

Review Article

Sustainable fashion trade-offs: material innovation, circularity, and systemic change

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Abstract

The fashion industry is widely recognized as one of the most environmentally harmful industries, prompting increasing attention to technological and circular solutions promoted as pathways toward sustainability. This review paper critically examines whether these approaches can deliver meaningful sustainability outcomes by focusing on the trade-offs they entail. Using a critical narrative review of the interdisciplinary literature, the paper analyzes three illustrative cases: recycled polyester as a material innovation, secondhand clothing as a circular economy business model, and garment rental services as an access-based consumption model. The analysis evaluates environmental, economic, social, and technical trade-offs, including life-cycle impacts, technological constraints, consumer behavior, rebound effects, scalability, and systemic implications. The findings indicate that each solution addresses specific environmental challenges while simultaneously creating new limitations. Recycled polyester can reduce demand for virgin raw materials but remains constrained by technical limitations, reliance on plastic waste streams, uncertain environmental performance, and ongoing microplastic pollution. Secondhand clothing can extend product lifetimes, yet its environmental benefits depend on replacing new purchases and may be undermined by rebound effects, overconsumption, and market distortions. Garment rental services can increase product utilization but generate additional impacts through transportation, cleaning, logistics, and barriers to consumer acceptance. The review argues that evaluating individual products or business models in isolation risks overlooking the broader production and consumption dynamics that drive the industry's environmental impacts. Sustainable fashion should therefore be understood as a systemic challenge rather than the outcome of individual innovations.

Keywords: fashion industry; sustainability; trade-offs; circular economy; recycled polyester; secondhand clothing; garment rental

1. Introduction

The fashion industry carries a highly significant weight in the global economy and mainly operates through the wasteful, linear model of production, consumption, and disposal [1]. Most fashion companies primarily follow cost-efficient manufacturing in countries with lax environmental regulations and poor pollution-mitigating technologies [2], and this globalized operation makes the accurate assessment of environmental impacts challenging [3]. The environmental impact of the fashion industry is undoubtedly increasing [4, 5], despite

critiques highlighting its heavy CO₂ emissions and water, chemical, and microplastic pollution besides textile waste [2, 6].

Data acts as the foundation for modern sustainability by enabling measurement, for example, of carbon footprints, water usage, and waste, as well as optimization and accountability. However, we cannot even see the exact environmental impact of fashion: there is widespread misinformation [7], unsupported claims [8], and biased data [9] on the environmental impact of certain materials. Furthermore, the most significant emissions are generated in Tier 2–3, compared to Tier 1, direct suppliers, yet companies often overlook these processes. Unreviewed, questionable data on the environmental impact of certain textiles are used as benchmarks for policymaking [9]; however, data on sustainable fibers and recycled feedstock are generally lacking [10]. Furthermore, energy consumption tends to be the most thoroughly covered aspect [10]. The data are uneven in terms of environmental impacts: CO₂ emissions, water, and energy use tend to be available more frequently than data on toxicity, land use, and the subsequent effects on ecosystems, such as soil quality, erosion, and biodiversity [10]. In contrast, the positive environmental aspects are often overrepresented in the public discourse, promoting ecological features such as recycled content or organically produced materials. The discussion of fabric content has transformed from a niche sustainability topic to a mainstream health one [11].

Overproduction and overconsumption are central sustainability problems in the fashion industry [1, 2]. These two phenomena are closely interconnected but analytically distinct dimensions of the fashion system. Overproduction refers primarily to the volume of garments brought to market relative to actual needs or demand, whereas overconsumption concerns purchasing practices, high acquisition frequency, and the rapid turnover of garments. These processes are mutually reinforcing: high production volumes can be supported by market incentives that encourage frequent purchases, while low prices, rapidly changing trends, promotional strategies, and increased product availability can stimulate consumption and shorten garment use periods. In turn, rapid consumption turnover generates continued demand for new products, helping sustain high levels of production. The resulting dynamic is therefore not simply a problem of producing too much or consuming too much, but systemic feedback between supply, market incentives, purchasing practices, and garment turnover. From this perspective, interventions that address only one side of the system may have limited effects if the underlying relationships between production volumes and consumption practices remain unchanged. The dimension of consumption also carries significant obstacles challenging more sustainable operation. Besides serious overconsumption, consumers also have a limited understanding of the sustainability, environmental, and social impact of products [11]. Even if they declare sustainability important, they tend to act differently: the attitude–behavior gap—the disconnection between people’s stated values and their purchasing behavior—is now widely studied in the marketing sciences, in addition to the great variation in cultural views on sustainable fashion [12]. Sustainable business combines environmental, social, and economic values [13]. A focus on sustainability encourages actors to move beyond thinking in trade-offs [14], understood as compromises in which one objective may need to be sacrificed to obtain benefits in another. Since the introduction of the triple bottom line approach (considering social, environmental, and economic effects in business accounting), developed by John Elkington in 1994, the scientific literature has started to perceive trade-offs and synergies between the pillars of economic, environmental, and social dimensions [15].

