organizational cultures characterized by selective disclosure, in which knowledge asymmetries were preserved as strategic assets. The recent increase in regulatory frameworks and reporting requirements has disrupted this practice, compelling companies to disclose information regarding their supply-chain integrity and the environmental and social impacts of their operations (Yang, 2024). This shift toward greater transparency, instead, has revealed substantial organizational and infrastructural constraints. After decades of limited visibility or insufficiently practiced control over their supply networks, many companies now struggle to retrieve, standardize, and verify the data needed to comply with traceability requirements across complex, global supply chains (Onuma, 2025). This often results in traceability activities demanding significant investments in terms of time, financial resources, and the acquisition of specialized expertise. Attention is therefore often diverted to contingent organizational issues rather than to designed or strategic interventions capable of producing substantial environmental or social improvements, resulting in transparency functioning primarily as a compliance-driven process, rather than as a lever for systemic transformation (Singh et al., 2026).

Furthermore, the implementation of traceability remains uneven and often selective. Disclosure practices tend to prioritize suppliers, materials, and processes that are more reputationally advantageous or for which data is readily available, leaving less visible or more problematic segments of the supply chain underreported. This selective approach to transparency not only

limits the analytical and transformative potential of traceability systems but also reinforces existing power asymmetries between brands and suppliers and limits the capacity of traceability to address structural issues embedded within global production networks (Gardner et al., 2019).

## 1.4 The cultural crisis of product knowledge

Beyond governance and supply-chain dynamics, the fashion system is also affected by a profound cultural crisis of product knowledge. This crisis is closely linked to a gradual shift in the criteria used to evaluate brand and designer performance, increasingly prioritizing financial indicators over qualitative attributes such as material integrity, construction quality, durability, and aesthetic value (Sellitto et al., 2022). Within this framework, the overproduction of high-margin, low-quality products has progressively eroded shared standards of product excellence, contributing to an overall impoverishment of material culture (Ozdamar-Ertekin, 2016).

The effects of these dynamics have been evident both at the level of design practice and in consumer behavior.

From a design perspective, creative processes have become increasingly constrained by cost parameters and margin expectations, rather than guided by product-specific considerations of quality, durability, or the appropriateness of materials and manufacturing techniques (Ferguson et al., 2024). Across market segments—including the luxury sector—traditional markers of craftsmanship and quality have been progressively replaced by simpler solutions aimed at reducing costs and enhancing scalability. Examples include the substitution of embroideries with printed motifs, the replacement of high-quality fibers such as cashmere or fine wool with blends incorporating synthetics or lower-grade recycled fibers, and the shift from complex woven structures—such as satins, brocades, or velvets—to jerseys, fleeces, and other less resistant alternatives (Long and Nasiry, 2022). Over time, this systematic downgrading of materials and technical processes has contributed to the normalization of lower-quality standards across both design practices and organizational cultures (Aus et al., 2021).

On the consumer side, the erosion of product knowledge has been exacerbated by aggressive marketing strategies and the growing dominance of digital and social media. Purchasing decisions are now predominantly shaped by visual representation, influencer endorsements, and price positioning, often in the absence of direct sensory engagement with materials, construction, or fit. As a result, consumers experience growing difficulties in assessing product value, including the intrinsic quality of materials, the complexity of manufacturing techniques, and the environmental and social implications embedded within garments. This dynamic has facilitated the widespread acceptance of products characterized by limited durability and short lifespans (Sagapova et al., 2022).

The combined effects of these processes carry significant implications for sustainability outcomes. When durability is no longer perceived as an essential attribute, garments are designed and consumed with the expectation of limited use

and rapid disposal (Aakko and Niinimäki, 2022; Niinimäki, 2011). This accelerates material throughput and amplifies waste flows, thereby necessitating the activation of secondary cycles—such as second-hand markets or recycling platforms—that often reproduce the same profit-driven logics underpinning linear consumption models. Simultaneously, the erosion of stable product identities weakens long-term relationships between brands and consumers, generating uncertainty about brand meaning and undermining the cultural foundations that support more sustainable consumption patterns (Adamkiewicz et al., 2022).

From this perspective, sustainability in fashion cannot be reduced to improved materials or more efficient processes alone; it also requires a transformation in the cultural imaginaries and evaluative criteria through which products are designed, communicated, and consumed.

## 2 Materials and methods

This research adopts a qualitative case-study methodology to critically interrogate the roles of design-driven processes in shaping sustainability principles with regard to fashion products, processes and organizational structures within the fashion system, focusing on how sustainability is constructed and operationalised through design-related practices rather than on assessing sustainability performance through quantitative indicators.

The case study method foregrounds the situatedness of specific practices, allowing researchers to engage with real-world phenomena that are difficult to analyse with quantitative methods (Eisenhardt and Graebner, 2007; Yin, 2008), thereby challenging traditional concepts and narratives. This in-depth exploratory dimension is crucial in a dominant sustainability discourse that, in fashion, is characterized by recurrent rhetorical patterns, such as solutionism, selective transparency, and impact displacement, and helps identify alternative pathways toward a systemic approach to sustainability.

Although single case studies do not support statistical generalization, they yield rich empirical insights that underpin analytical reasoning and theory-building. In this article, the adoption of multiple case studies strengthens methodological rigor by enabling critical analysis, enhancing analytical depth, and partially offsetting limitations related to generalizability (Yin, 1994). Its empirical rigor is grounded in systematic comparison across heterogeneous cases, triangulation of sources, and theory-informed interpretation (Yin, 2014). Comparative analysis across multiple cases facilitates the construction of an interpretative framework that can inform and be further developed by subsequent research (Nixon and Blakley, 2012). Within this perspective, the case study method provides direct observational evidence and contributes to the articulation of theoretical insights grounded in practice (Kohlbacher, 2006). For these reasons, multiple case study designs are widely adopted in fashion-related scholarship, spanning fashion studies (Granata, 2016), business and management research (Bonoma, 1989), and design research (Bertola and Colombi, 2014).

