


Review

Looking for Sustainability Scoring in Apparel: A Review on Environmental Footprint, Social Impacts and Transparency

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Abstract: Sustainability has been recognized as a major concern globally since the Brudtland Report, in 1987, and further reinforced in 2015 by the United Nations Sustainable Development Goals (UNSDG) 2030. This paper reviews the methodologies and criteria of sustainability applied to fashion products, regarding products' environmental footprint (environmental life cycle assessment/analysis; e-LCA), the social issues (including the social life cycle assessment/analysis; s-LCA) and the transparency in reporting sustainability. In our review we seek KPIs (key performance indicators) that allow classification of a pair of shoes or a piece of cloth on a scale from A to E, i.e., products can be compared with a benchmark and classified accordingly with a simple labelling scheme, which is easily understandable by the consumers. This approach is similar to those used to classify electrical appliances, housing energy consumption for thermal comfort, food Nutri-Scores, CO₂ levels of road vehicles, and tire performance. In this review we aim to identify the initiatives and measures being put into practice by the top global fashion brands. We found that, despite the existence of GRI (global sustainability reporting initiative) standard reporting, most companies follow their own methods or others created within the industry rather than those created in the scientific community. Examples include the Higg index, the Transparency Index, and the Social Codes of Conduct (CoC). In this study, we conducted an extensive review of certification schemes and labels already applied to fashion products, and identified a multitude of labels and lack of harmonization in communicating sustainability. As result, we compiled a summary table of all criteria, methodologies, and possible KPIs that can be considered the basis for a benchmark and score of a fashion product. This topic is crucial to avoid "green washing" and a lack of transparency for the buyer's community, i.e., business to consumer (B2C), and for the business community, i.e., business to business (B2B) relationships, which comprise a complex multi-layer supply chain of suppliers and sub-suppliers. The UNSDG 2030 "Responsible Consumption and Production" frames these efforts to facilitate standardization of KPIs in terms of structure, criteria, and their measurement. The most common KPI is environmental global warming impact (expressed as CO_{2eq}) based on life cycle assessment/analysis (LCA) principles (established in 2000), which provide an appropriate base to monitor and benchmark products. However, in our innovative review of t-shirt e-LCA, we identified a wide range of e-LCA assumptions, relating to different boundaries, allocations, functional units, and impact categories, which represent a major challenge in benchmarking.



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Keywords: Sustainable Development Goals (SDG); life cycle analysis/life cycle assessment (LCA); eco-cost; ecolabels; key performance indicators (KPI)

1. Introduction

The Brudtland Report [1] defines sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". The United Nations Sustainable Development Goals (UNSDG/SDG)

set 17 objectives for 2030 [2]: in the fashion industry, Objective 6 (SDG 6), Clean Water and Sanitation, aims to reduce the negative impact of product manufacturing on water streams, which implies the use of fewer chemicals; Objective 8 (SDG 8), Decent Work and Economic Growth, relates to the collateral effects of mass production at lower cost, which is usually displaced to developing countries with poor working conditions; Objective 13 (SDG13), Climate Action, aims to reduce all activities' CO_{2eq} emissions and global warming potential, which relates to all phases of the fashion product supply chain, including buildings' energy efficiency; Objective 12 (SDG 12), Responsible Consumption and Production, refers to eco-friendly production methods and reducing the amount of waste in the context of the circular economy while avoiding depletion of the Earth's materials. The latter SDG is noted as having the greatest number of trade-offs with the other SDGs, e.g., with SDGs 1, 2, and 3 [3,4]. The sustainability concept in "products" is often associated with the terms "green products", "pro-environment behaviours", "environmentally friendly", which relate more to environmental aspects (water and air pollution) than to social aspects (e.g., gender equality, workers' rights, exploitation) of sustainability. The European Green Deal states "Companies making 'green claims' should substantiate these against a standard methodology to assess their impact on the environment, but also does not address the social aspects of sustainability.

The fashion industry relates to all activities associated with fashion, for example, fashion shows, tailoring, the use of marketing strategies by influencers, and the fashion product itself, e.g., a bag, a garment, or a pair of shoes. Typically, fashion products can be divided into footwear (comprising all articles designed to protect or cover the foot, with an applied sole which comes into contact with the ground) and textiles (comprising all clothes (both interior and exterior), fibers, yarn, fabric, and accessories, such as bags, scarves, and belts). The term "fast fashion" relates to inexpensive clothing produced rapidly by mass-market retailers in response to the latest trends, with a high rate of new products in stores and more frequent purchasing and disposal by consumers [5].

According to the Ellen MacArthur Foundation, in 2015, the fashion industry was responsible for the consumption of 79 billion cubic meters of water and 1.72 million tons of CO₂ emissions; in 2019, these figures were 93 billion cubic meters of water and 3.30 million tons of CO₂ emissions (10% of annual global carbon emissions). Moreover, around 20% of wastewater is produced by fabric dyeing and treatment; of the total fiber input used for clothing, 87% is incinerated or disposed of in a landfill. Only 20% of clothing is collected for reuse or recycling [6].

Businesses are facing increased pressure to incorporate environmental and social responsibilities into their corporate strategies, and these can be a differentiation factor that increases business competitiveness. However, little knowledge exists on how companies can integrate environmental and social sustainability into new product development [7]. The main drivers for companies to manage environmental and social risks are pressures and incentives from stakeholders, particularly non-governmental organizations (NGOs) [8]. Companies [9] are faced with different guidelines, tools, and methods which currently address the issue from various perspectives, and different sustainability labels are already in place. Moreover, the textile and apparel (T&A) sector faces several critical barriers to the sustainable development of their supply chains; for example, based on a multi-criteria analysis, the lack of effective governmental policies [10].

Consumers, by comparison, are more aware that protecting the environment and people is fundamental for the future of humanity. In particular, the "millennial" generation, born subsequent to the beginning of 2000, show greater concern for the environment and social issues; as a result, most possess positive attitudes toward sustainable products and are willing to pay more for sustainable services, products, or brands. Nonetheless, it is a challenge for retailers to successfully communicate "sustainable" messages [11]. Successful communication strategies currently exist for electric appliances, housing energy consumption for thermal comfort, food Nutri-Scores, CO₂ levels of road vehicles, and tire performance. Mandatory energy labelling requirements for individual product groups

were established in the EU’s Energy Labelling Framework Regulation (2017/1369) for air conditioners, domestic/household appliances, electronic displays including televisions, and tires. For buildings, Directive 2002/91/EC obliges European Member States to ensure that an Energy Performance Certificate is made available when buildings are constructed, sold, or rented. Car labelling [12] and the Nutri-Score food label [13] are not mandatory.

Kareiva et al., 2015 suggests a score from A to E based on environmental aspects [14] and the European Product Environmental Footprint (PEF) related to non-leather shoes PEF [15] (see Figure 1).

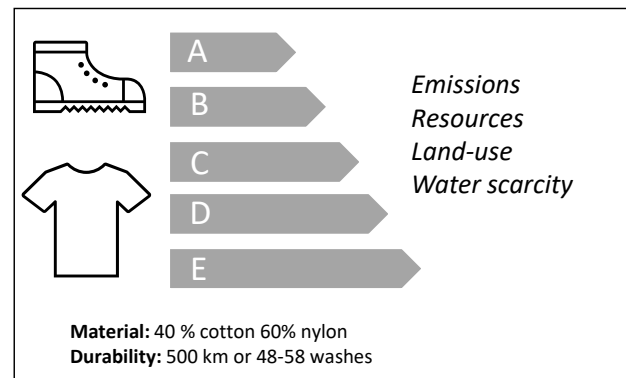


Figure 1. Suggestion of simple communication with consumers adapted from [14–16].

It is also highly important to ensure that the garment is properly distributed and used by the final consumer to ensure that sustainable criteria are met throughout the cradle-to-cradle life cycle. Longer delivery times, on-time last-mile delivery to the home (with messages stating delivery time to ensure reception at the customer’s home, thus preventing fuel wastage during redelivery of an item) are some of the logistic issues to be addressed. Consumer care is also very important. The garment must be washed fewer times and have a longer life, rather than being used once or twice before disposal; if so, the achievement of sustainability in the cradle-to-retailer supply chain (see Figure 2) is “wasted”. Therefore, consumer awareness campaigns are key to ensuring sustainability in the cradle-to-cradle life cycle.

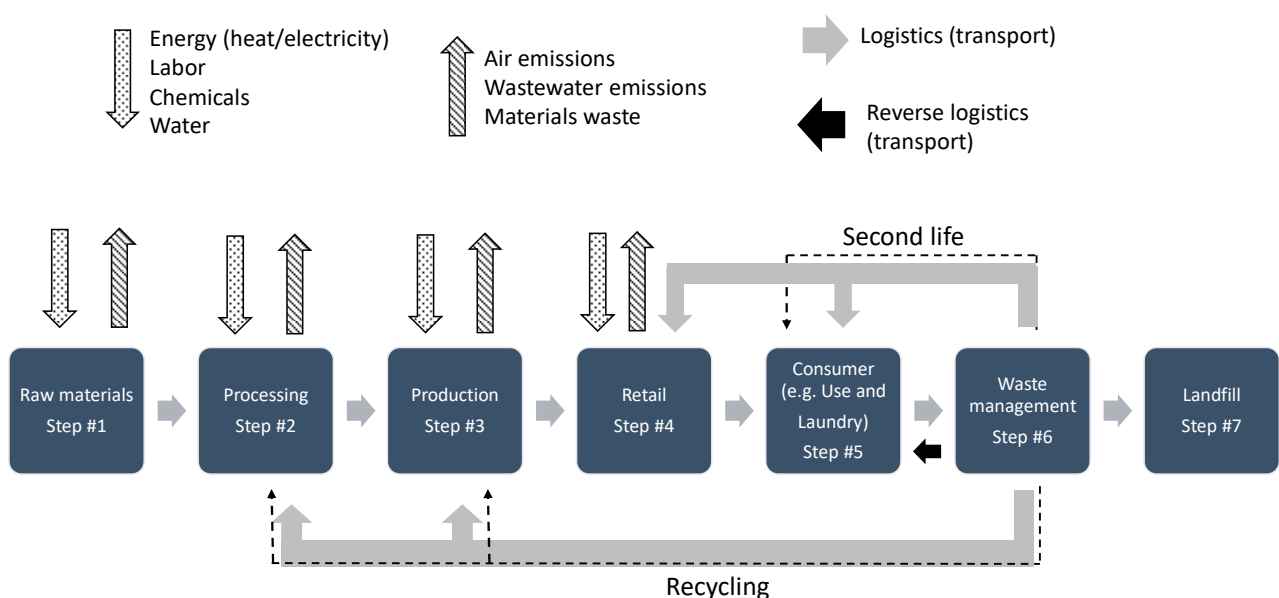


Figure 2. Supply chain of fashion products and life cycle steps. Logistics and reverse logistics create air emissions due to tire abrasion on roads or hydrocarbon fuel combustion in maritime, air, and road transportation.

A query search of the Scopus database (see Figure 3) reveals that research on apparel sustainability has been active during the past 20 years, particularly after 2005 and following the definition of the UNSDG 2030.

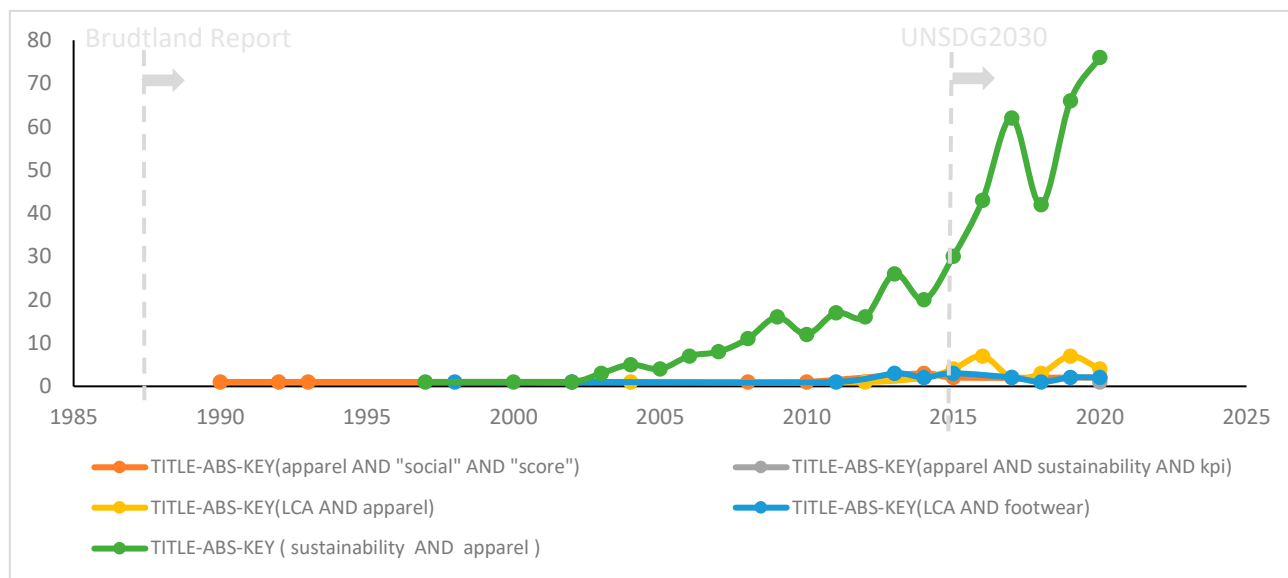


Figure 3. Query results from the Scopus database.

It is noteworthy that the query TITLE-ABS-KEY (apparel AND “transparency” AND “score”) or TITLE-ABS-KEY (apparel AND “transparency” AND “index”) retrieved no results. In fact, use of the phrase “apparel transparency index” provided results at the industry level (not at the research level) from a project entitled “A Background Analysis on Transparency and Traceability in the Garment Value Chain” funded by the European Union, and from the Fashion Transparency Index developed in 2016 by the activist organization Fashion Revolution, which has been applied to more than 200 apparel companies in relation to how much they disclose about their social and environmental policies, practices, and impacts.

These results provide the framework for growing concern with sustainability in the apparel industry and the need for legal recognition of a sustainability label linked to each fashion product covering environmental, social, and transparency aspects, and able to be certified by independent entities. The UNSDG 2030 “Responsible Consumption and Production” frames these efforts to facilitate standardization of key performance indicators (KPIs) in terms of structure, criteria, and measurement. The vast majority of related studies apply the life cycle assessment (LCA) tool to quantify and compare the environmental impacts of materials and processes, and to identify critical areas of improvement. It is therefore important to understand its application in the apparel context and the different approaches taken in studies for the same environmental impact categories.