The frequently asked question of whether fashion can be sustainable motivates the present review. The paper is not trying to determine whether fashion is sustainable in an absolute sense; rather, it critically examines why widely promoted sustainability solutions involve trade-offs and what this means for sustainability policy and practice. The research question of the paper is as follows: What sustainability trade-offs characterize material

innovations and circular economy solutions in the fashion industry, and what implications do these trade-offs have for the transition toward a more sustainable fashion system?

2. Review methodology and case selection rationale

The circular economy enjoys prominence in business discourse as a path toward sustainability [4]. This paper adopts a critical narrative review approach to examine the sustainability trade-offs associated with selected solutions promoted within the fashion industry. Rather than conducting a systematic review or meta-analysis, the paper synthesizes interdisciplinary literature from environmental science, sustainability, circular economy, fashion, marketing, and business research to critically evaluate competing evidence and identify recurring patterns of environmental, economic, and social trade-offs.

For screening the relevant literature, peer-reviewed academic literature constituted the primary evidence base for scientific claims and was primarily identified through Scopus and Web of Science. Gray literature, including governmental and EU policy documents, industry reports, non-governmental organization (NGO) reports, and institutional publications, was used primarily to provide market data, policy context, industry statistics, emerging evidence, information on market discourse and greenwashing claims, and industry trends that were not yet available in the peer-reviewed literature. Media articles and other non-peer-reviewed sources were used only where they documented industry developments or public discourse and were not treated as equivalent to peer-reviewed scientific evidence. Search terms were combined around four thematic groups: fashion and textiles (e.g., “fashion industry”, “apparel”, “textile”, “sustainable fashion”); sustainability and trade-offs (e.g., “environmental impact”, “life-cycle assessment”, “trade-off”, “rebound effect”, “circular economy”); recycled materials (e.g., “recycled polyester”, “rPES”, “recycled PES”, “textile recycling”); and alternative consumption models (e.g., “secondhand clothing”, “resale”, “garment rental”, and “fashion rental”).

The search covered literature published between 2020 and 2026. Overall, 125 sources were used, of which 86 are scientific journal papers and 39 sources are not journal articles (proceedings papers, book chapters, academic research projects, government/EU/NGO/industry/institutional reports, and website articles). Earlier publications were retained selectively where they provided foundational concepts or theoretical frameworks directly relevant to sustainability trade-offs, circular economy, product-service systems, or sustainable fashion. Reference lists of key publications were also examined to identify seminal and relevant additional studies. Studies were included when they addressed fashion, apparel, clothing, or textiles and provided evidence relevant to at least one environmental, economic, social, technical, or behavioral dimension of sustainability. Studies examining trade-offs, life-cycle impacts, material properties, circular business models, consumer behavior, rebound effects, product longevity, scalability, or systemic effects were considered particularly relevant. Publications unrelated to fashion and textiles, duplicate records, sources lacking sufficient evidentiary basis, and promotional material without transparent methodology were excluded. English-language publications were included, along with a few relevant technical papers in Hungarian.

Although existing reviews provide important insights into circular economy strategies, textile waste management, used-clothing supply chains, systemic sustainability, and alternative ownership and end-of-life scenarios [16–20], a comparative examination of the trade-offs associated with different types of fashion sustainability interventions remains limited. Existing studies primarily focus on particular circular strategies, supply-chain configurations, systemic approaches, or environmental impacts, rather than bringing different types of sustainability interventions together within a common, multidimensional trade-off framework.