This study adopts an abductive research approach, whereby initial domain knowledge informed case selection, while analytical categories were iteratively refined through engagement with

empirical material (Timmermans and Tavory, 2012). In line with case-based theory building (Eisenhardt, 1989) the research develops interpretative constructs grounded in systematic cross-case comparison.

According to the tradition of design research (Frayling, 1993; Cross, 2006; Laurel, 2003; Friedman, 2003) and research-through-design (Frayling, 1993, 2015; Stappers and Giaccardi, 2017), cases are not presented as best practices to be replicated, but as knowledge-creating elements that reveal tensions, trade-offs, and possibilities for systemic change. Within this perspective, cases are treated as knowledge-generating artifacts that reveal systemic tensions and opportunities for transformation. In fact, the selected cases do not represent the mainstream sustainability strategies of the fashion system. They challenge dominant rhetorical frameworks and propose alternatives rooted in their operations, offering a heterogeneous yet complementary view of how sustainability is embedded upstream in strategic and design decisions and can be reframed as governance and design challenge, rather than a purely compliance-oriented exercise retrofitted into impact reporting.

The selection of the case studies followed a purposive and maximum variation sampling strategy (Patton, 2002), aimed at identifying information-rich and theoretically relevant cases. Rather than pursuing representativeness, cases were selected to capture diverse approaches to structural sustainability challenges across the fashion supply chain, leveraging the authors' domain expertise.

Case selection was guided by the following aspects:

- (i) Counter-rhetorical positioning to move beyond generic sustainability claims by addressing specific structural issues such as overproduction, waste accumulation, opacity, or end-of-life responsibility.
- (ii) Adoption of a design-driven innovation approach to materials, products, processes, and systems.
- (iii) Supply chain reconfiguration through the development of new organizational and governance models, or technological infrastructures, at different stages of the value-chain.
- (iv) Operationalisation of sustainability principles into evidence-based, actionable mechanisms, metrics, or technical solutions.

These criteria ensured coverage of multiple leverage points across the fashion supply chain, including material innovation, production models, waste management, end-of-life systems, and transparency mechanisms.

Nine case studies, selected on the basis of these criteria, were analyzed using empirical material and theoretical concepts, applying multiple lenses to examine how sustainability is enacted: first, circularity principles allowed the analysis to focus on how each case addresses material flows, waste prevention, reuse, recycling, and end-of-life scenarios; second, the use of a design-driven innovation lens focused attention on how design acts as a mediator between technological possibilities, organizational structures, and stakeholders' interests; lastly, governance models, infrastructural dependencies, and the redistribution of responsibility across the value chain were considered for each case.

The analysis followed a three-step procedure:

- (i) Within-case interpretation, in which each case was analyzed through the selected analytical lenses
- (ii) Cross-case comparison, aimed at identifying similarities, divergencies, and recurring patterns across cases; and
- (iii) Abstraction, through which these patterns were synthesized into higher-level interpretative constructs.

According to the type of systemic leverage they activate, the analysis of the cases allowed the identification of eight pathways. They do not represent predefined categories, but merge from cross-case analysis as recurring mechanisms through which sustainability is operationalised across different domains of intervention. The use of maximum variation sampling allowed identifying patterns that persist across heterogeneous cases, strengthening the analytical robustness of the proposed framework.

The eight pathways can contribute to more transparent, resilient, and accountable fashion supply chains, as follows:

1. Material transition and circular integration
2. Waste prevention and stock valorisation
3. Territorial fiber-to-fiber, evidence-based circularity
4. Component-level circularity of premium waste
5. Design for disassembly and end-of-life enablement
6. On-demand production and value-chain reconfiguration
7. Systemic governance of end-of-life and flow allocation
8. Radical transparency and economic accountability.

The definition of these pathways aims to synthesize the logics, mechanisms, and leverage points through which sustainability is enacted across fashion supply chains and progressively reframed from operational optimisation to value-chain reconfiguration and, ultimately, to system-level governance and accountability, rather than being a function of technological features.

Desk research and qualitative analysis of primary and secondary sources ensured evidence triangulation and structured a robust data collection process. These resources included: (a) Policy and institutional reports on sustainability, circular economy, and Extended Producer Responsibility (EPR) in textile and fashion; (b) Brands' official websites, corporate reports and statements, and public-facing communication materials; (c) Project documentation, including technical reports and files and project descriptions; (d) Field research conducted at trade shows, in retail contexts, and during company visits; (e) Academic literature on design studies, fashion studies, innovation and sustainability studies, used to ground the analytical framework.

## 3 Results

### 3.1 Emergent alternative pathways toward systemic sustainability

This section presents the empirical findings of the research based on the analysis of selected case studies. Through a cross-case analytical approach, the section identifies recurring patterns in how sustainability is operationalised across different contexts

TABLE 1 Cross-case analytical matrix.