This paper provides a review of the scientific literature and real initiatives, with the aim of structure the existing knowledge regarding the following:

- RQ1: Has research been conducted regarding the application of environmental life cycle analysis (e-LCA) and social life cycle analysis (s-LCA) to the apparel multi-layer supply chain?
- RQ2: How is the industry tackling environmental, social, and transparency sustainability issues?
- RQ3: What are the existing KPI, labelling, and third-party certification schemes?
- RQ4: How do end-users (consumers) perceive sustainability in fashion, and how can KPIs be used to compare the same fashion product “type” (e.g., t-shirt A and t-shirt B with the same shape and color) in a credible, quantitative, and transparent manner to help consumers make an informed decision and avoid “green washing”.

This review is, therefore, distinct from previous research studies [17], and aims to structure the main criteria for a fashion product to be considered sustainable, in addition to highlighting the more relevant methodologies to score fashion products' sustainability (including the environmental and social impacts at product and company level). The study covers the supply chain, consumer perceptions, and the more relevant certification schemes already in existence, not only from the research perspective but also regarding the best practices being implemented by the retailers (as main players in the fashion industry). The contribution of this paper is that it not only summarizes the existing scientific knowledge, but also validates its relevance and practical application by the industry, taking account of the best practices implemented by the world's biggest fashion retailers. In addition to identifying the tools available to score and communicate a fashion product as sustainable, our intention is to identify practical and feasible solutions. The study results are also aimed to assist in the development of certification schemes and to support private label programs for companies who are seeking to offer sustainable fashion products and communicate their sustainability in a transparent way to their customers.

The paper is organized as follows:

Section 2.1 reviews scientific literature regarding e-LCA, s-LCA, and the integration of the two approaches to address RQ1: Has research been conducted regarding the application of e-LCA and s-LCA to the apparel multi-layer supply chain? Section 2.2 reviews methodologies for companies' sustainability evaluation (such as company sustainability reporting, audits and certifications, the Transparency Index, the Higg Brand and Retailer Module, and sustainability from the consumer's perspective) to tackle RQ2: How is the industry tackling environmental, social, and transparency sustainability issues? Section 2.3 reviews several product certification schemes (e.g., Ecolabel, ICEC, Better Cotton Initiative, Global Organic Textile Standard) and Top 10 Global Retailer Best Practices, as reported in their sustainability reports, to answer RQ3: What are the existing KPI, labelling, and third-party certification schemes? In Section 2.4, sustainability benchmarking for apparel is reviewed to address RQ4: How do end-users (consumers) perceive sustainability in fashion, and how can KPIs be used to compare the same fashion product "type" (e.g., t-shirt A and t-shirt B with the same shape and color) in a credible, quantitative, and transparent manner to help consumers make an informed decision and avoid "green washing". Section 3 summarizes the criteria to be considered when scoring the level of sustainability of a product. The Table S3 also provides guidance about the methodologies to be used to obtain some evaluations (e.g., environmental life cycle assessment, audits for social assessment).

2. Materials and Methods

Our method consisted of an extensive review of proposed research methodologies and tools (retrieved from publicly available documents applied by the industry) in the area of sustainability of apparel, namely, by addressing the following research questions:

- RQ1: Has research been conducted regarding the application of e-LCA and s-LCA to the apparel multi-layer supply chain?
- RQ2: How is industry tackling environmental, social, and transparency sustainability issues?
- RQ3: What are the existing KPI, labelling, and third-party certification schemes?
- RQ4: How do end-users (consumers) perceive sustainability in fashion, and how can KPIs be used to compare the same fashion product "type" (e.g., t-shirt A and t-shirt B with the same shape and color) in a credible, quantitative, and transparent manner to help consumers make an informed decision and avoid "green washing".

2.1. RQ1: Has Research Been Conducted Regarding the Application of e-LCA and s-LCA to the Apparel Multi-Layer Supply-Chain?

e-LCA is a general methodology (ISO standard 14040) [18] that quantifies potential environmental impacts with the aim of highlighting bottlenecks or providing a basis for comparative purposes in a decision-making context. It can be used to improve the supply chain of a product and/or to compare different supply chains for the same functional product.

The life cycle steps can be highly complex and can cover all of the life cycle of products, including purchase, use, and disposal, or only raw material extraction and manufacturing, i.e., covering a product's cradle-to-cradle or cradle-to-gate. The complexity escalates if considering the cascade of multi-layer supply chain and manufacturing processes, and transportation between two adjacent steps, and, in particular, when use patterns, reverse logistics, and/or secondhand retail chains are considered.

Different raw materials (cotton, wool, leather, lyocell, rayon, polyester, spandex, nylon, elastic, fur, linen, silk, recycled PET, PLA, bamboo) blend composition and recycling grades (0% to 100%), and end-of-life (EoL) processes add additional complexity to the evaluation of the LCA of a garment. For example, t-shirts made from virgin polyester, chemical recycled polyester, or mechanical recycled polyester would have different impacts [19].

The basis for developing an e-LCA is a proper definition of the scope and boundary, and a detailed inventory of energy and material mass flows entering and exiting the boundary of the system under analysis. The most common inputs are energy (electricity and heat), water, and chemicals. The most common impact category is climate change or global warming potential (measured as CO_{2eq} and usually named greenhouse gases, GHG).

The European Commission developed the Product Environmental Footprint (PEF) with the objective to harmonize methods for measuring and communicating the potential life cycle environmental impact of a product [20]. PEF takes into account the product's entire life cycle, raw material acquisition, processing, distribution, use, and final disposal. Throughout these stages, it includes all environmental impacts, such as resource-related threats and adverse health effects, resulting in 16 environmental impact categories (e.g., climate change, acidification, eutrophication, and use of mineral and metal resources), known as the PEF profile. The Product Environmental Footprint Category Rules (PEFCRs) aim to provide detailed technical guidance on how to conduct a PEF study for each category [20]. Regarding fashion, PEFCRs are available for leather, t-shirts and footwear. Table 1 shows different studies that apply e-LCA to apparel; all include the CO_{2eq} metric, including the European PEF for t-shirt and footwear. Moreover, real apparel industry e-LCAs for specific products are also presented: Levi Strauss & Co jeans [21], GORE-TEX® jackets [22], and boots. An extended version of the table is available in the Supplementary data.

Global warming potential, or an indicator of GHG, given as CO_{2eq}, is a simple metric that is easy to understand. The disadvantage, however, is that toxicity, material depletion, and land use are not taken into account.

Regarding access to information about the social impacts of products, the s-LCA of the products can be considered, based on certain indicators and metrics [33]. According to the United Nations Environmental Programme (UNEP) Guidelines "A social and socio-economic Life Cycle Assessment (s-LCA) is a social impact (and potential impact) assessment technique that aims to assess the social and socio-economic aspects of products and their potential positive and negative impacts along their life cycle encompassing extraction and processing of raw materials; manufacturing; distribution; use; re-use; maintenance; recycling; and final disposal" [34].

Table 1. Review sample of e-LCA studies applied to apparel (research and industry-wide). Extended table provided in the Supplementary data.

Reference	Context	Boundary (see Figure 6)	Total Impact Category w/ Climate Change	CO _{2eq} w/o Use and EoL	Difference w/ Use and EoL
[23]	Research	#1; #2; #4 (1, 9, 10); #5; #6 (1).	1	23 kg CO _{2eq} /wool knit sweater; 7 kg CO _{2eq} /polyester knit shirt; 8 kg CO _{2eq} /cotton knit shirt	+18 kg CO _{2eq} /wool knit sweater; +21kg CO _{2eq} /polyester knit shirt; +21 kg CO _{2eq} /cotton knit shirt;
[24]	Research	#1; #2 (1–6); #4 (1–6, 11); #5 (1); #6 (1)	4	Conventional t-shirt 18 kg CO _{2eq} /kg apparel	+21 kg CO _{2eq} /kg apparel
[25]	Research	#1; #2 (1–6); #4 (1); #5 (1–2); #6 (1)	20	Cotton 23 kg CO _{2eq} /kg knitted fabric; Acryl 16 kg CO _{2eq} /kg knitted fabric; Nylon 22 kg CO _{2eq} /kg knitted fabric; PET 16 kg CO _{2eq} /kg knitted fabric; elasthan 18 kg CO _{2eq} /kg knitted fabric	−0.60 kg CO ₂ equivalent/kg for cotton
[26]	Research	#1; #2; #3 (2) #4 w/o (7–9, 11) #5; #6 (1)	10	5 kg CO _{2eq} /t-shirt	+1 kg CO _{2eq} /t-shirt
[27]	Research	#1; #2; #3 (2); #4 (w/o 7–11); #5	9	22 kg CO _{2eq} /sweater (cotton) 12 kg CO _{2eq} /sweater (wool) 24 kg CO _{2eq} /sweater (blend) 55 kg CO _{2eq} /sweater (acrylic)	+28 kg CO _{2eq} /sweater (100% cotton); +10 kg CO _{2eq} /sweater (100% wool); +38 (blend); +31 kg CO _{2eq} /sweater
[28]	Research	#1; #2; #4 w/o (7–9, 11); #5 (1, 2); #6 (1, 4)	7	2.55 kg CO _{2eq} /t-shirt (triclosan); 2.7 kg CO _{2eq} /t-shirt (nanosilver–FSP) 7.67 kg CO _{2eq} /t-shirt (nanosilver–PlaSpu)	
	Research	#1, #2, #4 w/o (7–9, 11), #6 (1, 2, 4)	7	2 kg CO _{2eq} /pair	+0.5 kg CO _{2eq} /pair
PEF t-shirt [15,29]	Research and industry	#1; #2; #3; #4; #5; #6	16	5.43–3.18 kg CO _{2eq} /t-shirt (33.9 kg CO _{2eq} /kg Men Tshirt–42.4 kg CO _{2eq} /kg baby t-shirt)	+0.85 kg CO _{2eq} /man t-shirt, +0.44 kg CO _{2eq} /baby t-shirt (+5.3 kg CO _{2eq} /kg man t-shirt, +5.87 kg CO _{2eq} /kg baby t-shirt)
PEF footwear [11,15]	Research and industry	#1; #2; #3; #4 (w/o 11); #6 (1, 4)	16	5.23–14.9 kg CO _{2eq} /pair	NA

Table 1. Cont.

Reference	Context	Boundary (see Figure 6)	Total Impact Category w/ Climate Change	CO _{2eq} w/o Use and EoL	Difference w/ Use and EoL
[30]	Research and industry	#1; #2 (2); #3 (2); #4 (1–6) (9–11); #5; #6 (1)	12	17–2 kg CO _{2eq} /garment	Credits for incineration w/ energy recovery compensate the usage burden
Nudie Jeans [31]	Research/ Industry	#1; #2; #3; #4 (1–6, 10); #5 (1, 2); #6 (1)	18	4.0 kg CO _{2eq} /jeans (0 reuse) to 2 kg CO _{2eq} /jeans (3 reuses)	+0.5 kg CO _{2eq} /jeans
GORE [32]	Industry	#1; #2; #4 (9, 10); #5 (1); #6 (1)	18	47 kg CO _{2eq} /1 jacket	+25.3 kg CO _{2eq}
Levi Strauss & Co [21]	Industry	#1; #2; #3; #4; #5; #6	6	20 kg CO _{2eq} /pair jeans	+13.4 kg CO _{2eq} /pair jeans

The s-LCA includes the definition of social impacts, the classification of social and socioeconomic indicators, and the development of subcategories for social and socioeconomic assessments of products. The causes of social impacts can be divided into three dimensions: behaviors, social-economic processes, and capitals. The social/socio-economic subcategories can be classified by stakeholder category (e.g., workers, local community, society, consumers, and value chain intervention) and according to the impact categories of human rights, working conditions, health and safety, cultural heritage, governance, and social-economic repercussions. The s-LCA starts with the definition of goal and scope, proceeds with the life cycle inventory analysis and life cycle impact assessment, and finishes with the life cycle interpretation [35].

The Social Hotspots Database [36] was the first database constructed for social life cycle analysis, providing the data and the tools necessary for visibility of social hotspots in the product supply chain. The 54 social indicators provided by the PSILCA database version 2.1 [37] are also relevant for s-LCA.

Few studies have dealt with the s-LCA of the supply chain of apparel. A recent case study in which s-LCA was applied using PSILCA to understand the social performance of a textile product and its potential contribution to the SDGs [38] examined a men's t-shirt with a weight of 243 g, and made of 97% cotton and 3% elastane, using a cradle-to-gate approach (Figure 4); this related to boundaries #1 and #2 of Figure 6 (#3, #4, #5 and #6 are not included).

The combination of e-LCA and s-LCA was attempted using the eco-cost methodology. The eco-cost methodology (see Figure 5) was conceptualized in the 1990s [39] at the Delft University of Technology and established in 2012 as a reference methodology. It is updated every 5 years and the most recent edition is version 1.6, from 2017. This approach combines environmental burdens related to the scarcity of the Earth's resources, airborne emissions, and water-related emissions with social aspects. The model is based on the marginal prevention costs of emissions and material depletion, and the marginal compensation costs for land use (loss of biodiversity due to transformation of land). Eco-costs express the amount of environmental burden of a product on the basis of prevention of that burden.

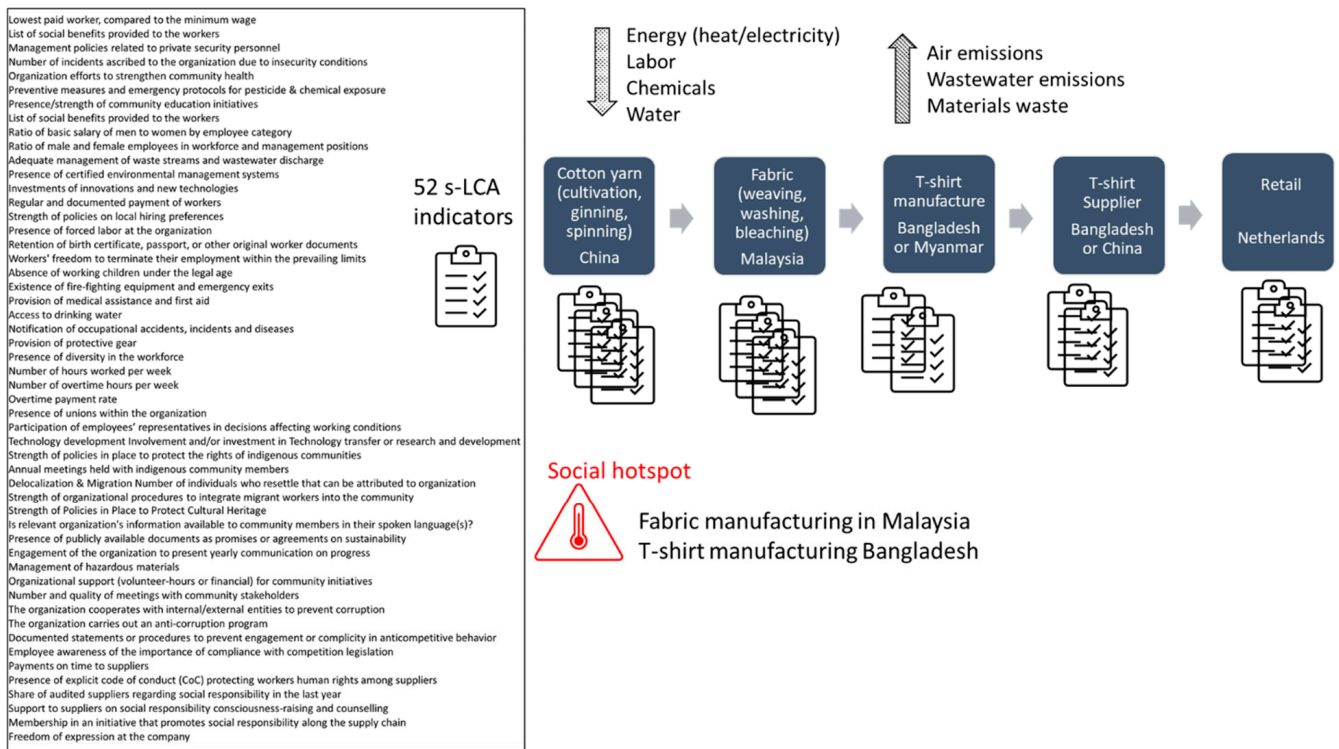


Figure 4. Social hotspot identification of a t-shirt supply chain using selected s-LCA indicators from the PSILCA database (own drawing from [38]).