To operationalize the analysis, three illustrative examples—highly visible fashion sustainability interventions—were selected based on their prominence in the academic literature, industry discourse, and policy initiatives: (1) recycled polyester as a material innovation/substitution, (2) secondhand clothing as a circular economy resale/reuse business model, and (3) garment rental services as an access-based circular consumption model. Recycled polyester occupies a contested, transitional position in sustainable fashion, and is promoted as a practical tool for reducing immediate plastic waste. Its use is also widespread: many (fast-)fashion brands embrace this fabric to lower their reported environmental footprints and meet initial sustainability goals. Secondhand clothing is also championed as a primary tool for reducing environmental impact, as it seems to allow consumers to enjoy “new” items without triggering the extraction of raw materials or the energy-intensive manufacturing processes of new garments. Garment rental is also an emerging business model within the sustainability initiatives of fashion, shifting the focus from ownership to access, keeping clothes in use longer. These cases were analyzed through the lens of common sustainability trade-offs, considering life-cycle impacts, technological and economic constraints, consumer behavior, rebound effects, scalability, and systemic implications. **Figure 1** gives an overview of the intended benefits and main trade-offs of the illustrative cases. The three cases were selected purposively rather than as an exhaustive inventory of circular-fashion strategies. They were chosen because they represent three distinct intervention mechanisms operating at different levels of the fashion system: material substitution (recycled polyester), product-life extension through resale (secondhand clothing), and access-based utilization (garment rental). Together, they enable comparison of trade-offs arising from technological innovation, market-mediated reuse, and changes in consumption mode. Where studies produced conflicting findings, evidence was not aggregated into a single estimate. Instead, findings were compared concerning system boundaries, functional units, assumptions, geographical context, data sources, technological maturity, allocation procedures, and the specific sustainability dimension assessed. Greater weight was given to peer-reviewed studies using transparent and methodologically appropriate life-cycle or empirical approaches. Where methodological differences plausibly explained divergent findings, the disagreement was retained rather than interpreted as evidence of a universal effect. By comparing evidence across these cases, the review paper aims to demonstrate that solutions frequently presented as inherently sustainable involve complex compromises and may fail to deliver their intended environmental benefits when broader production and consumption dynamics are taken into account.

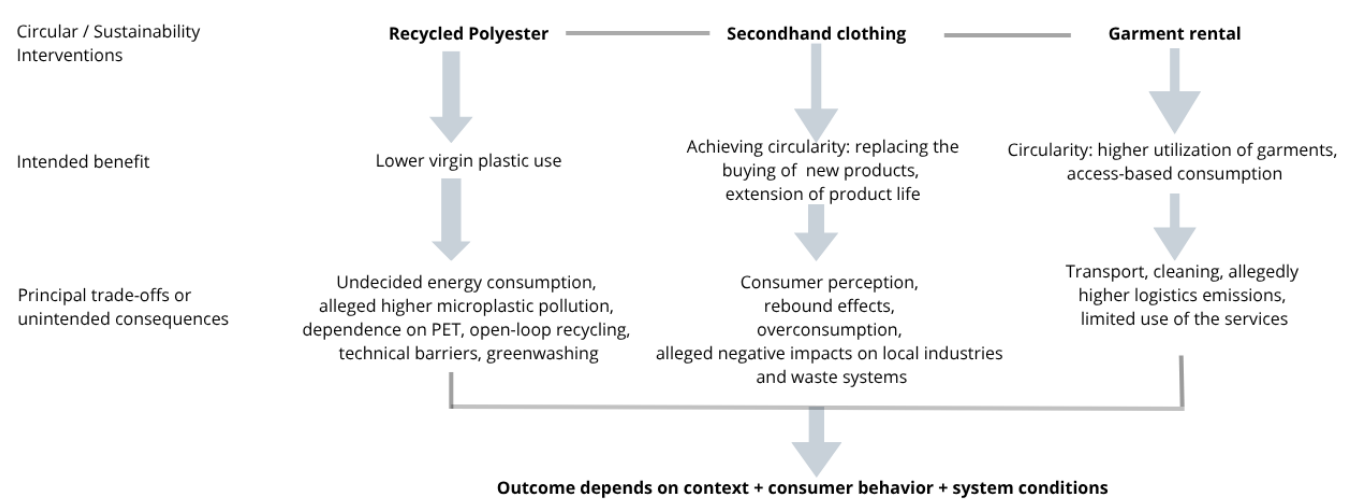


Figure 1. Overview of the intended benefits and main trade-offs of the illustrative cases.