Case	Company/ initiative	Supply chain stage	Key sustainability challenge	Intervention domain	Analytical lens (circularity/ design/ governance)	Pathway
1	Spiber	Upstream (materials)	Fossil-based dependency, material innovation limits	Biofabricated materials, circular integration	Design + circularity + governance	Material transition and circular integration
2	Manteco (Prato district)	Upstream (materials and processing)	Fiber recyclability, quality degradation	Mechanical recycling ecosystem	Circularity + evidence-based processes	Territorial fiber-to-fiber circularity
3	Imbotex	Component level	Underutilisation of premium waste	Functional component upcycling	Design + circularity	Component-level circularity of premium waste
4	Nona source (LVMH)	Pre-production	Overproduction, deadstock accumulation	B2B deadstock marketplace	Governance + circularity	Waste prevention and stock valorisation
5	Wetreturn	Pre-production/ manufacturing	Waste traceability, material opacity	Waste collection, sorting, traceability	Governance + circularity	Waste prevention and stock valorisation
6	Resortecs	Design and end-of-life	Non-recyclable garments due to assembly	Design for disassembly technologies	Design + governance	Design for disassembly and end-of-life enablement
7	Candiani custom	Production and retail	Overproduction, demand mismatch	On-demand production, microfactory	Design + governance	On-demand production and value-chain reconfiguration
8	Retex.green	End-of-life system	Lack of coordinated waste management	Collective infrastructure, flow allocation	Governance	Systemic governance of end-of-life
9	Honest by	Cross-chain (transversal)	Lack of transparency and accountability	Radical transparency (cost, supply chain)	Governance + design	Radical transparency and economic accountability

TABLE 2 Sustainability pathways by type of leverage and level of intervention.

Pathway	Type of leverage	Level
Material transition	Technological + design	Upstream
Waste valorization	Market + governance	Midstream
Disassembly	Design + infrastructure	Cross-stage
On-demand	Business model	Production
Governance systems	Institutional	System-level
Transparency	Informational	Cross-chain

of the fashion value chain. The aim is not to generalize beyond the analyzed cases, but to articulate empirically grounded pathways that describe distinct modes of intervention.

To enhance analytical transparency and make explicit the comparative logic underpinning the study, Table 1 presents a cross-case analytical matrix linking each case to its corresponding sustainability challenge, intervention domain, and pathway. This overview clarifies how heterogeneous cases contribute to the identification of recurring mechanisms across the fashion supply chain.

A complementary synthesis is provided in Table 2 which reorganizes the identified pathways according to their type of leverage and locus of intervention, highlighting how different mechanisms operate across and within the fashion value chain.

As discussed, the fashion system's structure reveals several rigidities that often make it difficult to incorporate new solutions aligned with robust sustainability objectives. Nevertheless, over the past decades, the industry has been moving toward concrete solutions spanning multiple stages of the value chain, frequently introducing next-generation actors established to address specific opportunities and needs. These initiatives engage deeply with the system's underlying logics and capture aspects that mainstream sustainability narratives do not address. Rather than relying on the mere use of the term "sustainability" as a label applied to a widely recognized problem and treated only at the surface, these approaches originate from real issues identified by practitioners and sectoral actors who have leveraged structural challenges intrinsic to the system itself. In doing so, they move beyond communication-driven sustainability by prioritizing structural interventions that generate measurable, repeatable systemic mechanisms. Considered together, these cases demonstrate that sustainability outcomes are not primarily determined by the presence of greener inputs. Rather, they are shaped by the configuration of governance mechanisms

that structure decision-making across the value chain: material innovation determines substitution opportunities only if aligned with circular rules; market infrastructures determine whether surplus becomes waste or resource; disassembly determines whether recycling is practically feasible; production models determine whether inventories are structurally overproduced; systemic consortia determine whether end-of-life flows can be allocated and monitored at scale; transparency determines what can be measured and contested.

Understanding sustainability as an emergent property of governance configurations, these guidelines contribute to the development of a framework that can support the redefinition of roles and dynamics that currently stabilize unsustainable production and consumption patterns, reorient the fashion product narrative toward the attributes and values that historically enabled its development and growth, and contribute to consumer-facing communication that supports a new, information-based approach grounded in real systemic issues. In this sense, the pathways identified do not only address industrial and technical dimensions, but also implicitly engage with the cultural assumptions and temporal logics—such as acceleration, disposability, and symbolic consumption—that shape sustainability outcomes in the fashion system.

Building on the cross-case analysis, the eight pathways are here reframed as an interpretative framework—visually represented in [Figure 1](#)—that articulates how design-driven approaches enable sustainability across different leverage points of the fashion value chain. Rather than representing discrete or isolated solutions, the pathways capture recurring mechanisms through which sustainability is operationalised, revealing how interventions at different stages of the system interact and contribute to broader systemic transformations. In fact, the framework operates across multiple levels of intervention, including upstream material innovation, midstream production and manufacturing systems, downstream end-of-life infrastructures, and cross-cutting governance and transparency mechanisms. In this perspective, sustainability is not treated as an intrinsic property of materials or products, but as an emergent outcome of coordinated decisions, infrastructures, and value-chain configurations.

Moreover, the pathways are not mutually exclusive: they may co-exist, overlap, and reinforce each other within the same system, generating cumulative effects. For instance, material innovation requires alignment with end-of-life infrastructures; waste valorisation depends on market and governance mechanisms; and transparency acts as an enabling condition for accountability across all stages.

By structuring these pathways into a coherent framework, the study contributes to theory-building by shifting the understanding of sustainability in fashion from a set of isolated practices to a system of interdependent governance mechanisms. This framework provides an analytical tool to interpret, compare, and design sustainability strategies beyond communication-driven approaches, supporting a transition toward systemic, accountable, and evidence-based sustainability models.

The following sub-sections unpack these pathways through a discussion of the selected case studies, while maintaining a primary focus on the empirical evidence and the patterns emerging across cases.