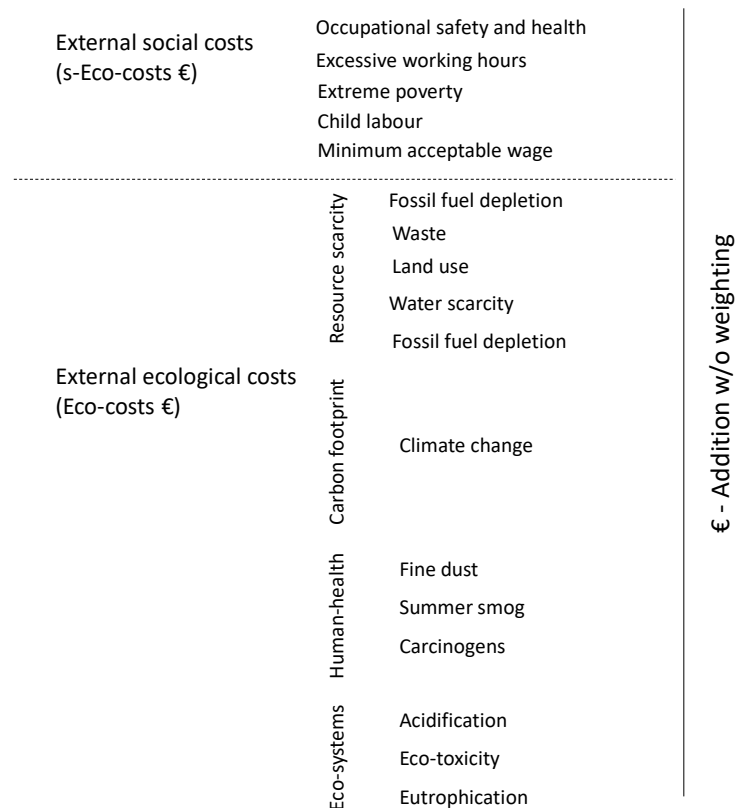


Figure 5. The eco-cost method (environmental and social aspects combined, e-LCA and s-LCA), established in 2012 and last updated in 2017 (version 1.6, updated each 5 year period) [40].

The eco-cost methodology was applied to fashion products [25,40], for a t-shirt and a pair of jeans. In the case study of the jeans, three supply-chain pathways are analyzed: case 1—cotton produced in USA, fabric production and assembly in Belgium; case 2—cotton produced in China, fabric production in India and final assembly/sewing in Bangladesh; case 3—cotton produced in India, fabric and assembly in Bangladesh. The results are summarized in Table 2. The minimum wage (int. USD PPP/h) for 2014 was 7.25 for USA, 10.31 for Belgium, 1.99 for China, 1.02 for India, and 0.9 for Bangladesh. The specific inventory data for child labor and extreme working hours were not traceable in the supply chain because the International Labor Organization (ILO) data on these factors are not yet available for the garment industry; thus, these categories were outside the scope of the research. According to Figure 2, the boundaries for these t-shirt and jeans studies were #1; #2 (1–6); #4 (1); #5 (1–2); #6 (1). The identified hotspots were the Indian cotton fields and the Bangladesh garment factories.

Table 2. Example of eco-cost analysis (e-LCA combined w/ s-LCA) of a pair of jeans [25,40], in the context of research not applied in the industry. MAW—minimal acceptable wage, EP—extreme poverty, OSH—occupational safety and health.

Supply-Chain Jeans	Category	Indicator	Eco-Costs (€/Jeans)
China-India-Bangladesh	Env	Human toxicity	0.04
		Ecotoxicity	0.14
		Resource depletion	0.21
		Carbon footprint	0.28
	Social	MAW	1.918
		EP	0
India-Bangladesh-Bangladesh	Env + social	OSH	0.755
		Total	0.67 + 2.674
	Env	Human toxicity	0.04
		Ecotoxicity	0.18
		Resource depletion	0.21
		Carbon footprint	0.31
Social	MAW	0.135	
	EP	11.668	
	OSH	0.759	
USA-Belgium-Belgium	Env + social	Total	0.74 + 12.561
		Env	Human toxicity
	Ecotoxicity		0.34
	Resource depletion		0.54
	Carbon footprint		0.82
	Social	MAW	0
EP		0	
OSH		0.384	
Env + social	Total	1.78 + 0.384	

Although e-LCA and s-LCA attempt to establish scores and metrics (KPIs) related to apparel sustainability, these approaches do not account for transparency issues and have yet to be extensively adopted by the apparel industry.

The main issue regarding LCA studies is the difficulty associated with checking the underlying datasets, because researchers have constructed their own datasets by combining information from different and sometimes old or confidential sources; researchers have also disregarded the apparel pre-consumer waste footprint [41]. In the case of the latter, in boarder #6.3 of Figure 6, only 5% mass efficiency is expected for apparel (clothes and shoes), i.e., a t-shirt weighting 200 g generates 3800 g of waste (including wastewater, sulfidic tailing, and scrap). Third-party certification of KPIs resulting from the combination of e-LCA and s-LCA is therefore challenging if “transparency” is not fully achieved.

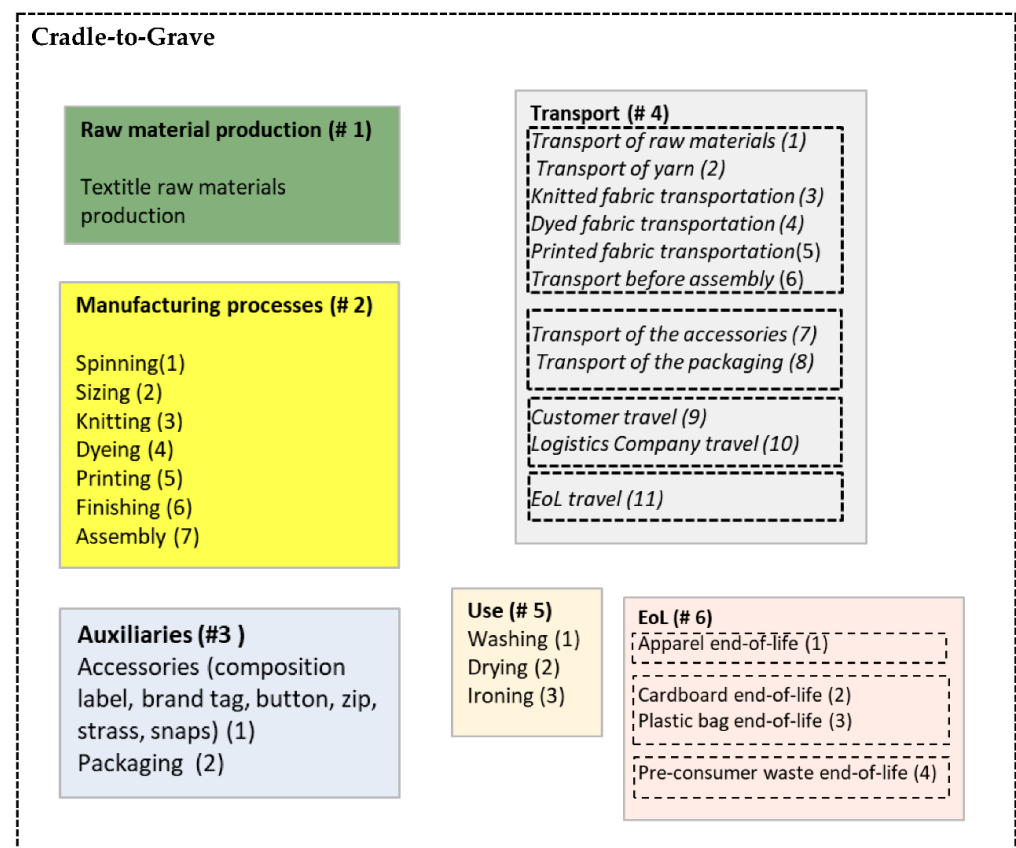


Figure 6. Possible boundaries for LCA studies related to apparel. Cradle-to-gate #1, #2, #3 and (w/transport #4 1–8); cradle-to-use #1, #2, #3, #5 and (w/transport #4 1–11).

2.2. RQ2: How Is Industry Tackling Environmental, Social, and Transparency Sustainability Issues?

2.2.1. International Standards with Generic Application in Industry

The Global Reporting Initiative (GRI) states that a sustainability report “helps organizations to set goals, measure performance and manage change in order to make their operations more sustainable” [42,43]. GRI sets voluntary recommendations for writing a sustainability report (three documents known as the 100 series) encompassing the environment (eight documents known as the 300 series), financial (seven documents known as the 200 series), and social aspects (19 documents known as the 400 series) of the company. Third-party verification is not mandatory because the report is a self-assessment that should be publicly available.

ISO 26000 “Guidance on Social Responsibility” is a voluntary standard to help companies achieve the benefits of operating in a socially responsible manner. The standard does not provide certification because no requirements are provided; rather, it provides guidance on seven core subjects of social responsibility, namely: organizational governance, human rights, labor practices, environment and fair operating practices, consumer issues, and community involvement and development.

A number of countries have mandatory regulations. For example, all companies involved in the fashion product supply chain should have their own sustainability reporting, in addition to those of the upstream supply chain. Article 225 of Grenelle II requires that many listed companies on the French stock exchange incorporate information on the social and environmental consequences of their activities into their annual reports, in addition to their societal commitments for sustainable development. The decree that implements Article 225 of Grenelle II was passed on April 2012 [44,45]. Climate change (measured as CO_{2eq}), water consumption, and waste production are the environmental impacts that are covered.

Parallel to GRI reporting, certification initiatives, such as international private standard ISO 14001 and European public regulation EMAS, have auditing schemes to certify companies who voluntarily request it.

ISO 14001 [46] sets out the criteria for an environmental management system that can be certified, mapping out the framework that a company/organization can follow to establish an effective environmental management system. This can be used by any organization regardless of its activity or sector. Using ISO 14001:2004 can provide assurance that environmental impact is being measured and improved.

The public regulation EMAS (Eco-Management and Audit Scheme, adopted by the European Commission in 1993), is based on the private standard ISO 14001, but was restricted to Europe until 2010 [47]. EMAS and the EU Ecolabel (see Section 2.3) are voluntary regulations that provide support to producers and organizations that go beyond legislative requirements.

Leadership in Energy and Environmental Design (LEED) is a widely used green building rating system, addressing topics such as energy efficiency, water conservation, site selection, material selection, day lighting, and waste reduction. The Building Research Establishment Environmental Assessment Method (BREEAM) is a third-party certification of an asset's environmental, social, and economic sustainability performance applicable to master planning projects, infrastructure, and buildings.

A number of initiatives exist to promote workers' rights across all sectors; nevertheless, these are based on the standards of the International Labour Organization (ILO), United Nations Human Rights [48], and national laws. The Ethical Trading Initiative (ETI), amfori BSCI (previously the Business Social Compliance Initiative), Sedex, the Initiative for Compliance and Sustainability (ICS), and Social Accountability International (SAI) are some of the most representative organizations that offer methodologies to assess companies' social performance [49].

The ETI is an alliance of companies, trade unions, and non-governmental organizations (NGOs) (with a combined turnover of over £166 bn) that promotes respect for workers' rights globally and collectively tackles a number of challenging issues that cannot be addressed by individual companies working alone. ETI defines best practices in ethical trade and supports companies' implementation via working groups, provision of training and support to trade unions, strategic alliances, influencing key players, and driving improvements in the member companies' performance. (Table 3 has a summary of the main topics on the ETI Base Code of labor practice) [50].

Amfori is a business association for open and sustainable trade, which brings together over 2400 retailers, importers, brands, and associations, with the objective to enable each of its members to "enhance human prosperity, use natural resources responsibly and drive open trade globally". amfori BSCI's Code of Conduct has 11 principles (see Table 3), and offers a framework and platform to manage the social performance of the member's supply chain [51].

Sedex is an ethical trade membership organization that works with businesses to improve working conditions in global supply chains (with more than 60,000 members). Sedex provides an online platform, tools, and services to help businesses operate responsibly and sustainably, protect workers, and source ethically. The Sedex Members Ethical Trade Audits (SMETA) is the audit methodology, which covers the four pillars of labor, health and safety, environment, and business ethics, although companies may also adopt only two pillars: labor and health and safety. Table 3 provides a summary of the main topics of these two pillars of SMETA. Suppliers can share one audit with several customers, reducing duplication in ethical auditing [52].

Table 3. Social responsibility aspects.

Ethical Trading Initiative [50]	Amfori BSCI [51]	SMETA 2 Pillars (Sedex) [52]
Employment is freely chosen	The rights of Freedom of Association and Collective Bargaining	Universal Rights covering UNGP
Freedom of association	No Discrimination	Management Systems and Code Implementation
Working conditions are safe and hygienic	Fair Remuneration	Freely chosen employment
Children Labor shall not be used	Decent Working Hours	Freedom of Association
Living wages are paid	Occupational Health and Safety	Health and Safety
Working hours are not excessive	No Child Labor	Child Labor and Young Workers
No discrimination is practiced	Special Protection for Young Workers	Wages and Benefits
Regular employment is provided	No Precarious Employment	Working Hours
No harsh or unhuman treatment is allowed	No Bonded Labor	Discrimination
	Protection of the Environment	Regular Employment
	Ethical Business Behavior	Sub-Contracting and Homeworking
		Harsh or Inhumane Treatment
		Entitlement to Work
		Environment

The Initiative for Compliance and Sustainability (ICS) is an international sectoral initiative, which includes 48 multinational retailers and brands (nonfood consumer products) and aims to enhance working conditions along the global supply chains of its members. The ICS Social and Environmental Code of Conduct defines the core requirements, which are subsequently audited and lead to corrective actions (if applicable). Audit information is shared on the ICS database for the members who work with the related supplier [53].