3. Literature review: trade-offs in (sustainable) fashion

Sustainable fashion is part of a growing design, manufacturing, and consumption philosophy and trend [21], and generally refers to the efforts to minimize the fashion industry's environmental and social impacts [22] through designing, creating, and marketing socially and environmentally responsible products [22]. Sustainable fashion is also considered to be part of the slow fashion movement [23], and the term is used interchangeably with eco-, green, and ethical fashion [24]. These overlapping concepts are circulating primarily through market and industry discourse [25]. As sustainability is intuitively understood, with no coherent definition [26], the definition of sustainable fashion is also not unified and can be controversial [27]. However, defining the exact terms of sustainable fashion is crucial to avoid greenwashing [23]. Sustainable fashion can also be described as an oxymoron [28], since fashion is associated with a short shelf life and quick updates of seasonal trends, while sustainable fashion indicates longevity and long-term usage of products [22]. The interpretation of the term sustainable fashion is context- and person-dependent [23]. There is even a remarkable variety across people working in the fashion industry in how to define and operationalize sustainability [29] and different narratives around the limits of growth [30]. In general, media seems to promote sustainable fashion as garments that are somehow "less fast" [13].

Sustainable fashion seems to have become a "hot topic" during the last decade, entering mainstream discourse. Along with the development of ecological thinking and environmental protection, concerns regarding the fashion industry's operation and the roots of the sustainable fashion movement can be traced back many decades. During the 1970s, a dynamic debate was centered on a fundamental conflict between economic and ecological interests, which framed the relationship as an inherent and fixed trade-off. There are trade-offs mainly between economic and environmental objectives [31], indicating the conflicting nature of entrepreneurial and sustainability ambitions [32]. Over the course of recent decades, this viewpoint has been overcome due to governance reforms and the interplay between environmental protection and economic prosperity [14]. A growing body of literature also emphasizes trade-offs between sustainability and socioeconomic objectives, with a preference for the latter over environmental standards [33]. Trade-offs are frequently present between different alternatives, such as a government intervention that may lead to improved environmental performance but may do little to combat social inequity or political feasibility [5]. However, there is a growing body of literature stating that trade-offs are more common than exceptions [34].

A fundamental trade-off is embedded in the fast-fashion business model, in which low prices may come at the expense of material quality and product construction, increasing disposability [35]. While designers understand that overseas manufacturing may be less sustainable, trade-offs are accepted to overcome financial challenges [23]. In this case, higher emissions, less environmental protection, and waste management are traded for more cost-efficient manufacturing processes. Although it has been stated that fashion firms' investment in sustainability may be compensated by reductions in material, energy, and resource waste [15], there is a prioritization of economic objectives among fashion brands over ecological and social objectives [32].

The initial "green" fashion in the 1990s suffered criticism over offering poor-quality garments at a premium price [36]. It has also been argued that there is a perceived trade-off between the creation of desirable, fashionable garments and timeless, sustainable ones [37]. Fashion designers face internal challenges and find it difficult to balance design criteria, such as perceived trade-offs [38] between sustainability, aesthetics, costs, fashion styles, and trends, as it is challenging to create sustainable products with hedonistic attributes, such as fashionability [39].