### 3.1.1 Material transition and circular integration

As outlined in [Table 1](#), this case exemplifies material transition and circular integration as a pathway, addressing upstream challenges related to material innovation and end-of-life compatibility. Substituting conventional fossil-based or animal-derived materials with bio-based or biofabricated materials aims to reduce impacts and dependencies on limited resources, while challenging industrial standards of performance, scalability, and compatibility ([Seidu et al., 2024](#); [D'Itria and Colombi, 2022](#)). Material innovation constitutes a prominent axis, but its systemic implications depend on whether governance frameworks connect material design to end-of-life and infrastructural conditions. The Japanese company Spiber Inc. illustrates this through its Brewed Protein™ fibers, a family of materials based on engineered protein polymers produced through biotechnological processes ([Spiber Inc, n.d.](#)). Operationally, the project involves designing the protein sequence to achieve target properties, producing the protein via fermentation in bioreactors, and converting it into material and spinning/processing it into forms compatible with textile applications. Brewed protein fibers are therefore not a simple bio-based drop-in but represent an approach to material design aimed at making material properties, such as hand feel, strength, and performance, tunable. On this technological basis, the Biosphere Circulation Project ([Spiber Inc, n.d.](#)) extends the proposition beyond material substitution, focusing on designing materials and products with attention to end-of-life trajectories—in particular blend compatibility, downstream processability, and recovery logics—and on the infrastructures required to manage them. This project functions as a platform connecting material innovation and design-for-circularity, seeking to avoid next-generation fibers remaining isolated solutions that cannot be integrated into industrial post-use management systems, being assimilated into unchanged industrial logics, without coordination across processing, blending, finishing, and end-of-life pathways.

### 3.1.2 Territorial fiber-to-fiber, evidence-based circularity

As summarized in [Table 1](#), this case illustrates territorial fiber-to-fiber circularity, grounded in historically embedded industrial practices and evidence-based recyclability. Territorial industrial ecosystems with historical know-how in selection and regeneration derive sustainability from value chains already predisposed to mechanical recycling, often supported by experimental evidence on repeatability of cycles. In the Italian panorama, the Prato textile district, historically known for mechanical wool recycling. A distinctive component of the district is the socio-technical infrastructure of selection, given to the “cenciaioli”, ragmen, who, for more than 100 years, have been sorting garments and waste by composition and color, enabling optimisation of regeneration and, in some cases, reducing or avoiding dyeing through weight, composition and, most importantly, chromatic sorting. This step makes the cenciaioli the forerunners of a sustainable practice that today seems impossible, as methodical sorting is structurally relevant for the quality of mechanical recycling, which depends on the length and purity of input fibers. Manteco products and

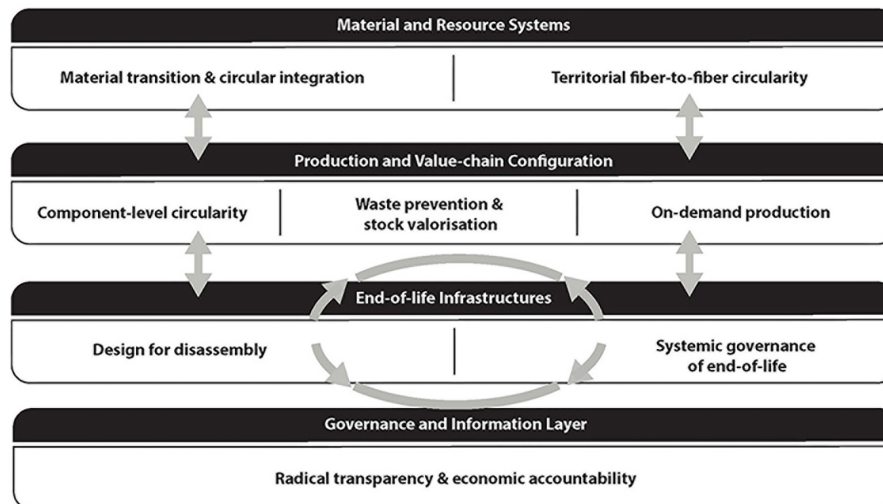


FIGURE 1  
Design-driven sustainability framework. Sources: Authors.

processes are rooted in this tradition and in research on the iterative recyclability of wool. Manteco positions recycled wool as a premium material and—particularly relevant for a scientific framing—includes experimental research and industrial testing on the number of possible mechanical recycling cycles for wool fibers under controlled input-quality conditions (Manteco, n.d.; Barberis Canonico, 2021). This positioning allows recycled wool to be discussed not as a one-off solution, but as a material potentially compatible with iterative looping logics, provided that technical control of input quality and regeneration processes is ensured.

### 3.1.3 Component-level circularity of premium waste

As indicated in Table 1, this case represents component-level circularity of premium waste, focusing on scalable upcycling at the level of functional materials. This domain refers to initiatives that pursue circularity by recovering high-value waste streams for functional components, taking advantage of an opportunity often underappreciated in the sustainability discourse in fashion. Imbotex operates in this framework, in regard of the production of circularity at the component level, such as paddings, insulation, technical linings, where premium waste streams can be transformed into engineered materials incorporated in a more controllable and replicable way across many merchandise categories—outerwear, accessories, bedding, workwear—, revealing a more scalable approach than recycling at the garment level. In fact, substituting virgin inputs in a functional component can be replicated across brands and product types more readily than garment-level recycling, and it can be monitored through clearer technical specifications.

Cameluxe<sup>®</sup> by Imbotex is an example of premium waste upcycling that valorises selected scraps/offcuts from high-end apparel production and transforms them into a functional accessory (Imbotex, n.d.), maintaining material value and reducing

the waste of precious fibers. Luxepad<sup>®</sup> by Imbotex follows a similar paradigm by engineering a high-performance padding that integrates recycled content (Imbotex, n.d.), with the logic of substituting virgin materials and improving resource-use efficiency.