SAI is an NGO dedicated to protecting the rights of workers. SAI created the social standard SA8000 for decent work, which is presently used in over 3800 factories globally. The SA8000 Standard is one of the first auditable social certifications for decent workplaces in any industry, and covers the following topics: child labor; forced or compulsory labor; health and safety; freedom of association and the right to collective bargaining; discrimination; disciplinary practices; working hours; remuneration; and management systems. SAI have also worked on codes of conduct, industry standards, and other social certification programs. Table 3 summarizes the social responsibility aspects.

2.2.2. Higg Index (Created by the Apparel Industry for the Apparel Industry)

For the apparel, footwear, and textile industry, the Global Value project selected the Higg index as the most suitable tool to measure the impact on sustainable development for this sector, because it considered it to provide a highly comprehensive and detailed assessment that covers most of the applicable key environmental and social issues across all of the value chain [54].

The Global Value project is one of the largest European Union (EU)-funded research projects in the area of measurement and management of business impacts on global sustainable development. It has tested more than 220 impact measurements and management tools, and selected 15 of these, in different categories, which are considered to be the most suitable for the assessment and evaluation of impacts and risks, and for improving sustainability management systems [54].

The Higg index was developed by the Sustainable Apparel Coalition (SAC) in 2011 to create a common tool with comparable results to measure (and communicate) a company or a product's sustainability performance, thus empowering the fashion industry to imple-

ment improvements that protect the well-being of factory workers, local communities, and the environment.

SAC is the apparel, footwear, and textile industry's alliance for sustainable production, with more than 250 global members including apparel brands, retailers, manufacturers, academic institutions, affiliates, governments, and non-government organizations. SAC represents a significant portion of the global apparel chain and its main objective is to represent an apparel, footwear, and textile industry that does not inflict unnecessary environmental harm and has a positive impact on society. SAC aims to achieve this objective with coordinated efforts among all of the supply chain partners, ensuring transparency, fair employment practices, and a safe working environment, and implementing actions to reduce the generation of waste and the consumption of water, energy, and chemicals [55].

The Higg index is a package of self-assessment tools applicable to products, factories, and retailers. Practice questions are used to evaluate sustainability performance and drive improvement. This approach includes the Higg Product Tools, Higg Facility Tools, and Higg Brand and Retail Tool.

The Higg Product Tools can be applied to apparel, footwear, or textile products, during the design phase or after a product's completion, to understand its predicted environmental impact. This includes the Higg Materials Sustainability Index (Higg MSI) and the Higg Product Module (Higg PM). The Higg MSI Contributor can be used by the industry to submit data about innovative materials or production processes.

Higg MSI is a cradle-to-gate material scoring tool, which addresses environmental impacts from extraction or production, and manufacturing and finishing, to when the material is ready to be assembled into a final product. This is based on the life cycle impact assessment methodology, using data from around 80 base materials, and can be used to compare more than 400 different production processes. It includes the MSI Contributor tool, which is freely available to those who wish to submit data about their own sustainable products to be scored and included in the Higg MSI database [56].

Higg MSI measures five environmental impacts of material production: global warming, nutrient pollution in water (eutrophication), water scarcity, fossil fuel depletion, and chemistry [55].

Launched in September 2020, Higg PM allows users to calculate, score, and compare the environmental impacts for numerous apparel, footwear, and textile products throughout their life-cycle (from cradle to factory gate). According to SAC, this is a critical step toward future product labeling and potential environmental legislation [57].

The Higg PM calculations consider inputs (such as energy, water, materials and chemicals, agricultural land) and outputs (such as product and amount, solid waste, emissions, and wastewater) for all relevant life cycle stages. The production stages depend on the material category, whereas the finished goods consider processes such as assembling, finishing, and final product packaging. Information about the processes were taken directly from the Gabi database [58] and the World Apparel & Footwear LCA Database (WALDB) [59,60]. Higg PM also allows the calculation of the impacts of second-hand products, which are re-sold rather than entering the waste stream.

Higg Facility Tools were developed to measure the social and environmental performance of manufacturer facilities. The environmental impact can be assessed with the Higg Facility Environmental model (Higg FEM). The Higg Facility Social and Labor Module (Higg FSLM) is a tool dedicated to promoting safe and fair social and labor conditions for value chain workers globally, and is directly informed by the findings of the Social and Labor Convergence Program (SLCP).

The Higg Brand and Retail Model (Higg BRM) can be used by apparel and footwear retailers to measure the environmental and social impacts of their value chain, allowing the identification of sustainability risks and impacts throughout the life cycle stages of a product: management system, product, supply chain, packaging, use and end of use, retail stores, offices, transportation, and distribution centers.

SAC has created a verification program for Higg FEM to ensure consistency, credibility, and comparability of the scores, and is working on verification programs for the Higg BRM.

Because transparency is the best means to ensure accountability and enable the apparel industry to thrive in a responsible manner, SAC provides guidelines for clear, trustworthy, and meaningful communication about sustainability, thus empowering consumers to make more informed purchasing decisions. Table 4 summarizes the topics addressed by each Higg tool.

Table 4. Higg Index—summary table (* not included on the MSI score, at the moment) [61].

Higg Product Tools	Higg Facility Tools	Higg Brand and Retail Module
Higg Materials Sustainability Index (MSI)		Forced Labor or Human Trafficking
Inputs		Child Labor
Energy	Higg Facility Social and Labor Module	Wages and Benefits
Water	Recruitment and Hiring,	Working Hours
Materials and Chemicals	Working Hours,	Freedom of Association and Collective
Agricultural Land	Wages and Benefits,	Bargaining
Outputs	Employee Treatment	Health and Safety
Product (intermediate output)	Employee Involvement	Access to Water and Sanitation
Solid waste	Health and Safety	Decent Work
Emissions	Termination	Discrimination, Harassment, and
Wastewater	Management Systems	Abuse Sexual Harassment and
Or	Facility workforce standards and those of	Gender-Based Violence
Climate Change	value chain partners	Bribery and Corruption
Eutrophication	External engagement on social and labor	Right to Health
Abiotic Resource depletion-Fossil Fuels	issues with other facilities or organization	Right to Privacy
Water Scarcity	Community engagement.	Right to Security of the Person Minorities’
Land use *		and Communities’
Human Toxicity *		Rights Land Rights
Ecotoxicity *		
Higg Product Module		Animal Welfare
Product type	Higg Facility Environmental model	Biodiversity/Land Use/ Habitat loss
Product category	Environmental Management systems.	Deforestation,
Bill of Materials	Energy use and Greenhouse Emissions	Energy/Fuel Use
Material production processes	Water Use	Greenhouse Gas (GHG) Emissions Air
Materials in trims/components	Wastewater	Emissions/Air Pollution (non GHG)
Packaging (retail store or to ship to	Emissions to Air (if applicable)	Solid Waste
consumer)	Waste Management	Hazardous waste
Tier 1 production process	Chemical Use and Management	Chemical Hazard/Management
		Water use/water scarcity
		Wastewater/Water pollution
		Eutrophication

The Higg index has been used for 9 years to measure the social and environmental impacts on the global apparel industry. Only recently has the index included the need for third-party verification to ensure comparable results, and issued guidelines for more transparent communication on supply chain and material sustainability.

2.2.3. Fashion Transparency Index (Created by Activist Organization to Apparel Industry)

This index measures the extent of disclosure by retail companies about their social and environmental policies, practices, supply chain, and impacts. It is based on a questionnaire to provide information related to 220 indicators. The response rate for the questionnaire is 50% of the company universe selected by the researchers.

In 2020, the average score was 23% out of 100% (see Figure 7) and the worse indicators among the five considered (policy and commitments; governance; traceability; know, show and fix; spotlight issues) were traceability and spotlight issues. The former refers to the supply-chain levels of manufacturing, processing facilities and mills, and raw materials; the latter refers to working conditions, consumption, product/material composition, and climate.

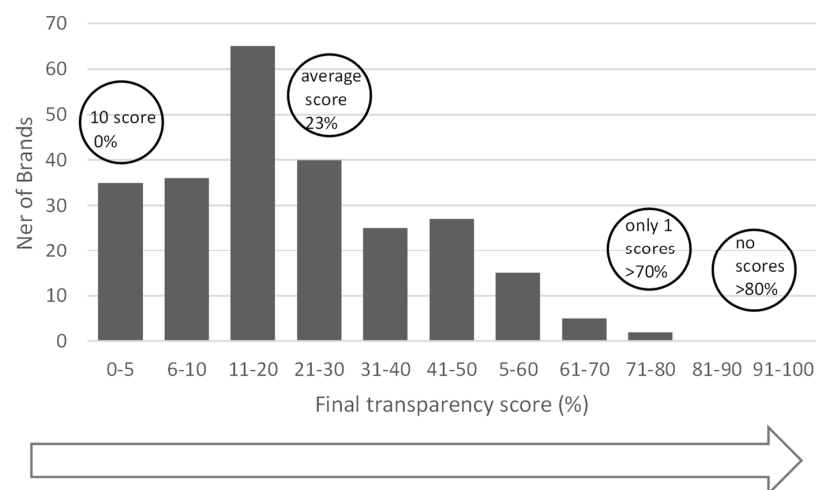


Figure 7. Quantity of companies versus the Transparency Index (in percent; 100% corresponds to a maximum of 220 points).

Regarding traceability, the questionnaire relates to the disclosure of information by the brand relating to: all supplier addresses; types of products and services provided by each supplier; approximate number of workers; sex disaggregation of workers; if the facility has a trade union; if the facility has an independent worker committee; the percentage of migrant or contract workers; the name of the parent company; the business relationship of the different facilities at the different levels of their supply chain; if the list is available and updated; facilities with which brands have a direct relationship and typically do the cutting, sewing and final trims of the products; subcontracted facilities which conduct wet processing, printing, embroidering, laundries; raw material suppliers of leather, cotton, down, or wool.

Spotlight issues are those related to: social issues (modern slavery and supply-chain recruitment practices, living wages and wage data in the supply chain, purchasing practices, and actions taken by the brand to be a good business partner to their suppliers); the circular economy (how many items were produced in the reporting period, how much textile waste is generated and how much of this was destroyed or recycled, strategies and progress on reducing pre-consumer waste and recycling post-consumer waste); use of materials (strategies and progress on the switch to more sustainable materials, strategies and progress on the reduction of the use of virgin plastics; actions taken by the brand to minimize the impact of microfibers; investments in textile-to-textile circular recycling; strategies and progress on the use of hazardous chemicals); and climate change (publication of science-based targets; publication of a commitment to deforestation; publication of a carbon footprint in owned facilities and in the supply chain; disclosure of the amount of renewable energy used in owned facilities and in the supply chain; publication of the water footprint in owned facilities and in the supply chain; linking of environmental impacts to the business bottom line).

2.2.4. Environmental Profit and Loss (EP&L) Open Methodology (Created by the Apparel Industry for the Apparel Industry)

This open source methodology was developed and used by the Kering Group (Balenciaga, Bottega Veneta, Gucci, Saint Laurent) in the luxury fashion space. It is based on the PEF methodology developed by the European Commission in 2013. EP&L encompasses six criteria:

- Climate change related: Leather product environmental footprint.
- Air quality related: To improve the understanding of human exposure to air pollutants, meteorological data used in pollution dispersion models are updated and collected for more locations.

- Land use related: The soil organic carbon content of soil under different farming practices is included as a proxy for ecosystem services values. Metrics used are above-ground biomass, species richness, and soil organic carbon (SOC).
- Waste production related: Data on quality and type of waste treatment facility is updated to better reflect the likely impacts of non-recycled waste.
- Water consumption related: To improve the correlation between corporate or agricultural water consumption and the prevalence of waterborne diseases in water stressed areas, the applied statistical approach is updated.
- Water pollution related: The latest version of the USEtox database is used as the basis for estimating the quantity of water pollutants that are likely to affect the human population.

The Kering Standards for Raw Materials and Manufacturing Processes act as a guide for suppliers to ensure compliance with the environmental and social requirements of Kering and the brand's houses, which are freely available on their website [62]. This guide, which comprises 180 pages, explains all of the sustainability criteria. The EP&L methodology converts environmental impacts into euros using the PricewaterhouseCoopers (PwC) methodology document, "Valuing Corporate Environmental Impacts" [63]. This document has six chapters, each related to an environmental category.

2.2.5. Apparel Industry Reality (Top 10 Retailers)

To identify the main disclosures considered within the scope of sustainability, a document review was undertaken of the sustainability reports of the ten largest global apparel and footwear retailers, as ranked by the Deloitte report "Global Power of Retailing 2020" [64–74]. Using these criteria, we covered retailers from the main selling markets—United States, Europe, and Japan—in addition to different business models, such as off-price, sports fashion, fast fashion, and luxury. These retailers have concerns related to sustainability, and provide communication about the actions they have undertaken, to promote social and environmental best practices. It is clear that the main challenges arise from their global multi-tier supply chains. These reports highlighted that there is no common and widespread methodology for calculating fashion product sustainability.