Selecting and choosing certain fabrics and materials is central within the sustainability discourse of fashion. However, the selection of sustainable materials and manufacturing processes is also time-consuming and more expensive [40]. As fashion brands, aspiring to be seen as “green”, emphasize the use of naturally derived and organically produced materials [41], these efforts only scratch the surface of problems and can even lead to paradoxical situations [42]. Both cotton cultivation and synthetic-fiber production are associated with negative environmental effects and represent environmental ‘hotspots’ [10]; however, where and how fibers are manufactured should also be considered due to their impacts in terms of scale, geographical distance, the energy used, chemical suppliers, and waste management [43–45]. Life-cycle-impact-assessment-informed textile-fiber choices may also be treated as though different environmental impacts can simply be traded off against one another. More sustainable textile choices involve trade-offs and unintended consequences that are difficult to solve; for example, as previously noted, the organic cultivation of cotton requires more water than the conventional method [46], and requires more arable land because of its lower yield rate [47]. However, cotton is produced in approximately 75 countries with different water requirements for cultivation [7]. In terms of material choices, recycled cotton is often associated with lower quality [48]. While bamboo is frequently portrayed as more sustainable than cotton, due to its lower water requirement for cultivation, the extraction of bamboo fibers may require environmentally harmful chemicals in order to create suitable fibers for clothing [49]. The greater cost of organically or ecologically produced materials is related to the limitations of scaling [32]. Using organic materials can lead to higher production costs, which companies must consider [50]. While natural and man-made cellulosic textile fibers and microfibers have been viewed as environmentally benign due to their biological origins, as a recent review has highlighted, these fibers undergo multiple chemically intensive processing stages, and these processes influence fiber degradation, increase the potential for pollution adsorption, and contribute to the environmental persistence and impact of microfiber shedding [51].

Many sustainable solutions also face challenges regarding scalability, representing a fundamental trade-off between environmental and economic aspects. Upcycling occurs when textile leftovers are used to create products with a higher retail value than traditional recycled products [52]. However, the method is labor-intensive and requires highly skilled manufacturing, thereby creating serious barriers to mainstreaming material reuse in circular business models [53]. While zero-waste fashion design involves no pre-consumer waste, it was also highlighted that the solution suffers from material limitations and the costly need to reengineer the supply chain [54]. Sustainably made fashion items are generally perceived as more expensive [55], so sustainable fashion can even create social exclusion [56], as people must bear the costs of a firm’s sustainability efforts, either through higher prices or lower employee wages [57].

Sustainable design can also shift environmental burdens, whereby reducing hazards associated with one industrial process may increase pressure on another ecosystem [58]. Although the incineration of textiles results in the recovery of some energy, it also generates emissions and air pollutants [59]. The dependence on agriculture or industrial waste carries the risk that the raw material will run out, which can lead to deforestation and the loss of biodiversity [60]. Therefore, the diversity of fibers is important for the maintenance of healthy ecosystems and building a resilient fiber supply [10].

4. The interplay of trade-offs: material solutions and circular tools

4.1. Recycled polyester

Recycled polyester (rPES) is the most common recycled, and therefore frequently perceived as “sustainable”, material in the public discourse: many widely accessible fast-fashion and premium brands have started to offer a wide selection of items containing this fiber. As the European Union requires an increasing share of recycled fibers for textile products [61] within its Strategy for Sustainable and Circular Textiles, this requirement is increasing pressure on the industry and recycling.

Virgin polyester is made from crude oil and has a competitively low price [62], compared to natural fibers. More than half of all textile fibers are made from oil-based polyester [63], owing to its characteristics, cost efficiency, and projected increase in consumption in emerging countries adopting Western lifestyles [64]. There is a growing demand for recycled polyester products that eliminate the use of virgin materials [65]. However, phasing out petrochemical fibers is necessary, but this would pressure the production of other materials [60], given current and projected volumes of consumption.

One of the most significant challenges associated with polyester recycling is that, although large quantities of polyester fabrics are used in the fashion industry, blended fibers (such as cotton and polyester combined in a single fabric) are the most common, making recycling more challenging [66]. The textile-to-textile recycling of post-consumer polyester remains technically and economically constrained, particularly for blended, contaminated, and chemically finished textiles [67], so the recycling of polyester mostly relies on the use of polyethylene terephthalate (PET). The use of PET for recycled polyester (rPES) interrupts the closed-loop recycling cycle of the beverage sector. The recycling of PET involves secondary or open-loop recycling, and the rPES has weaker physical, mechanical, and chemical properties [68]. However, recycled polyester currently accounts for only 14% of the polyester market share [69], while its market share declined slightly to 12% in 2024 [70]. The recycling of PET for textile industry use has not been widespread, despite the growing amount of secondary raw materials. A significant amount of PET waste goes to landfills or incineration, and companies specializing in PET recycling often import the raw materials due to the low rate of local separate waste collection [71]. The recyclability of PET is negatively affected by the contamination of the material, while cleaning also entails financial costs and energy and water use.