### 3.1.4 Waste prevention and stock valorisation

As shown in Table 1, these cases exemplify waste prevention and stock valorisation, addressing structural inefficiencies related to overproduction and surplus management. Intervening before materials become waste represents another path to reducing impacts, addressing sustainability as a problem of structural inefficiency in planning, minimum order quantities, and demand volatility. Such an approach is implemented by companies reallocating surplus, unsold goods, and deadstock toward new uses or new production cycles, with strong relevance for material efficiency and the reduction of “avoidable” waste.

This is the case of Nona Source, a B2B luxury deadstock marketplace launched by LVMH that operates as a re-sourcing infrastructure for high-quality fabrics and leathers originating from the surplus of the conglomerate’s luxury fashion houses (LVMH, n.d.). The sustainability rationale is waste prevention and the substitution of virgin production with materials that have already been produced but remain unused, transforming potentially immobilized inventory into productive inputs for third parties, particularly designers and small brands, and thereby enabling pre-production circularity. This model addresses a structural inefficiency of the fashion supply chain, linked to minimum order quantities, overproduction, and demand variability, which generate excess even in premium segments. In terms of circularity governance, the platform acts as a “market device” that reduces barriers to access to high-end materials, normalizes upstream reuse practices, and makes circularity compatible with the aesthetic and performance requirements of luxury. However, the intervention is merely a correction, as it mitigates the consequences of

overproduction without necessarily altering its causes, thereby remaining compatible with the underlying growth-oriented logic of seasonal production and accelerated turnover.

A complementary, more manufacturing-proximate strategy is represented by Weturn, a certified B-corp company that combines collection, selection, and redirection of pre-consumer waste toward reuse/recycling channels, with traceability (Weturn, n.d.). They manage (i) unsold goods and dormant stock; (ii) surplus fabric rolls; and, in a particularly relevant industrial dimension, (iii) cutting-room waste derived from cost-optimized industrial cutting layouts, which represents a pre-consumer fraction often characterized by high fiber quality yet difficult to reintegrate without quality loss. The materials are then used to produce high-level outputs, such as new traceable yarns and fabrics suitable for premium products, rather than downcycling. Traceability, segregation by composition, and the maintenance of lot-level information support more robust claims for regenerated material and reduce the typical opacity of mixed recycled content, making sustainability statements more credible. Weturn serves as an orchestrator between brands, manufacturers, and recyclers, enabling action in response to emerging regulatory drivers such as obligations to manage unsold goods and increasing pressure to trace recycled content. Therefore, circularity is not shown as a mere question of recycling capacity but of governance over material flows and, at the same time, over information flows, as it requires additional organizational work—for data capturing, auditing, and coordination—which is necessary to perform in a time-to-market dominated system as is the fashion one.

### 3.1.5 Design for disassembly and end-of-life enablement

As outlined in Table 1, this case reflects the pathway of design for disassembly and end-of-life enablement, repositioning design as a critical lever for downstream circularity. The proposition of this pathway is to define disassembly as a design requirement, transferring part of end-of-life complexity upstream to the design and manufacturing level (D'Itria and Trejo Machin, 2024), considering that many fashion items are theoretically recyclable but not in practice because disassembly is costly, and not always technically possible, and material contamination reduces recycled quality.

Initiatives in this area propose solutions that enable downstream separation of components and recycling of complex garments, reducing disassembly costs and increasing the purity of fractions.

A remarkable case is Resortecs, a Belgian company developing disassembly technologies, such as threads and accessories designed to release assembly under controlled conditions, to address the structural bottleneck presented by most of the fashion production at the end-of-life stage of a product (Resortecs, n.d.). The relevance of this pathway extends beyond the environmental to the infrastructural, as there is a shift from downcycling to a higher-value recovery pathway. Constraints on recycling change from the absence of recycling technologies to the impact of design decisions that generate complex material assemblies (Dumée,

2022). However, the possibility that disassemblability become an operational outcome depends on an inter-organizational governance that bridges design, manufacturing, sorting, and recycling actors as it requires that (i) brands decide to embrace this approach; (ii) garment manufacturers adopt the solution during production; (iii) sorting and recycling operators are equipped with lines capable of activating disassembly with standardized procedures; and (iv) specialized recyclers for the disassembled fractions are part of the ecosystem.

### 3.1.6 On-demand production and value-chain reconfiguration

As indicated in Table 1, this case exemplifies on-demand production and value-chain reconfiguration, challenging conventional production logics and inventory structures. A fourth set of interventions challenges the economic and temporal architecture of production itself. Proximity production and made-to-order or made-to-measure initiatives reduce waste and impacts reducing unsold inventory, and, in some cases, reconnecting consumers with the product's material culture. In this framework, Candiani Denim, a denim manufacturer, has been demonstrating an alternative pathway for all fashion companies and brands through its Candiani Custom microfactory (Candiani Denim, n.d.), by shifting from forecast-driven mass output to pull-based customized production. It proposes an urban model for made-to-measure, on-demand denim production aimed at reducing overproduction, typical of seasonal models, by rationalizing the offer to the minimum styles and components needed to personalize a pair of denim jeans, respecting the heritage and historical elements that characterize this item. Beyond the quantitative lever of reducing unsold inventory Candiani Denim introduces experiential transparency in building your own custom jeans, offering a cultural and cognitive lever. In fact, proximity to the production process enables consumers to directly observe materials, workmanship, and production phases, increasing their ability to evaluate quality and reducing the distance between the material/manufacturing's value and the customer's perceived value. This product literacy is particularly relevant in a context where digital purchasing, visual marketing, and price signaling reduce opportunities for sensory assessment of hand feel, density, construction, and finishing, thereby diminishing consumers' competence in evaluating product quality. This re-anchoring of value in material and manufacturing knowledge can be interpreted as a countermeasure to the cultural drivers of disposability.