We determined the number of companies that published environmental and social issues. For example, in Figure 8, a value of 100% indicates that all of the companies cover a specific environmental item in their sustainability report or related communication. These results represent qualitative analysis based on the information reported by each company and available online. Eighty percent of the selected companies have objectives to use more sustainable cotton (e.g., Better Cotton (BCI), organic cotton, recycled cotton) because cotton is frequently the most commonly used raw material. Conventional cotton farming can have a significant environmental impact due to the use of water and pesticides, and can also present the risks of forced and child labor. The use of sustainable and/or recycled linen, wool, or cashmere was reported by only 30% of the companies, and in a very small volume. Just 50% of the companies were already communicating about their work with stakeholders across their value chains and other industries, to minimize the shedding of microfibers and identify long-term scalable solutions to the release of microfibers during the process of laundering synthetic fibers. Other recycled materials are also being used, although in smaller scales, such as recycled rubber, synthetic leather, and ethylene-vinyl acetate (EVA). The Canopy Initiative and FSC certification were selected by 60% of the selected leading clothing brands to shape their purchasing practices and create solutions to protect threatened forests, by eliminating the use of wood-derived fibers (e.g., viscose) and products from ancient and endangered forests. Increasing the use of metal-free tanned leather, and sourcing from more responsible suppliers, were chosen by 40% of the companies to reduce the environmental, social, and animal welfare impacts of their leather products. Animal welfare policies have been implemented to address the companies' commitments to ensure that all animal-based components in their products are sourced from ethically and responsibly treated animals (e.g., leather from animals raised for their food not solely for their hide; Responsible Down Standard certified; Fur Free commitment; no animal

testing; crocodile farms complying with minimum welfare requirements; Responsible Wool Standard (RWS) certified). The industry is also conducting trial projects to use innovative raw materials, such as mushroom leather, fiber made from citrus peel waste creating during juice production, or new leather material made using at least 50% recycled leather. The textile industry is considered a major user of hazardous chemicals and an industrial polluter of freshwater globally [75]. Regarding footwear, the manufacturing and raw material extraction stages are the biggest contributors in all impact categories. All of the retailers in the study have included environmental concerns in their Code of Conduct for Suppliers and Manufacturers; in addition, the majority also communicate about CoC assessments (including Higg FEM [61]), remediation mechanisms, and training along the supply chain. The Zero Discharge of Hazardous Chemicals (ZDHC) Roadmap to Zero Programme, which was created to provide a coordinated response to the Detox Campaign, is an industry collaboration of major fashion brands and retailers, and value chain affiliates and associates, who work together to eliminate and substitute hazardous chemicals in the global textile, apparel, leather, and footwear supply chain. The study shows that 80% of the companies communicate about their chemical management systems, including ZDHC initiatives or objectives, water and wastewater reduction projects, the Restricted Substances List, and chemical tests on final products, to determine conformity with legislation and company requirements. For example, several companies are undertaking specific actions related to denim products or laundries because the normal process generates significant quantities of wastewater. The level of chemical restrictions is extremely high, as seen in legal requirements such as the “Registration, Evaluation, Authorization and Restriction of Chemicals” (REACH) in Europe; the Consumer Product Safety Improvement Act (CPSIA), Consumer Product Safety Act (CPSA), and California Proposition 65 in the United States [76]; and the Guobiao (GB) standards in China [77]. Eighty percent of the companies indicate that they ensure compliance with the applicable requirements in selling markets, which are not only related to legislated chemical requirements, but also often also to additional chemical restrictions, flammability, safety, and physical requirements.

Sixty percent of the studied companies currently use sustainability labels to differentiate products and inform consumers about their sustainability initiatives for these products. Additional product certifications are also used, such as Organic, Fair Trade, Vegan, and Animal Welfare (see Table S1 of Supplementary Material), with claims related to the use of most sustainable raw materials, the use of environmentally friendly production processes during manufacturing, or empowering customers to care for and use the product sustainably. The majority of the companies also have take-back programs for collection of used clothes for donations, re-purposing, recycling, or re-selling. In addition, a number of companies have developed new business models, such as made on-demand, repair, rental, and re-commerce [67]. The study highlighted the need to provide a simple indication of the product’s sustainability, to enable customers to make quick and well-informed choices [67]. Only one of the selected companies has developed and implemented its own tool to measure the environmental impact of all of its activities, which encompasses every tier of its own operations, and all of the upstream processes, to the production of raw materials. This company is presently working to incorporate the impacts from the consumer use and the end of product life into the tool. Across the full life-cycle of the products, the tool measures all of the indicators that cover GHG emissions, water consumption, waste production, water pollution, air pollution, and land use. The objective is to influence daily company choices and make responsible sourcing decisions, with thorough and transparent information that makes impacts visible, quantifiable, comparable, and converted to a monetary value. A small number of companies report about the use of e-LCA tools to provide information about the impact of materials and to support decisions, particularly during the design stage. Only one company communicates about scoring its own products in terms of sustainability and reports about the evolution of the average product carbon footprint ($\text{kg CO}_{2\text{eq}}/\text{unit}$).

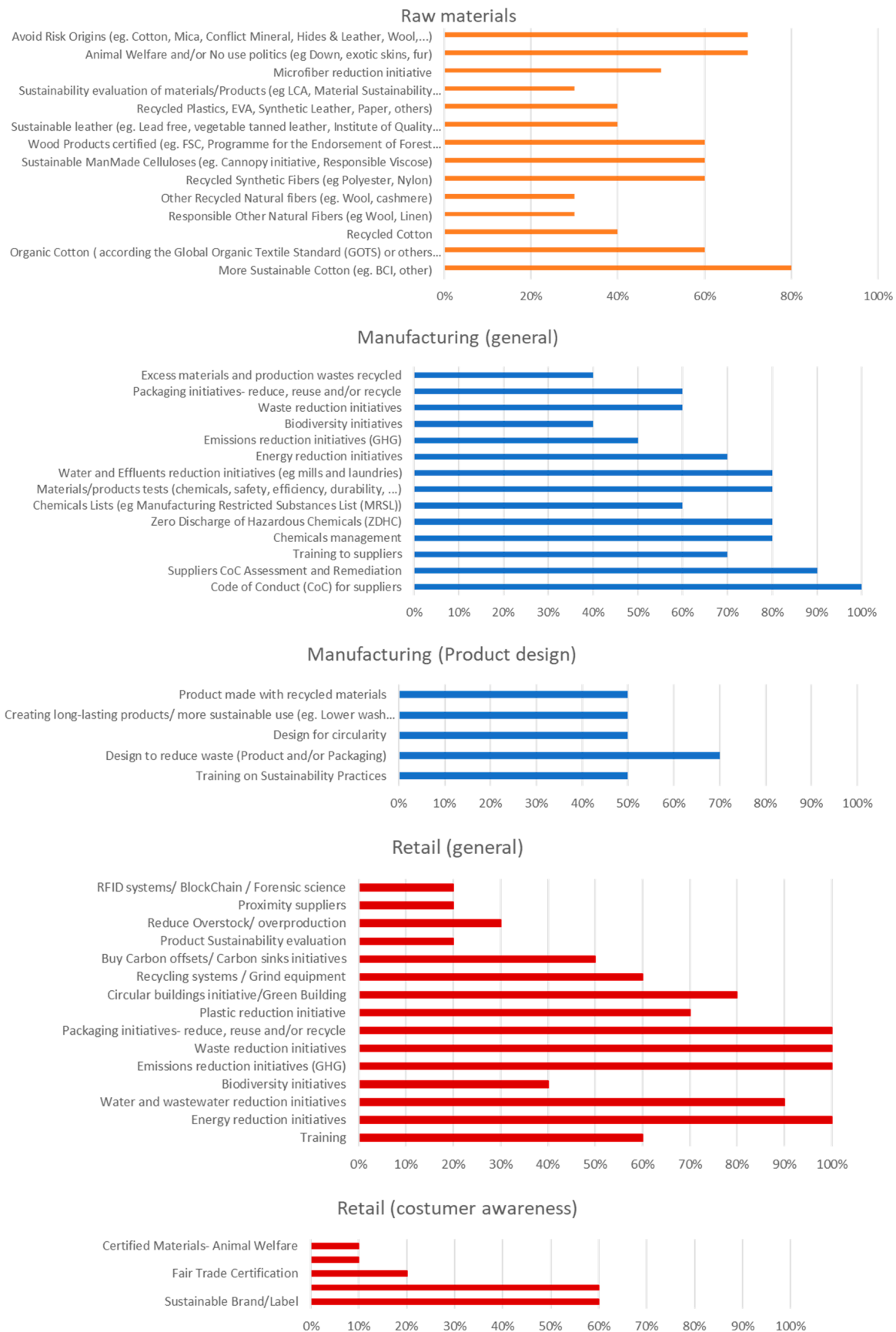


Figure 8. Percentage of top 10 retailers that report about a certain environmental item.

Regarding social issues, fashion companies are making efforts to train workers and suppliers, and achieve commitment with Codes of Conduct (CoCs). Social concerns are addressed by all of the selected retailers (see Table 5). As a basic requirement of sustainability, the majority of the studied companies have started to address the social topics under study, in regard to their own infrastructure and/or their suppliers' facilities. Data protection is a new area of concern, although just 30% of the retailers have considered this concern in their sustainability reports. Philanthropy, volunteer initiatives, and charity work in local communities are also priorities of the brands under their social corporate responsibilities and alignment with the UNSDGs 1 and 2 (i.e., reduce poverty and hunger). [62]. Fifty percent of the retailers rate their suppliers' performance to provide an effective means to benchmark, track, and identify the core challenges, and thus define the actions required to overcome these challenges and analyze progress. As previously indicated, 70% of the companies also have internal policies to avoid risks associated with origins of materials, such as hides and leather from Brazil, merino wool from Australia, and cotton from Uzbekistan and Turkmenistan. Child and forced labor are considered to be critical issues that require immediate remediation. Several retailers have specific initiatives or simply reject products that were made with raw materials from countries that have relied on unacceptable working conditions, forced child labor, and/or forced labor (e.g., the Responsible Mica Initiative [67], Conflict Minerals, and the Cotton Campaign). The study suggests that these measures are the only means of addressing these social concerns in the context of Tier 4: production and extraction of raw materials.

Table 5. Percentage of the top 10 retailers that communicate about a certain social item in their sustainability reports or related documentation available online.

Social	% of the Selected Top 10 Retailers
Social Responsibility Policy	100%
Training and Education	100%
Health and Safety Initiative	100%
Non-Discrimination Initiative	100%
Women initiative	60%
Modern Slavery Initiative	30%
Data Protection initiative	30%
Living wage/ wellbeing initiatives	40%
Volunteer initiatives	70%
Philanthropy/charity/donations	90%
Suppliers Facilities rated	50%

Regarding transparency issues, transparency and public disclosure are considered to be the first step in holding big brands to account for the human rights and environmental impact of their business practices, given the companies' particular reliance on complex, multinational supply chains. The majority of retailers score less than 50% (based on the Transparency index [73]); H&M is the leading company with a score of 73%, and implements traceability programs and communicates supplier lists as the main initiatives to manage transparency along its supply chain. However, the extension of these initiatives for Tier 2 and beyond remains limited. Traceability throughout the multi-tier supply chain is considered to be one of the main factors to achieve sustainability, not only for the Transparency Index [73] and the Greenpeace Detox Campaign [71], but also by the CEO Agenda [74], which classifies traceability as a prerequisite to identifying challenges along the supply chain, assessing risks, understanding and managing opportunities to implement more sustainable practices, more productively cooperating with peers and stakeholders, and supporting more credible communication with customers, investors, and manufacturers. In addition, the literature identifies lack of transparency as one of the main challenges in the assessment of supply-chain performance, particularly beyond the Tier 1 level of the buyer-supplier relationship [75].

It is a significant challenge to ensure good working conditions, fair wages, and equal opportunities because the fashion manufacturing industry is often located in countries where labor laws and institutions are developing and not yet in compliance with international standards. Nevertheless, all of the brands have their own Code of Conduct guided by international standards, such as those of the International Labour Organization (ILO), United Nations Guiding Principles on Business and Human Rights (UNGPs) [48], ETI code, Higg Index, Sedex, and amfori BSCI. All of the retailers are attempting to prevent human rights abuses in the supply chain via risk management, internal audits, business partner assessments, grievance handling, remediation, and training.

The topic of modern slavery and human trafficking is particularly relevant to migrants and refugees, who are potentially more vulnerable to such abuse [65,71]. Internal migration is common in China and India, and Turkey has become a major host to migrants and refugees due to the conflict in Syria; thus, these countries are considered to be high-risk countries that are often subject to close monitoring. A fair living wage is a subjective concept because it depends on several factors, such as time, place, economic development, family, taxes, and working hours. In addition, it can be questioned whether a living wage should provide for more than the necessities of life (food, shelter and clothing) or also consider proper health care, education, transportation, recreation, or savings [78]. Companies believe that improving wages also provides a sustainable income for parents, so that children with working parents can benefit. Initiatives in this area include understanding and improving wage management systems, appropriate purchasing practices, mechanisms for the involvement of workers in decision making, industry level collective agreements, monitoring working hours, and overtime control. Achieving gender equality and empowering all women and girls is Goal 5 of the United Nations Sustainable Development Goals. It is likely that, because of this, 70% of the retailers are undertaking specific initiatives to ensure women are well represented in the group at all levels (see Table 5), empowering women in the regions of its supply chains via micro-loans, skills training and education, or promoting global parental policies.

Because of the importance of traceability, to ensure transparency in supply chains that involve a large number of sub-suppliers, and in which indirect sourcing is often a routine practice, some companies have adopted traceability audits, radio frequency identification (RFID), and block chain systems, in addition to forensic methods, to be able to determine the true origin of the raw materials.

2.3. RQ3 What Are the Existing KPI, Labelling, and Third-Party Certification Schemes?

From our review, the most addressed KPI in research and the industry is e-LCA. This is mainly addressed in relation to climate change (measured as CO_{2eq}) and is selected by the industry as a means to communicate with the consumer. To date, s-LCA remains within the research context and has not yet been adopted by the industry.

It was possible to identify that many existing certification labels can be associated with products, the origin of a product's raw materials, and/or a product's production processes. Some labels are brand specific and created by companies without any impartial auditing/certification schemes. All are voluntary schemes. To add more complexity, specific labels exist for each country.

Companies in the fashion industry producing raw materials, intermediate products, or final products face the challenge of choosing some form of label to ensure their sustainability to third parties, either business (B2B) or consumers (B2C). Table S2 of the Supplementary Material provides an overview of some of the existing certification labels. A set of generic standards is applied to all industries and is not textile specific. ISO 9001 certifies the quality of the company and ISO 14001 provides guidelines for a phased approach to establish, implement, maintain, and improve an environmental management system (EMS) that organizations, including small and medium-sized enterprises (SMEs), can adopt to enhance their environmental performance. Both are generic but can be useful in allowing for more efficient and effective management of a sustainable supply chain [79].

The ISO 14020 series of standards can assist companies with the rules and guidelines to establish a trusted environmental label or declarations, considering three scopes: Type I applies to eco labelling schemes, and awards a mark or logo to products or services upon fulfilling a set of criteria (covered by ISO 14024); Type II is applicable to self-declared environmental claims, and provides credibility for the claims made by manufacturers, marketers, and resellers regarding their products (covered by ISO 14021); Type III relates to a quantified life cycle data declaration that enables comparison between similar products; these declarations are commonly known as Environmental Product data (EPD) sheets (covered by ISO 14025).

ADEME, the French Agency for Ecological Transition, reviewed more than 100 environmental labels (Type I) to help consumers make more conscientious choices. In the case of footwear, the EU Ecolabel indicates an Excellent Choice; for garments, an Excellent Choice is indicated by the EU Ecolabel, the Global Organic Textile Standard, and the DEMETER, and a Very Good Choice is indicated by the BIORE, ECOCERT Textile, Made in Green by OEKO-Tex, Bluesign, and Fairtrade Max Havelaar labels [80].