The rPES fiber faces many technical trade-offs, since it has different mechanical features than conventional fibers, such as greater durability but less flexibility. The fiber also carries a creamy color that makes the production of white and bright colors challenging. Furthermore, its dyeing process is more difficult, requires more dye, water, and energy, and suffers from limitations in use, as the technology currently cannot provide fine fibers; thus, it is mostly used for polar products, workwear, and formalwear, or blending with virgin polyesters for fashion products [72]. However, fabrics made from recycled PET shed microplastic pollution when washed [73] and continuously require a flow of plastic waste to produce the material at scale [19]. Furthermore, although there is no scientific consensus on this issue, an NGO-reported laboratory finding indicated that recycled polyester creates 55% more microplastic pollution particles on average during washing than virgin polyester [74].

There is not even a consensus on the energy requirement of producing rPES currently. A systematic analysis suggests that 125 MJ/kg of energy is required for the production of virgin polyester and emits 9.52 CO₂/kg; only 66 MJ/kg is needed for recycled polyester and emits 5.19 CO₂/kg for recycled polyester production [75], but other sources suggest a broader range in the energy consumption of polyester production [10]. Overall, recycling faces technical and economic barriers [76]. Consequently, the environmental benefits of using recycled fibers

can be questioned if the replacement of virgin fibers is low or if the existing production practices have a small ecological footprint [10], and the outcomes vary by the method used.

Due to the trending topic of ocean plastic waste and the demand for recycled polyester, several projects have emerged and used misleading advertising, claiming that their products are made from ocean plastic waste without any proof. Furthermore, from the perspective of consumption practices, it is important to consider whether producing new garments from recycled polyester (rPES) is worthwhile if consumers discard these garments shortly after purchase.

4.2. Secondhand clothing

While this claim has not been verified, it is frequently echoed in the public discourse that “globally there is enough clothing in the system to clothe the next six generations of people” [77]. Different media sources cite different numbers of garments produced (80–150 billion garments a year), and widely circulated data suggest that approximately 92 million tons of textile waste are discarded each year [78]. There is a significant degree of overproduction and overconsumption within the textile industry. The paradigm of the circular economy has recently emerged as a way to combat pollution and climate change [79]. Reuse, secondhand purchasing, or resale, as part of the circular economy, is often portrayed as a way to generate income through alternative business models without producing new apparel. One of the more sustainable clothing acquisition options is to select pre-owned products [80], as alternative circular consumption models based on secondhand items have gained prominence [81], and is cheered for its potential to reduce textile waste, extend product lifetimes and promote circularity in fashion [5, 82].

Many industry and consultancy reports indicate that consumers are increasingly turning to secondhand platforms, with the secondhand market growing at a faster pace than the primary market in recent years [83–85]. The growth of the secondhand clothing trade can be attributed to the development of multiple business models [86], such as digital technologies [87, 88], and the diminished perceived stigma around secondhand clothing [89]. However, secondhand clothing relies on the quantity and quality of garments originating from the primary market, and evidence indicates that the quality of secondhand garments has significantly worsened, while the quantity of available items has exponentially grown, due to the popularity of fast fashion—and even ultra-fast fashion [90, 91]. Meanwhile, the secondhand clothing trade has several channels, both online and physical, including thrift and vintage stores, charity shops, and online customer-to-customer (C2C) retailers that face different challenges. While donation is perceived as a sustainable act in high-income countries, due to overproduction, charity shops are overwhelmed [92].

The environmental benefits of secondhand clothing prevail only if secondhand replaces brand-new items [93], but it is unclear whether secondhand purchases replace or simply supplement the consumption of new clothing [17]. The behavioral and market feedback may weaken or worsen the expected environmental gains [93]. Despite its alleged environmental benefits, such as reducing waste and extending the lifetime of garments, consumer perceptions remain a key barrier to secondhand adoption [94]. Many non-consumers associate secondhand clothing with poor quality and cleanliness, including worn, faded, damaged, smelly, or unclean items [80, 81, 95]. A second common drawback is limited choice: shoppers often report outdated styles, one-off inventory, difficulty finding specific items, and poor size availability, especially for larger bodies and an unappealing selection [90, 96]. There has been stigma reported surrounding purchasing or wearing secondhand due to its association with a lower socioeconomic status among certain groups of customers

and geographies [81, 97]. While secondhand clothing is considered to be cheap, it may also be less financially attractive because of the availability of inexpensive new clothing [80].