Moreover, the microfactory makes empirically observable the gap between typical luxury markup structures commonly reported in the luxury fashion sector (D'Arpizio et al., 2022; Deloitte, 2021), sustained by branding and distribution, and the real cost of local, personalized production. Candiani Custom's product is positioned at a price point typically higher than mass-market, yet potentially competitive with traditional bespoke and certain luxury tiers, particularly because it integrates customization, local production, and process visibility. It foregrounds how certain forms of premium pricing can be supported by real manufacturing service content, such as customization, local production, and process

visibility, rather than primarily by symbolic value extraction, inviting a critical comparison on the economic dimension of products that is frequently discussed but rarely operationalised in sustainability debates.

### 3.1.7 Systemic governance of end-of-life and flow allocation

As summarized in [Table 1](#), this case illustrates systemic governance of end-of-life and flow allocation, focusing on collective infrastructures and traceability systems. A systemic governance approach is implemented by consortia, platforms, and infrastructures that aim to govern the collection, sorting, and determination of the destination of material streams, focusing on flow traceability and valorisation decisions, whether they involve reuse, recycling, or disposal.

The Italian consortium Retex.Green addresses end-of-life and circular flows through collective infrastructures aligned with EPR-like logics, aiming to structure value chains for the collection and management of flows, such as unsold goods, industrial waste, and, more broadly, post-use fractions ([Retex.Green, n.d.](#)). Their relevant feature is the combination of traceability and allocative decision-making: not all collected material has the same quality or optimal destination; therefore, an effective system must be able to measure, classify, and allocate fractions to the most appropriate channels to enable the preparation for reuse, refurbishment, recycling, or residual management. Circularity is thus not an intrinsic product attribute but an emergent property of the end-of-life system's capacity to treat materials in a differentiated and verifiable manner. It requires not only technological options but also governance mechanisms capable of handling heterogeneity in material quality, composition, and market outlets in a measurable, scalable, and auditable way. Such an approach calls for a change in upstream economic paradigms so that end-of-life governance becomes a driver that feeds back into design and production decisions rather than a compliance cost to be minimized.

### 3.1.8 Radical transparency and economic accountability

As outlined in [Table 1](#), this case represents radical transparency and economic accountability, addressing informational asymmetries across the value chain. This domain refers to initiatives that intervene in sustainability not (only) through materials or processes, but through informational governance: they make visible attributes that are normally opaque, thereby reducing information asymmetries and enabling accountability in procurement and manufacturing relationships.

An exemplary case is Honest By, a fashion company founded by Bruno Pieters, characterized by the application of radical transparency to fashion products, structuring product sheets as comprehensive techno-economic dossiers and, more generally, reconfiguring sustainability governance through end-to-end transparency. In fact, the initiative made explicit: (i) materials' origin and the sequencing of production; (ii) the identity and location of suppliers and subcontractors; (iii) the bill of costs

and, distinctively, (iv) the margin structures and mark-ups along the value chain, including the brand's margin. Beyond this level of economic disclosure, the model introduced a rarely observed element in the fashion system: the mapping of production phases and their corresponding time/steps, enabling reconstruction of the product's process architecture, from components to assembly, with direct implications for assessing the credibility of claims and for comparability across products. In this way, Honest translates sustainability from a theoretical claims-based concept into an auditable set of economic and process parameters ([Strähle and Merz, 2017](#)). The brand was launched in 2012 and ceased operating as an active fashion label between 2018 and 2019, as reported in industry interviews and public communications by the founder ([Pieters, 2019](#); [Business of Fashion, 2019](#)), having a more symbolic impact than commercial scalability, but it remains a proof of feasibility for extreme transparency in a sector typically grounded in competitive opacity. It exposes a foundational contradiction of the fashion system and its economy: while sustainability is frequently framed as a property of materials or certifications, the most influential determinants of environmental and social outcomes are often embedded in pricing structures, margin allocation, and time constraints imposed on suppliers.

## 4 Discussion

### 4.1 Systemic interpretation of sustainability in fashion

This section moves from the empirical findings presented in the Results section toward a higher-level interpretation, focusing on the systemic implications of the identified pathways and their relevance for understanding sustainability in the fashion system. Rather than discussing individual cases, the following analysis synthesizes cross-case insights to highlight structural dynamics, tensions, and contradictions.

The empirical findings presented in the previous section highlight a discrepancy between the rhetoric of sustainability in fashion and its material outcomes, emerging not from a lack of innovation or technical solutions, but from structural misalignments within the fashion system, particularly between governance frameworks, design practices, and sustainability objectives. Consistent with [Payne \(2019\)](#), the paper positions itself as one interpretation within the plural field of sustainable fashion, contributing a design-driven, supply chain-embedded perspective.

The cases examined reveal that sustainability is frequently approached as an operational or reputational requirement added onto existing systems, rather than as an approach capable of reshaping their principles and functioning. From this perspective, communication-led sustainability is not simply a managerial distortion, but a systemic expression of growth-driven governance. Sustainability is often rendered compatible with existing market logics by being translated into symbolic and reputational value, rather than being allowed to challenge the economic structures that depend on speed, volume, and competitive differentiation.

Across the cases, sustainability initiatives tend to operate within pre-existing economic and organizational constraints such

as accelerated fashion calendars, rigid cost–margin structures, and growth-oriented performance indicators. As evidenced by the analysis of cost–margin governance, social and environmental outcomes in fashion supply chains are not primarily determined by individual ethical intentions, but by pricing structures, margin expectations, and time-to-market constraints embedded in growth-oriented economic models. Illustrative cases such as Honest By and Candiani Custom’s microfactory highlight how deeply sustainability outcomes are conditioned by pricing strategies, margin allocation, and time constraints, which are rarely included within sustainability governance. On the other hand, initiatives focused on waste valorisation and circular inputs, such as Nona Source, Weturn, and Manteco’s business model, demonstrate that even highly efficient material strategies are limited in their impact if they do not influence upstream decisions on volumes, forecasting, and design.