Brands such as Maximo Dutti (Inditex), Nike, and GAP use their own private labels (Type II) to communicate to the consumer that the products are more sustainable. A Join Life item (Inditex group) must include at least one raw material that uses fibers with less environmental impact than that of conventional fibers, and that are sustainable based on the results of life cycle analyses. In 2011 Levi launched its innovative Water<Less[®] collection with a label for consumer communication, indicating the adoption of schemes for reusing water during production and creating new finishes that require less water than traditional processes.

Type III labels currently have limited application to the fashion industry because, according to the Environmental Product Declaration Library, there are only 39 EDPs globally for textile, footwear, and apparel products, registered by 14 companies [81].

ISO technical specification ISO/TS 17033 “Ethical claims and supporting information—Principles and requirements”, sets out internationally agreed means to make a credible ethical claim, relating to animal welfare, local sourcing from fair trade, child labor, etc. In October 2020, ISO launched the new standard ISO 22095—Chain of Custody—General terminology and models, which is applicable to any step of the supply chain, and is a common framework describing chain of custody models in a generic manner using terminology that can be easily understood and used across different sectors or applications. The application of the standard can enhance the transparency of specific claims regarding materials or products, and thereby support the reliability of these claims [82].

The relevance of the classification of certifications (see Table S2 of Supplementary data) identified in the current study indicates these can also be applied to other product types or services; however, this was outside the scope of this article. In addition, in some cases a single organization may have several certification schemes; however, we selected the scheme that was most complete or had the most differentiated scope.

2.4. RQ4: How Do End-Users (Consumers) Perceive Sustainability in Fashion, and How Can KPIs Be Used to Compare the Same Fashion Product “Type” (e.g., t-Shirt A and t-Shirt B with the Same Shape and Color) in a Credible, Quantitative, and Transparent Manner to Help Consumers Make an Informed Decision and Avoid “Green Washing”

At the higher educational level, sustainability-related degree programs have proliferated [83]. Among 54 analyzed courses, sustainability and social sciences were found in more than 85% of both bachelor’s and master’s programs. At lower educational levels, primary schools have also increased sustainability education [84]. This will have repercussions for so-called pro-environment behavior and options for “green” or “environmentally friendly” products.

Between 21 and 25 April 2009, the European Commission conducted an interview survey [85] of over 26,500 randomly selected citizens, aged 15 and over, in the 27 EU Member States and Croatia. It highlighted that almost half (47%) of EU citizens felt that ecolabelling played an important role in their purchasing decisions. Moreover, slightly

more than 8 in 10 EU citizens felt that a product's impact on the environment is an important element when deciding which products to buy (34% "very important" and 49% "rather important"); only 4% said this was not important at all. In 2013, Eurobarometer conducted a field study in 2012 of 25,568 respondents, of which 54% said that they occasionally bought environmentally friendly products. Confidence that products carrying an environmentally friendly label are less harmful to the environment was highest in Portugal (84%), Malta (82%), France (81%), and Belgium (81%). However, confidence was significantly lower in Germany (44%), Romania (46%), and the Netherlands (47%). Confidence was close to the EU average in Croatia (68%). More than three-quarters of respondents were willing to pay more for environmentally friendly products if they were confident that the products were truly environmentally friendly (77%). Moreover, 84% believed the environmentally friendly label was important; 95% of respondents agreed that using environmentally friendly products was "the right thing to do"; 91% agreed that buying environmentally friendly products set a good example; and 80% agreed that their family and friends would think it was a good thing if they used environmentally friendly products.

Specific surveys on sustainable fashion are scarce. One survey was conducted by Ipsos MORI during 5–9 October 2018 [86], covering 1088 adults aged 16–70 in Germany; 1100 adults aged 16–75 in France; 1094 adults aged 16–70 in Italy; 1098 adults aged 16–65 in Spain; and 1129 adults aged 16–75 in the UK. The aims were to determine the information consumers would like fashion brands to share regarding social and environmental impacts, and to better understand the roles consumers think governments and laws should play in ensuring clothing is sustainably produced. They concluded that, amongst other findings, consumers think it is important for companies to: protect the environment at every stage of making their products (75%); provide information about the social impacts of their business (68%); and provide information about the environmental impacts of their business (72%).

In the Italian context [87], a survey of 8000 Italian consumers revealed that labels are important as drivers of consumer's positive attitudes, and increase the frequency of purchasing green products. These labels can be effective in engaging unconcerned or mildly concerned consumers, whereas they lose their effect when environmental concern is already high.

The EU Ecolabel indicates that the issue of trust is genuine, with four out of five European consumers wishing to buy more environmentally friendly products, provided that they are properly certified by an independent organization. Ultimately, certification requires well-defined and transparent criteria.

The global impact of lockdowns due to the coronavirus pandemic (occurring in last trimester of 2019 and first trimester of 2020, and consequent second waves during November across Europe) may have provided a perspective for fast fashion; demand for clothing plummeted, and individuals prioritized their budgets for more lasting and quality items, rather than on disposable, non-durable items [88].

The Sustainable Brand Index™ is a European brand study on sustainability, which measures the stakeholders' perception of the sustainability of more than 1400 brands, across more than 35 industries and eight countries (mainly in North Europe). The index helps to identify the gaps between how brands think they are perceived in regard to sustainability and the reality.

Brands are selected for the study based on their market share and general brand awareness, in industries which are more often present in consumers' lives and considered to be important for the transition to a sustainable product. The study is based on desk research, quantitative web surveys, and in-depth interviews with more than 1000 respondents per brand.

In the B2C brands' study, the target group comprises consumers, whereas the B2B study focuses on decision makers with purchasing responsibilities. Respondents are recruited or invited to participate in 10 min surveys. The studies are complemented with desk research and in-depth interviews. Brands are evaluated and ranked in terms of environmental and social responsibility according to the UNSDG. Using this methodology, it is

possible to obtain concrete views about how people in each country perceive a brand's sustainability efforts at that time. The objective of the Sustainable Brand Index is to encourage brands to improve their communication about sustainability, and promotion of consumer awareness and informed choices. An increasing number of companies are investing and communicating about their sustainability initiatives, and consumers are more aware of sustainability, which they consider in their purchasing decisions [89]. For this reason, it is important to measure fashion companies' sustainable performance based on consumers' evaluations, and to understand the value of sustainability perceived by consumers and how much this influences customer equity, which also indicates future profitability.

The Sustainability Fashion Index within the American Customer Satisfaction Index (ACSI) [90] measures factors related to the Economy (including price, quality, promotion, management quality, and service systems); Environmental (if companies use recycled products/packaging, reduce waste/energy use, and use new technology/products design in environmentally friendly ways); Social (when companies divert resources for purposes such as charity, corporation reputation, employees training on compartmental skills); and Culture, which is considered to be the "collective programming of mind" (considering cultural diversity of products, support for arts and cultural expression, and environmental and culture protection ideas in product design).

The study considers that perceived sustainable quality, perceived sustainable value, and sustainable expectations are influencing factors and antecedents for customer satisfaction. Reliable, standardized, non-defective, and customized products and services, which are able to meet varying customer needs, are essential for consumers to perceive quality in fashion. Perceived value is derived from the combination of perceived sustainability of products and their prices, whereas customer expectations are associated with advertising and word-of-mouth. The index captures attitudes towards the fashion industry in terms of overall satisfaction, confirmation of expectations, and distance from the customer's hypothetical ideal product. According to this study, satisfaction with sustainability creates greater customer equity in companies and brands through stronger customer relationships, because consumers evaluate product quality and develop intentions to repurchase if they perceive that the product is sustainable.

Several tools have been developed to compare the environmental impact of textiles. The most widely used are the Higg Materials Sustainability Index (MSI) and the MADE-BY Fiber Benchmark [19]. These do not apply to products created using these textiles because these indexes only include cradle-to-yarn life cycle boundaries. In relation to final products, the European Commission has tested alternatives to communicate the environmental footprint profile of products based on PEF [20]. Retailers are also undertaking trials to apply their own benchmarks and labels, specific to their own products (e.g., the Timberland green index, which was launched in 2007 but is not currently active) (see Figure 9).

The labels differ in various aspects: they can be mandatory or voluntary, they can address single or multiple issues, and the level of information provided can vary. Thus, it can be challenging for consumers to make comparisons between different labels. The European PEF is taking the first steps towards an A to E certification scheme. Nevertheless, it is environmentally driven, and its combination with social aspects and transparency remains to be conceptualized.

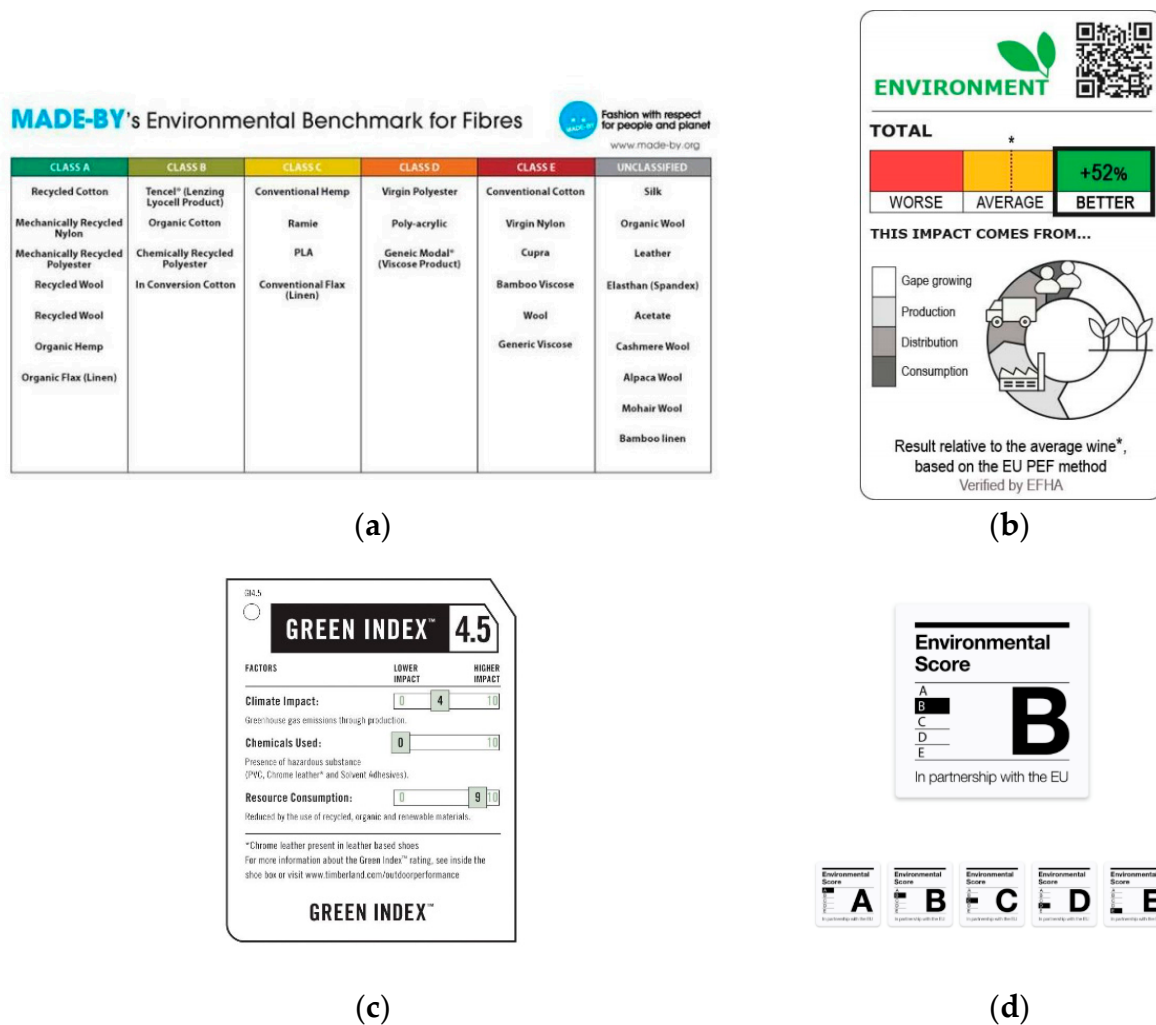


Figure 9. Examples of communication of sustainability benchmarks/labels [15,16]. (a) Class A to E—available data to score; Class F—data not yet available to score. Considers only cradle-to-yarn LCA regarding greenhouse gas emissions; human toxicity; eco-toxicity; energy; water; and land (recycled wool has the highest possible “A” scorecard rating whereas, controversially, virgin wool has the lowest rated “E” score.) [19]. (b) Overall PEF performance on a three-level scale, percentage relative to the average, and percentage contribution of life cycle stages to the total [20]. (c) Score 0 (lowest impact) to 10 (highest impact) in climate impact (kg CO_{2eq} for shoes/10); chemicals (0 uses = 0, 1 = 2.5, 2 = 5, 3 = 7.5, 4 = 10); resources (weight of non-recycled, organic, or renewable material/weight of shoe)*10. (d) Weights used for normalized impact categories are 22.19% for climate change; 9.54 for particle matter; 9.03 for water use; 8.92 for resource use, fossils; 8.42 for land use; 8.08 for resource use, minerals and metals; 6.75 for ozone depletion; 6.64 for acidification; 5.37 for ionizing radiation; 5.10 for photochemical ozone formation; 3.91 for eutrophication, terrestrial; 3.12 for eutrophication, marine; 2.95 for eutrophication, freshwater.

3. Answers to Research Questions and Sustainability Criteria Checklist

Table S3 in the Supplementary Material outlines all of the sustainability-related aspects in an initial checklist of criteria and evaluation methodologies that were identified during this review for sustainable fashion products. In summary, based on this extensive literature review, numerous initiatives have been implemented by the scientific community, companies, and associations to promote the sustainability of fashion products at environmental and social levels. Harmonization efforts have been made for the different criteria used for each methodology; however, a common set of criteria has yet to be implemented globally. Moreover, effective communication with the end user, which is simple and understandable, and allows the user to make a conscientious choice, remains a major challenge.

RQ1: Has research been conducted regarding the application of e-LCA and s-LCA to the apparel multi-layer supply-chain?

This research exists in the cases of, for example, raw materials and t-shirts, but e-LCA results are not harmonized in terms of boundaries, allocation principles, and number of impact categories. As a result, it is extremely difficult to compare similar products (e.g., t-shirts) produced by different companies. The most used metric is global warming potential expressed as CO_{2eq}. Scientific LCA principles (established in 2000) provide a suitable base for monitoring and benchmarking products. However, it is generally recognized that setting a common boundary, allocation, and functional unit is a major challenge to the implementation of a benchmark. LCA is more often applied to environmental assessments, and social metrics are starting to follow the same principles. The combination of two dimensions (environmental and social) into one unique metric/indicator that could be used both to monitor the sustainability of products of a single company, and to allow benchmarking with products of other companies, is gaining relevance.