The unique nature of each item can create a fear of missing out (FOMO), which may lead to overconsumption [22]. One of the key concerns over resale participation is that it may trigger rebound effects or moral licensing, leading to increased overall consumption [98–100]. If the consumption choice is perceived as environmentally virtuous, it may relax self-imposed consumption constraints and can result in additional demand [101, 102]. Even highly engaged consumers can exhibit overall high consumption and short garment retention, indicating that sustainability knowledge does not reliably predict sustainable behavior [103]. Many studies have also identified overconsumption as a potential consequence of online secondhand clothing purchases, emphasizing fashion and style, thereby creating a rebound effect [104, 105], due to the rapid disposal of still wearable clothing and the aggressive marketing of online resale retailers [106–108], along with quick inventory updates and thrift hauls [109]. Selling used garments can also expand consumers' expenditure capacity, triggering brand-new purchases [93].

The globalized, unequal secondhand trade further generates problems and trade-offs: while exporters and developed countries outsource the management and processing of unused garments, the growing volume of secondhand garments creates challenges in importing countries. The secondhand trade also places pressure on local industries, as it can undermine the competitiveness of local garment producers [110, 111]. The national ban on secondhand imports can also contribute to the illegality of trade, due to strong consumer demand and informal networks [112]. Imports can hurt local textile and apparel manufacturers and workers, depending on market conditions, and unsuitable or unsold imported secondhand clothing can add to municipal waste and strain waste systems [113]. While some analyses argue the trade causes environmental damage in importing countries rather than delivering a truly circular system, as Liu et al. [114] have suggested, it is not that obvious: import bans and the importation of secondhand clothes may both help and hurt local textile and garment manufacturers and workers' income, depending on the cost structures of both new and secondhand clothing.

4.3. Garment rental

In a study with a limited sample, the average wardrobe contained almost 200 items, and 20% of the items had not been used in the past 12 months [115]. Another study claimed that 26% of owned garments are unworn for at least a year [116]. These findings indicate that people own a considerable number of unused garments, pointing to their financial potential for renting. Relatively frequent changes in size; life situations, such as a new job with further dressing requirements; pregnancy and the postpartum period; and changing weather seasons also indicate that the content of one's wardrobe is constantly evolving.

In addition to leasing and sharing, renting is an access-based business model that shifts consumption from ownership to use and return [76]. It is a form of collaborative consumption in which environmental benefits are assumed to follow from increasing the utility rate of a product [18]. Others describe the model as a user-oriented product-service system [117]. Rental services keep products in use for a longer time and decrease the need for new raw materials. The rental of goods is a way to reduce overconsumption; however, its promotion comes at a significant cost [118]. Current models allow customers (a) to rent individual garments for a specific period or (b) to enroll in subscription models that allow them to rent a certain number of items for a certain period and may offer customers the option to purchase the item at the end of the rental period at a reduced price [119].

Circular economy strategies may also generate rebound effects when intended environmental benefits are offset by unintended changes in consumption or other system-level effects [18]. Regarding collaborative

consumption, environmental benefits might be outweighed by the impact of transportation [120]. Moreover, garment rentals rely on in-house and external services, such as dry cleaning, logistics, and repair [76, 121]. Similar to secondhand concerns, rental services also face barriers regarding price, availability, and hygiene [104, 121]. Based on the life-cycle analysis (LCA) of a pair of jeans, research has shown that under the assumptions of that particular LCA scenario, rental/sharing performed poorly largely because of transport and associated service requirements [18].