The limits of the fashion system thus do not lie in the absence of sustainable practices, but in the decision-making structure that frames them. In fact, sustainability is constantly required to adapt to economic rules considered immutable, resulting in partial improvements that fail to generate systemic change (Sahimaa et al., 2024). These observations suggest that the core issue is not the absence of sustainable solutions, but the systemic conditions that constrain their effectiveness.

A key systemic tension emerges in the disconnection between governance mechanisms and design processes: while governance, operationalised through ESG frameworks and compliance tools, focuses predominantly on monitoring, reporting, and certification, design processes are driven by trend-driven turnover, seasonal cycles, and cost sheets. This separation produces a situation in which sustainability targets are defined independently of the design decisions that most directly determine material use, durability, and labor conditions. For example, design-for-disassembly solutions or recycled material strategies require early-stage integration into product conception. However, when design is evaluated primarily through short-term economic performance, such integration becomes non-compulsory rather than structural. Governance thus fails to act as a coordinating agent between sustainability aspirations and design realities, reinforcing fragmentation rather than alignment (Dissanayake and Weerasinghe, 2022).

Technological innovation plays an ambivalent role within this landscape. On one hand, technologies enabling traceability, disassembly, or advanced materials, as in the cases of Spiber and Resortecs, expand the technical feasibility of circularity and transparency. On the other hand, the analysis reveals that the economic impact of technological processes is often unevenly redistributed across the supply chain. Suppliers and manufacturers are frequently expected to absorb the costs of technological upgrades, certifications, and data provision, while brands maintain unchanged margin expectations and time-to-market schedules, putting their supply chain under constant pressure. These dynamics risk intensifying existing power asymmetries: technology becomes a compliance requirement rather than a shared investment, and environmental sustainability achievements may coincide with increased economic and social tensions downstream. The problem, therefore, is not technology *per se*, but the absence of

governance mechanisms capable of ensuring equitable integration of technological change.

Another core limitation of current sustainability practices in fashion lies in the way sustainability knowledge is structured and operationalised. Although ESG frameworks were conceived as supporting tools to be integrated, their implementation within the fashion system has largely led to sustainability being fragmented into operational silos and, consequently, only partially addressed by choosing one focus over others—usually the most convenient or easy to address. In fact, environmental, social, and governance dimensions of sustainability are often addressed through separate organizational units, metrics, and compliance instruments, reinforcing functional separation rather than systemic coordination. This fragmentation is particularly evident in the predominant use of environmental indicators to represent sustainability performance (Maghsudipour and Sedita, 2024). Substitution of materials, recycling rates, and certifications are frequently considered self-contained solutions, while the economic and organizational structures that cause production volumes, cost pressures, and time constraints remain external to sustainability assessment. As shown by the analyzed cases, this siloed approach allows improvements in one dimension to coexist with unresolved—or even intensified—pressures in others. In this sense, selective transparency and solutionism can also be interpreted as effects of the commodification of sustainability, whereby environmental action is translated into communicable market attributes that support competition without necessarily producing structural transformation. ESG thus operates less as an integrative epistemology and more as a classificatory device that stabilizes existing organizational boundaries and decision-making hierarchies.

A further consequence of ESG fragmentation is the systematic marginalization of culture and knowledge as transversal attributes of sustainability. None of the environmental, social, or governance indices adequately captures the role of material literacy, design competence, or product understanding in shaping sustainability results. This is not able, given that the concept of cultural sustainability has been added to the triple-sphere framework of ecology, economy, and equity as a fourth pillar (Hawkes, 2001; Nurse, 2006; United Cities and Local Governments (UCLG), 2010). Rather, culture is understood as an operative condition enacted through design competence, material literacy, and governance choices, rather than as a separate conceptual domain. Yet the cases analyzed clearly demonstrate that the erosion of technical and material knowledge among designers, managers, and consumers alike is a structural driver of overconsumption, disposability, and declining product durability. Initiatives that reintroduce proximity to production, process visibility, and experiential engagement, such as Candiani Custom’s microfactory, show that cultural competence has multi-dimensional effects: it influences design decisions, perceived value, consumption behavior, and waste generation simultaneously. However, these outcomes are largely unexplored in ESG-based assessments, which manage sustainability as a technical and procedural issue rather than a socio-technical and cultural transformation. By excluding culture and knowledge from its evaluation criteria, sustainability governance consolidates short-term optimisation and limits its

ability to influence the deepest drivers of unsustainable practices. This suggests that more transformative approaches to sustainability require design to move beyond a narrowly process-oriented logic toward a broader life-centered and ethics-aware orientation, in which products, systems, and decisions are evaluated in relation to their long-term effects on human and more-than-human life.

In this context, sustainability is structurally confined to a compensatory role and becomes a stabilizing element of the system rather than a driver of transformation.

Framing sustainability as a governance failure shifts the analytical focus from incremental optimisation toward the redefinition of decision-making priorities and system objectives. In line with Ehrenfeld's (2008) *Sustainability by Design*, ethics and life-centered concerns are treated not as external prescriptions, but as dimensions embedded within design decisions that shape material flows, durability, time horizons, and accountability across supply chains. This reframing provides the conceptual foundation for the guidelines proposed in the following section, which translate these systemic insights into actionable principles for design, industry, technology, and education.