RQ2: How is the industry tackling environmental, social, and transparency sustainability issues?

Several international standards exist for the evaluation of company performance, including methodologies for self-assessment (such as GRI), auditing of the supply chain (SMETA audits), and third-party certification (such as ISO 14001). These methodologies are not specific to the fashion industry and are usually focused on specific impacts (such as social, environmental, or economic), or have a limited scope (such as a specific company, rather than encompassing all of the supply chain).

Transparency is key to tracking and tracing where and how products are made, and is the first step to assess risks to the supply chain (e.g., human rights, climate, or biodiversity). Our review of top retailers showed that transparency is still in its early stage: from the 2020 results, it is possible to conclude that significant work is still required by the world's biggest brands to achieve transparency, as reflected in the average score of 23% for 250 brands and retailers [91]. All of the brands address social issues such as social responsibility policy, training and education, health and safety initiatives, non-discrimination initiatives, and philanthropy/charity/donations. A small number of companies report on the use of e-LCA tools to gather information about the impact of materials and to support decisions, particularly during the design stage. Only one company communicates about scoring its own products in terms of sustainability, and reports on the evolution of its average product carbon footprint (kg CO_{2eq}/unit). The Higg index, created by SAC, is becoming widely adopted to monitor sustainability, but does not provide third party certification or an appropriate harmonized communication strategy with consumers. The monetization of environmental impacts, known as ecological economics and used in the environmental profit and loss (EP&L) methodology, was applied in 2007 by the PUMA company (Section 2.1). It was further developed in 2015 by the consultant PricewaterhouseCoopers and the luxury fashion company Kering Group. Traceability of a product's supply chain is becoming more important [92], and is fundamental for the evaluation of the product's environmental and social impacts across the supply chain, and to the point of disposal.

RQ3: What are the existing KPI, labelling, and third-party certification schemes?

Existing KPIs are generally consistent with e-LCA impact categories (1 to 20 impact categories related to air degradation, water degradation, and the Earth's materials or land depletion; see Table S1 of the Supplementary Material). S-LCA is still limited to research and the PSILCA database prevails in the provision of quantitative KPIs. Labels subject to third-party certification are listed in Table S2 of the Supplementary Material. Most of the certification schemes address different supply chain steps and only partially address sustainability issues, creating confusion for consumers and the industry [93].

EU Ecolabel is one of the best schemes because it is independent and uses a life cycle approach in terms of environmental impacts; however, it does not ensure labor protection for all stages of the supply chain [93].

RQ4: How do end-users (consumers) perceive sustainability in fashion, and how can KPIs be used to compare the same fashion product “type” (e.g., t-shirt A and t-shirt B with the same shape and color) in a credible, quantitative, and transparent manner to help consumers make an informed decision and avoid “green washing”.

The level of trust in product sustainability remains a key issue. Third-party certification is fundamental. The European PEF is taking the first steps towards an A to F certification scheme; however, this only addresses the environment impact. It is not yet clear what harmonized methodology and sustainability label should be used to certify products and communicate their sustainable credentials. Benchmarking is useful for comparison and to identify the potential for improving performance. It is also useful for comparing the sustainability of similar products, from the perspectives of both consumers (business to consumer, B2C) and other business (business to business, B2B), particularly when the supply chain of a product sold by one company involves many other companies. Voluntary certification and product labeling have taken on a new responsibility as fashion consumers’ concerns about sustainability have increased. Nonetheless, confusion is a significant problem due to the large number of ethical labels used in the industry, which complicate users’ understanding of who and what to trust. In practice, no single scheme or label exists which ensures transparency, traceability, and sustainability at every stage of the supply chain. It is important that companies invest in and communicate their sustainability initiatives, to allow companies’ sustainable performance to be measured based on consumers’ evaluations, and to identify the gaps between how brands think they are perceived regarding sustainability and the reality. These evaluations can be undertaken using methodologies such as the Sustainable Brand Index™ or the Sustainability Fashion Index with the ACSI (Section 2.4). In terms of communication with the consumer, some generic labels do not aim to allow comparison of products for the same purpose, whereas others provide comparisons and, hopefully, lead the consumer to a more sustainable choice.

4. Conclusions

Our review indicates that no harmonized consensus exists regarding KPIs (in the environmental, social and transparency dimensions) related to identifying a “sustainable fashion product” or the most sustainable products in a certain category (e.g., a t-shirt or a pair of jeans), for simple and trusted communication to consumers.

The use of KPIs related to the environment is becoming common practice in the apparel industry by means of e-LCA. Up to 20 impact categories related to air, ecosystems, and human health exist for measurement and monitoring. The most common KPI is global warming potential measured in CO_{2eq}. Environmental KPIs are typically adopted using physical or monetary units. For example, the Kering Group and the PUMA company use the latter (in the Environmental Profit and Loss (EP&L) methodology); these are based on e-LCA and monetization of environmental impacts, which relies on evaluating changes in the environment and the repercussions of these changes for people. The main issue regarding LCA studies and the related KPIs is that checking the underlying datasets is difficult because each analysis is based on specific datasets constructed by combining information from different and, sometimes, old or confidential sources. In addition, these analyses disregard the apparel pre-consumer waste footprint and/or have more than 10 different possible boundaries. s-LCA indicators (up to 54 in the PSILCA database) and their combination with e-LCA is rare in existing research (University of Delft Eco-cost is an example of one study) and even more rare in the industry. One of the reviewed research studies used 52 social indicators that measure the risks associated with working hours, which are related to the UNSDG.

The Higg index (created in 2012 by the industry for use within the industry, and still in development) is gaining momentum in companies in the USA such as Nike, The Gap, Levi Strauss, REI, Ann, and Patagonia. It is also being adopted by European retailers, e.g., the Portuguese Têxtil Amaral, LDA and Turkish Egedeniz textile, and others, e.g., the Chinese S.E.C. (Dongguan) Accessories Limited and FAKIR Fashion Bangladesh. This

index encompasses environmental, social, and transparency aspects, but the environmental module (Higgs FEM) is the most widespread. However, it is not yet subject to a third-party certification scheme (other than that of the creator, SAC) and, because it is aimed at the company's sustainable monitoring and self-assessment, is not yet suitable for clear and complete communication with the consumer.

Well-established KPIs that encompass the combination of environmental, social, and transparency issues, thus providing a sustainability benchmark and simple A to E classification related to the cradle-to-gate boundary, have yet to be developed. The PEF measure of the European Commission for t-shirts and footwear is a first step in this direction but only encompasses the environmental dimension.

Research should be conducted to develop a reliable scientific methodology to score the sustainability (environmental, social, and transparency) of fashion products. This methodology should result in measurable KPIs that can be easily converted to an A to E benchmark label that is understandable by consumers globally. This simple label would boost consumers' confidence. However, our review indicates there is still a gap in communicating sustainability information to consumers in a simple, understandable manner, and that can guide consumers to the most sustainable products. "Green washing" and a lack of transparency in the buyer's community, and in business to consumer (B2C) and business to business (B2B) relationships, will continue to exist in the absence of an appropriate scientific methodology that encompasses all aspects of sustainability, and that is applied throughout the supply chain (including embedded stages) and subject to a third-party certification scheme. The most common KPI related to the environment is global warming potential. In the current study, we identified why this KPI cannot be used without a proper definition of the boundaries, allocation criteria, and process considerations, using the example of a common fashion product, namely, a t-shirt (from a range using 100% cotton material with cradle-to-gate potential of 3–8 kg CO_{2eq}/t-shirt).

Supplementary Materials: 1 file with 3 tables. The following are available online at <https://www.mdpi.com/article/10.3390/en14113032/s1>, Table S1: Review sample of e-LCA studies applied to apparel (research and industry wide), Table S2: Diversity of existing 3rd party certification labels applicable to Fashion products, Table S3: Checklist of criteria and evaluation methodologies for a Sustainable Fashion Product.

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Nomenclature

ACSI	American Customer Satisfaction Index
ADP	Abiotic resource depletion potential
AP	Acidification potential
B2B	Business to Business
B2C	Business to Consumer
BCI	Better Cotton Initiative
BSCI	Business Social Compliance Initiative
BRM	Brand & Retail Model
BREEAM	Building Research Establishment Environmental Assessment Method

CEO	Chief Executive Officer
CoC	Code of Conduct
CO _{2eq}	Carbon dioxide equivalents
CPSA	Consumer Product Safety Act
CPSIA	Consumer Product Safety Improvement Act
EC	Energy consumption or European Commission
KPI	Key Performance Indicator
e-LCA	Environmental Life Cycle Assessment/Analysis
EMAS	Eco-Management and Audit Scheme
EoL	End of Life
EP&L	Environmental Profit and Loss
ESP	Spain
EU	European Union
EVA	Ethylene-vinyl acetate
FAETP	Fresh Aquatic Eco-Toxicity Potential
FEM	Facility Environmental model (Higg index)
FRA	France
FSC	Forest Stewardship Council
FSLM	Facility Social & Labor Module (Higg index)
FU	Functional Unit
GBR	Great Britain
GHG	Greenhouse Gas
GOTS	Global Organic Textile standard
GRI	Global Sustainability Reporting Initiative
GWP	Global Warming Potential
HTP	Human Toxicity Potential
ICS	Initiative for Compliance and Sustainability
ILO	International Labor Organization
ISO	International Standard Organization
JPN	Japan
LCA	Life cycle analysis/ life cycle assessment
LED	Light-Emitting Diodes
LEED	Leadership in Energy and Environmental Design
MAW	Minimal Acceptable Wage
NGO	Non-Governmental Organization
OECD	Organization for Economic Cooperation and Development
OSH	Occupational Safety and Health
PEF	Product Environmental Footprint
PEFC	Program for the Endorsement of Forest Certification
PETA	People for the Ethical Treatment of Animals
PM	Product Module (Higg index)
POCP	Photochemical oxidant creation potential
PSILCA	Product Social Impact Life Cycle Assessment database
REACH	Registration, Evaluation, Authorization and Restriction of Chemicals
RFID	Radio Frequency Identification System
RWS	Responsible Wool Standard
SAC	Sustainable Apparel Coalition
SDG	United Nations Sustainable Development Goals
s-LCA	Social Life Cycle Assessment/Analysis
SMETA	Sedex Members Ethical Trade Audits
SWE	Sweden
T&A	Textile and Apparel
UNGP	United Nations Guiding Principles
UK	United Kingdom
USA	United States of America
UNSDG	United Nations Sustainable Development Goals
WALDB	World Apparel and footwear LCA Database
ZDHC	Zero Discharge of Hazardous Chemicals

References

1. WCED Brundland Report: Our Common Future. 1987. Available online: https://www.are.admin.ch/are/en/home/sustainable-development/international-cooperation/2030agenda/un_-milestones-in-sustainable-development/1987--brundtland-report.html (accessed on 15 April 2021).
2. United Nations. The Sustainable Development Goals Report 2019. United Nations Publ. issued by Dep. Econ. Soc. Aff. 2019. Available online: <https://unstats.un.org/sdgs/report/2019/The-Sustainable-Development-Goals-Report-2019.pdf> (accessed on 15 April 2021).
3. Fonseca, L.M.; Domingues, J.P.; Dima, A.M. Mapping the Sustainable Development Goals Relationships. *Sustainability* **2020**, *12*, 3359. [CrossRef]
4. Pradhan, P.; Costa, L.; Rybski, D.; Lucht, W.; Kropp, J.P. A Systematic Study of Sustainable Development Goal (SDG) Interactions. *Earth's Future* **2017**, *5*, 1169–1179. [CrossRef]
5. Joy, A.; Sherry, J.F.; Venkatesh, A.; Wang, J.; Chan, R. Fast fashion, sustainability, and the ethical appeal of luxury brands. *Fash. Theory* **2012**. [CrossRef]
6. Ellen MacArthur Foundation. Accelerating the scale-up across global supply chains. In *Towards the Circular Economy*; Ellen MacArthur Foundation: Cowes, UK, 2014; Volume 3, pp. 1–64. [CrossRef]
7. Dangelico, R.M.; Pujari, D. Mainstreaming green product innovation: Why and how companies integrate environmental sustainability. *J. Bus. Ethics* **2010**, *95*, 471–486. [CrossRef]
8. Freise, M.; Seuring, S. Social and environmental risk management in supply chains: A survey in the clothing industry. *Logist. Res.* **2015**, *8*, 2. [CrossRef]
9. Arena, M.; Ciceri, N.D.; Terzi, S.; Bengo, I.; Azzone, G.; Garetti, M. A state-of-the-art of industrial sustainability: Definitions, tools and metrics. *Int. J. Prod. Lifecycle Manag.* **2009**, *4*. [CrossRef]
10. Raut, R.; Gardas, B.B.; Narkhede, B. Ranking the barriers of sustainable textile and apparel supply chains. *Benchmark. Int. J.* **2019**, *26*, 371–394. [CrossRef]
11. Lu, L.; Bock, D.; Joseph, M. Green marketing: What the Millennials buy. *J. Bus. Strategy* **2013**, *34*, 3–10. [CrossRef]
12. Correia, G.N.; Batista, T.P.; Marques, S.S.; Silva, C.M. How car material life-cycle emissions are considered in environmental rating methodologies? Suggestion of expedite models and discussion. *Renew. Sustain. Energy Rev.* **2014**, *38*, 20–35. [CrossRef]
13. De Temmerman, J.; Heeremans, E.; Slabbinck, H.; Vermeir, I. The impact of the Nutri-Score nutrition label on perceived healthiness and purchase intentions. *Appetite* **2021**, *157*, 104995. [CrossRef]
14. Kareiva, P.M.; McNally, B.W.; McCormick, S.; Miller, T.; Ruckelshaus, M. Improving global environmental management with standard corporate reporting. *Proc. Natl. Acad. Sci. USA* **2015**, *112*, 7375–7382. [CrossRef] [PubMed]
15. Gül, S.; Spielmann, M.; Lehmann, A.; Eggers, D.; Bach, V.; Finkbeiner, M. Benchmarking and environmental performance classes in life cycle assessment—Development of a procedure for non-leather shoes in the context of the Product Environmental Footprint. *Int. J. Life Cycle Assess.* **2015**, *20*, 1640–1648. [CrossRef]
16. Thinkstep First Draft Report Product Environmental Footprint Category Rules (PEFCR). 2020. Available online: https://ec.europa.eu/environment/eussd/smgp/pdf/PEFCR_guidance_v6.3.pdf (accessed on 15 April 2021).
17. Choi, T.-M.; Li, Y. Sustainability in Fashion Business Operations. *Sustainability* **2015**, *7*, 15400–15406. [CrossRef]
18. ISO 14044:2006 Environmental Management—Life Cycle Assessment—Requirements and Guidelines; International Organization for Standardization: Geneva, Switzerland, 2006; Available online: <https://www.iso.org/standard/38498.html> (accessed on 15 April 2021).
19. Karthik, T.; Gopalakrishnan, D. Environmental Analysis of Textile Value Chain: An Overview. In *Roadmap to Sustainable Textiles and Clothing. Textile Science and Clothing Technology*; Muthu, S., Ed.; Springer: Singapore, 2014; pp. 153–188. ISBN 978-981-287-109-1.
20. Elsen, M.; van Giesen, R.; van den Akker, A.D.K. Consumer Testing of Alternatives for Communicating the Environmental Footprint Profile of Products. 2019. Available online: https://ec.europa.eu/environment/eussd/smgp/pdf/2019_EF_commtest_report.pdf (accessed on 15 April 2021).
21. Levi Strauss & Co. The Life Cycle Understanding the Environmental Impact of a Pair of Levi's®501 Jeans. 2015. Available online: <https://www.levistrauss.com/wp-content/uploads/2015/03/Full-LCA-Results-Deck-FINAL.pdf> (accessed on 15 April 2021).
22. GORE-TEX. Available online: <https://www.gore-tex.com/pressroom/press-release/responsibility-sustainability/life-cycle-assessment-study-shows-dwr-performance-during-use-phase-can-significantly-impact-its-environmental-profile> (accessed on 15 April 2021).
23. Moazzem, S.; Daver, F.; Crossin, E.; Wang, L. Assessing environmental impact of textile supply chain using life cycle assessment methodology. *J. Text. Inst.* **2018**, *109*. [CrossRef]
24. Baydar, G.; Ciliz, N.; Mammadov, A. Life cycle assessment of cotton textile products in Turkey. *Resour. Conserv. Recycl.* **2015**, *104*, 213–223. [CrossRef]
25. Van Der Velden, N.M.; Patel, M.K.; Vogtländer, J.G. LCA benchmarking study on textiles made of cotton, polyester, nylon, acryl, or elastane. *Int. J. Life Cycle Assess.* **2014**, *19*, 331–356. [CrossRef]
26. Zhang, Y.; Liu, X.; Xiao, R.; Yuan, Z. Life cycle assessment of cotton T-shirts in China. *Int. J. Life Cycle Assess.* **2015**, *20*, 994–1004. [CrossRef]
27. Nolimal, S. Life Cycle Assessment of Four Different Sweaters. *DePaul Discov.* **2018**, *7*, 9.