Another trade-off is that fashion rental requires high-quality, long-lasting items because such products can maximize the profitability of the rental model; however, more expensive fashion items may be generally less durable, more difficult to clean, and require particular care, while customers tend to take less care of rental items than those that they own [121]. While there are existing services for providing everyday garments, kids and maternity wear, and designer and luxury items for rental, currently, these services mostly offer formal and designer or bridal wear, a smaller, niche fragment of the fashion market. Consumers explicitly consider everyday garments to be less ideal for renting [122, 123]. The main drivers of renting are the opportunity to experiment with different styles and brands without guilt and the possibility of saving money, while sustainability and a reduction in consumption are weak motivations for many [119]. Weak demand is listed as a main barrier for fashion rental [124], in addition to the inertia in adopting new ways of consumption and overcoming routines, hygiene and health concerns, product-quality and trendiness concerns, and the overall lack of trust in the service provider [119]. Several studies point to the desire for ownership as a barrier to the model's growth [122, 123], in addition to consumer liability in cases of damage and loss, the ease of use of the service, and the consumers' low willingness to pay a premium [119]. Based on the extensive examination of a fashion rental company, researchers concluded that the main barriers to success were the worsening quality of the inventory and its difficulty in acquiring and retaining customers due to their unfamiliarity with the concept [119]. Meanwhile, rental is also challenged by the rapidly growing resale segment [125]. The availability and easy access to new clothes also make the acceptance and use of rental challenging. The same applies to rental: the availability (quantity and quality) of garments determines which items can be offered for rent.

5. Conclusions

As the examination of recycled polyester, secondhand clothing, and garment rental has shown, the main argument of this paper is that sustainability interventions may solve one problem while creating or shifting impacts elsewhere. While many solutions, marketed as "sustainable fashion", involve significant sustainability trade-offs, focusing on these solutions can distract from the systemic drivers of the fashion industry's environmental impacts, particularly overproduction and overconsumption. Therefore, both policy and industry should evaluate sustainability interventions based on their net systemic effects rather than on individual product attributes or circular business models.

This review shows that the sustainability potential of fashion innovations and circular business models depends on the trade-offs generated across their wider environmental, economic, technical, and behavioral contexts. As **Figure 1** shows, the three illustrative cases demonstrate this clearly. Recycled polyester can reduce reliance on virgin polyester and associated fossil-based feedstocks, but its benefits are constrained by dependence on suitable waste streams, technical limitations in recycling and fiber production, uncertainty in comparative life-cycle impacts, and continued microplastic pollution. Secondhand clothing can extend garment lifetimes and reduce demand for newly produced garments, but its environmental benefits depend on actual substitution of new purchases. Rebound effects, overconsumption, declining garment quality, and the transboundary

movement of unwanted clothing can weaken or complicate these benefits. Garment rental can increase the utilization of individual garments and shift consumption from ownership toward access, but its potential advantages may be offset by transportation, cleaning, reverse logistics, product-care requirements, and limited consumer acceptance.

Taken together, these cases illustrate that sustainability interventions may address a specific environmental problem while creating or shifting impacts elsewhere. The relevant question is therefore not whether recycled polyester, secondhand clothing, or garment rental is inherently “sustainable,” but under which conditions each approach produces a net sustainability benefit. Their effectiveness depends on factors extending beyond the individual material, product, or business model, including feedstock availability, infrastructure, logistics, consumer behavior, substitution effects, rebound effects, and the scale and speed of production and consumption.

The findings consequently support a systemic understanding of sustainable fashion. Material innovations and circular business models can contribute to the transition, particularly as intermediary strategies, but they cannot by themselves resolve the structural drivers of fashion’s environmental impact. In particular, circularity is unlikely to deliver its full potential while overproduction, overconsumption, short garment use periods, and the economic incentives supporting rapid fashion turnover remain largely unchanged. Policy and industry strategies should therefore evaluate circular and technological solutions according to their life-cycle and system-level effects rather than their individual “green” attributes. This requires more consistent environmental assessment, greater transparency concerning data and assumptions, and policies that address product longevity, production volumes, consumption patterns, recycling infrastructure, and extended producer responsibility alongside technological innovation.

Overall, the review does not suggest that recycled polyester, secondhand clothing, or garment rental should be rejected. Rather, it demonstrates that their sustainability claims need to be evaluated conditionally and evaluated against the trade-offs they create. The transition toward more sustainable fashion therefore depends not on identifying a single sustainable material or circular business model, but on combining effective interventions while addressing the production and consumption dynamics that generate environmental impacts at the system level.

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