## 4.2. Guidelines for systemic and sustainable fashion practice

Building on the empirical findings and their systemic interpretation, this section translates the identified dynamics into a synthesized set of actionable guidelines aimed at reconfiguring governance, design, and production as an integrated system, while also challenging the cultural assumptions, temporal pressures, and ethical limitations that currently shape unsustainable fashion practices. In this sense, the guidelines are intended not only as operational recommendations, but also as a way to challenge the growth-driven economic conditions that tend to prioritize volume, speed, and margin extraction over durability, accountability, and long-term value creation.

### 4.2.1 Design guidelines

Shifting design practices from a product-centric to a process-oriented perspective is imperative, as real sustainable outcomes depend less on isolated product attributes than on how products are conceived within industrial systems. Moreover, when design incorporates visibility over processes, making costs, phases, and disassembly requirements transparent, sustainability becomes structurally embedded rather than cosmetically applied. In this perspective, design is not only a technical or creative activity, but also an ethical practice that shapes how value, responsibility, and sustainability are materialized within products and systems.

A second important requirement is the restoration of knowledge of fibers, structures, and manufacturing constraints to enable more responsible design decisions and reduce reliance on short-term substitutions, avoiding choices driven by availability, price, or certification rather than by performance and longevity. Material literacy should therefore be considered a core competence of sustainable design.

Equally important, sustainability requires the inclusion of durability and time within the design evaluation frameworks, redefining success metrics to include time-based performance, such as expected lifespan, reparability, and iterative use. Without integrating time as a design parameter, circular strategies risk becoming accelerators of consumption rather than alternatives to it.

### 4.2.2 Industrial and supply-chain guidelines

Effective sustainability initiatives emerge when brands and manufacturers co-develop solutions, sharing risks, knowledge, and investment. This suggests the need to replace extractive sourcing models with collaborative industrial governance.

A collaborative relationship with suppliers allows a redistribution of value across transparency, quality, and service, enabling the definition of alternative pricing and margin models and, consequently, allowing ethical costing—which explicitly accounting for environmental and social requirements—to be integrated into governance frameworks rather than treated as an external constraint.

Furthermore, transparency should extend beyond storytelling to include the communication of real constraints, such as technical limits, cost implications, and trade-offs, as make these explicit enables more realistic and accountable sustainability strategies across the supply chain.

### 4.2.3 Technological guidelines

Therefore, technological solutions should be framed as enablers of circular systems, not as substitutes for human labor or organizational responsibility or as tools that compensate for poorly designed products or inequitable governance structures. Their implementation should be facilitated by the definition of governance frameworks requiring shared investment models, capacity building, and protection against the unilateral transfer of compliance burdens to suppliers so that the costs, and benefits, of transformative technology are distributed equitably.

### 4.2.4 Cultural and educational guidelines

Consumer education should be considered an integral component of design and retail experiences, and it should be included in brands' missions as educated consumers can evaluate products' quality and durability, understand trade-offs, and consciously choose to reduce overconsumption.

In the same way, nurturing a technical understanding of materials, processes, and quality among designers, technicians, and managers, again through education and lifelong learning, is essential to counteract disposability and instrumental symbolic consumption upstream, in order to prevent the release of unsustainable options on the market.

To implement sustainable fashion practices, it is essential to promote a cross-disciplinary education that integrates design, engineering, economics, and managerial concepts, enabling professionals to understand how decisions in one domain affect

outcomes in others. This interdisciplinary approach is necessary to counter disciplinary silos within organizations that reinforce the fragmentation of sustainability initiatives and to promote collaboration among functions.

### 4.3 Limitations, implications and future research

This study uses a qualitative, descriptive approach and focuses on selected initiatives within the fashion system, which may not be representative of all market segments or geographic contexts. Accordingly, the study does not aim at statistical generalization, but at analytical generalization grounded in case-based evidence. As it relies primarily on qualitative case-based evidence, it has a limited ability to generalize quantitative impact across the industry, even if this was not the study's objective. Nonetheless, many sustainability outcomes remain difficult to measure due to inconsistent data availability, proprietary constraints, and evolving regulatory frameworks, thereby limiting the effectiveness of a systematic assessment of the relevance of the discussed solutions.

To build on this study, future research could (i) address these methodological limitations by developing longitudinal and comparative analyses examining how changes in governance affect sustainability outcomes over time; (ii) deepen the analysis by adopting a critical design approach to investigate sustainability not as an attribute of products but as a property of decision-making systems; and (iii) further develop the proposed guidelines, articulating detailed activities to advance sustainability toward a deeper interrogation of how value, success, and responsibility can be governed within the industry beyond simple optimisation within existing structures.

Overall, this study contributes to ongoing debates on sustainable fashion by demonstrating that meaningful transformation depends on the alignment of design practices, governance structures, and cultural change within a coherent systemic perspective. By moving beyond communication-led approaches and framing sustainability as an emergent property of interconnected socio-technical, economic, and cultural and ethical configurations, the research highlights the need to rethink how value, responsibility, and decision-making are structured within the fashion system. In this sense, sustainability is not achieved through isolated interventions, but through the reconfiguration of the conditions under which products are designed, produced, and consumed.

### Data availability statement

The original contributions presented in the study are included in the article/supplementary

material, further inquiries can be directed to the corresponding author.

### Author contributions

CC: Methodology, Writing – review & editing, Writing – original draft, Conceptualization, Resources. MR: Resources, Writing – review & editing, Writing – original draft, Validation.

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### Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

### Generative AI statement

The author(s) declared that generative AI was used in the creation of this manuscript. During the preparation of this work, the author(s) used ChatGPT for English proofreading. The author(s) assert that no hypotheses, discourse logic, or conclusions of the entire article were the result of the use of a system that integrates (Generative) AI, and they take full responsibility for the content of the publication.

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