28. Walser, T.; Demou, E.; Lang, D.J.; Hellweg, S. Prospective Environmental Life Cycle Assessment of Nanosilver T-Shirts. *Environ. Sci. Technol.* **2011**, *45*, 4570–4578. [CrossRef]
29. Pesnel, S.; Payet, J. Product Environmental Footprint Category Rules (PEFCR) T-Shirts. 2019. Available online: https://ec.europa.eu/environment/eussd/smgp/pdf/PEFCR_tshirt.pdf (accessed on 15 April 2021).
30. Roos, S.; Sandin, G.; Zamani, B.; Greg, P. Environmental Assessment of Swedish Fashion Consumption. 2015. Available online: <http://mistrafuturefashion.com/wp-content/uploads/2015/06/Environmental-assessment-of-Swedish-fashion-consumption-LCA.pdf> (accessed on 15 April 2021).
31. Nellström, M.; Saric, M. A Comparative Life Cycle Assessment of Nudie Jeans' Repair and Reuse Concept. Master's Thesis, Chalmers University of Technology, Gothenburg, Sweden, 2019.
32. Gore Life Cycle Assessment of a GORE Branded Waterproof, Windproof and Breathable Jacket. 2013. Available online: https://www.gore-tex.com/sites/default/files/assets/Gore_LCA_summary_report.pdf (accessed on 15 April 2021).
33. Benoît, C.; Norris, G.A.; Valdivia, S.; Ciroth, A.; Moberg, A.; Bos, U.; Prakash, S.; Ugaya, C.; Beck, T. The guidelines for social life cycle assessment of products: Just in time! *Int. J. Life Cycle Assess.* **2010**, *15*, 156–163. [CrossRef]
34. United Nations Environment Programme. Setac Life Cycle Initiative. In *Guidelines for Social Life Cycle Assessment of Products*; UNEP: Nairobi, Kenya, 2009; Volume 15, ISBN 9789280730210.
35. Norris, C. Data for Social LCA. *Int. J. Life Cycle Assess.* **2014**, *19*, 261–265. [CrossRef]
36. Norris, C.B.; Norris, G.A. Chapter 8: The Social Hotspots Database Context of the SHDB. *Sustain. Pract. Guid. Soc. Anal. Assess.* **2015**, *1*, 52–73.
37. Eisfeldt, F. PSILCA—A Product Social Impact Life Cycle Assessment Database—Database Version 2.1. 2017. Available online: https://www.openlca.org/wp-content/uploads/2017/12/PSILCA_documentation_update_PSILCA_v2_final.pdf (accessed on 15 April 2021).
38. Herrera Almanza, A.M.; Corona, B. Using Social Life Cycle Assessment to analyze the contribution of products to the Sustainable Development Goals: A case study in the textile sector. *Int. J. Life Cycle Assess.* **2020**, *25*, 1833–1845. [CrossRef]
39. Vogtländer, J.G.; Brezet, H.C.; Hendriks, C.F. The virtual eco-costs '99 A single LCA-based indicator for sustainability and the eco-costs-value ratio (EVR) model for economic allocation. *Int. J. Life Cycle Assess.* **2001**, *6*, 157–166. [CrossRef]
40. Van der Velden, N.M.; Vogtländer, J.G. Monetisation of external socio-economic costs of industrial production: A social-LCA-based case of clothing production. *J. Clean. Prod.* **2017**, *153*, 320–330. [CrossRef]
41. Laurenti, R.; Moberg, Å.; Stenmarck, Å. Calculating the pre-consumer waste footprint: A screening study of 10 selected products. *Waste Manag. Res. J. Sustain. Circ. Econ.* **2017**, *35*, 65–78. [CrossRef] [PubMed]
42. GRI G4 Sustainability Reporting Guidelines—Part 1: Reporting Principles and Standard Disclosures. Global Reporting Initiative 2013. Available online: <https://www.globalreporting.org/resourcelibrary/G3-Guidelines-Incl-Technical-Protocol.pdf> (accessed on 15 April 2021).
43. GRI GRI G4 Guidelines and ISO 26000:2010—How to Use the GRI G4 Guidelines and ISO 26000 in Conjunction. Available online: http://www.iso.org/iso/iso-gri-26000_2014-01-28.pdf (accessed on 15 April 2021).
44. Billet, P. De la loi Grenelle 1 à la loi Grenelle 2. *Rev. Jurid. l'Environ.* **2010**. [CrossRef]
45. Ministère de l'Écologie du Développement Durable et de l'Énergie Le Grenelle Environnement. 2010. Available online: https://www.doubs.gouv.fr/content/download/9112/55513/file/Hors_Serie_Grenelle_2_juillet_2010_cle5d1121-1.pdf (accessed on 15 April 2021).
46. ISO 14001: Environmental Management Systems—Requirements with Guidance for Use; International Organization for Standardization: Geneva, Switzerland, 2015; Available online: <https://www.iso.org/standard/60857.html> (accessed on 15 April 2021).
47. Freimann, J.; Walther, M. The impacts of corporate environmental management systems: A comparison of EMAS and ISO 14001. *Greener Manag. Int.* **2001**. [CrossRef]
48. United Nations. Guiding Principles on Business and Human Rights Guiding Principles on Business and Human Rights. 2011. Available online: https://www.ohchr.org/Documents/Publications/GuidingPrinciplesBusinessHR_EN.pdf (accessed on 15 April 2021).
49. Miller, G.; Kędzierska, D.; Ordyńska, K. Ethical and Social Standards Are the Pathway for Small and Medium Enterprises to Collaborate with Large Clients. 2018. Available online: <https://www.abris-capital.com/wp-content/uploads/2020/09/Ethical-and-social-standards.pdf> (accessed on 15 April 2021).
50. Ethical Trading Initiative The ETI Base Code. 2018. Available online: https://www.ethicaltrade.org/sites/default/files/shared_resources/ETI%20Base%20Code%20%28English%29.pdf (accessed on 15 April 2021).
51. Amfori BSCI Code of Conduct 1. 2017. Available online: <https://www.amfori.org/content/bsci-code-conduct> (accessed on 15 April 2021).
52. Sedex. Sedex Members Ethical Trade Audit (SMETA) Measurement Criteria. 2019. Available online: <https://www.sedex.com/wp-content/uploads/2019/05/SMETA-6.1-Measurement-Criteria.pdf> (accessed on 15 April 2021).
53. ICS Initiative for Compliance and Sustainability. Available online: <https://ics-asso.org/> (accessed on 12 September 2020).
54. Global Value. Available online: www.global-value.eu (accessed on 23 July 2020).
55. Sustainable Apparel Coalition The Sustainable Apparel Coalition. Available online: <https://apparelcoalition.org/> (accessed on 30 August 2020).

56. Olowu, T.O.; Sundararajan, A.; Moghaddami, M.; Sarwat, A.I.; Unigwe, O.; Okekunle, D.; Kiprakis, A.; Latif, A.; Gawlik, W.; Palensky, P.P. Higg Materials Sustainability Index (MSI) Methodology. 2020. Available online: <https://howtohigg.org/wp-content/uploads/2020/07/Higg-MSI-Methodology-July-31-2020.pdf> (accessed on 15 April 2021).
57. Sustainable Apparel Coalition Higg Product Module (PM) Methodology. 2020. Available online: <https://www.rse-et-ped.info/wp-content/uploads/2018/04/SAC-Overview-RSEPED.pdf> (accessed on 15 April 2021).
58. Sphera Solutions. GaBi Database. Available online: <http://www.gabi-software.com> (accessed on 13 October 2020).
59. Chrobot, P.; Faist, M.; Gustavus, L.; Martin, A.; Stamm, A.; Zah, R.; Zollinger, M. Measuring Fashion: Insights from the Environmental Impact of the Global Apparel and Footwear Industries Study. 2018. Available online: <https://refashion.fr/eco-design/sites/default/files/fichiers/Measuring%20Fashion%20Environmental%20Impact%20of%20the%20Global%20Apparel%20and%20Footwear%20Industries%20Study.pdf> (accessed on 15 April 2021).
60. Quantis World Apparel & Footwear Database (WALDB). Lausanne—Zürich—Paris—Montreal—Boston. 2016. Available online: <https://www.aramis.admin.ch/Default?DocumentID=61255&Load=true> (accessed on 15 April 2021).
61. Sustainable Apparel Coalition The Higg Index. Available online: <https://apparelcoalition.org/the-higg-index/> (accessed on 19 September 2020).
62. Kering. Kering Standards for Raw Materials and Manufacturing Processes. 2020. Available online: <https://www.kering.com/en/news/kering-open-sources-new-suite-of-industry-leading-standards> (accessed on 15 April 2021).
63. PricewaterhouseCoopers LLP Valuing Corporate Environmental Impacts-PwC Methodology Document. 2015. Available online: <https://capitalscoalition.org/valuing-corporate-environmental-impacts-pwc-methodology-document/> (accessed on 15 April 2021).
64. Deloitte Global Powers of Retailing 2020. Available online: <https://www2.deloitte.com/content/dam/Deloitte/at/Documents/consumer-business/at-global-powers-retailing-2020.pdf> (accessed on 15 April 2021).
65. Nike Purpose Moves US. 2019-Inc. Impact Report. Available online: <https://purpose.nike.com/> (accessed on 20 October 2020).
66. TJX. 2019 Global Corporate Sustainability Report. 2019. Available online: <https://www.tjx.com/docs/default-source/corporate-responsibility/tjx-2019-global-corporate-responsibility-report.pdf> (accessed on 20 October 2020).
67. H&M Group. Sustainability Performance Report 2019. Available online: <https://hmgroup.com/wp-content/uploads/2020/10/HM-Group-Sustainability-Performance-Report-2019.pdf> (accessed on 15 April 2021).
68. Ross Stores, Inc. Corporate Social Responsibility. 2018. Available online: https://corp.rossstores.com/media/53058/ross_csr_overview_2019.pdf (accessed on 15 April 2021).
69. L Brands. L Brands Responsibility. Available online: <https://www.lb.com/responsibility> (accessed on 5 July 2020).
70. Kering Group. Sustainability Progress Report 2017–2020. 2020. Available online: <https://www.kering.com/en/sustainability/crafting-tomorrow-s-luxury/2017-2025-roadmap/progress-report-2017-2020/> (accessed on 15 April 2021).
71. Inditex Annual Report 2019. Available online: <https://www.inditex.com/investors/investor-relations/annual-reports> (accessed on 15 April 2021).
72. Fast Retailing Sustainability Report 2020 PLANET. Changing Clothes. Changing Conventional Wisdom. Change the World. 2020. Available online: https://www.fastretailing.com/eng/sustainability/report/pdf/sustainability2020_en_print.pdf (accessed on 15 April 2021).
73. Primark Primark—Environmental Reporting. 2019. Available online: https://primark.a.bigcontent.io/v1/static/Primark_Environmental-Sustainability-Performance-Report_2019 (accessed on 15 April 2021).
74. Gap Inc. 2018 Global Sustainability Report. 2018. Available online: <https://www.gapincustainability.com/sites/default/files/Gap%20Inc%20Report%202018.pdf> (accessed on 15 April 2021).
75. Greenpeace International. Destination Zero. 2018. Available online: https://www.greenpeace.org/static/planet4-international-stateless/2018/07/destination_zero_report_july_2018.pdf (accessed on 15 April 2021).
76. AFIRM Group Chemistry Tool Kit. 2018. Available online: <https://www.afirm-group.com/toolkit/> (accessed on 15 April 2021).
77. American Apparel & Footwear Association Restricted Substance List (Rsl); AAFA: Gilbert, AZ, USA, 2020.
78. Anker, R. *Estimating a Living Wage: A Methodological Review*; Conditions of Work and Employment Series No. 29; International Labour Organization: Geneva, Switzerland, 2011.
79. Zimon, D.; Madzik, P.; Sroufe, R. The Influence of ISO 9001 & ISO 14001 on Sustainable Supply Chain Management in the Textile Industry. *Sustainability* **2020**, *12*, 4282. [CrossRef]
80. Agence de la Transition Ecologique Labels Environnementaux. Available online: <https://www.ademe.fr/labels-environnementaux> (accessed on 16 January 2021).
81. The International EPD System EPD Library. Available online: <https://www.environdec.com/library> (accessed on 16 January 2021).
82. International Organization for Standardization. ISO 22095:2020 Chain of Custody—General Terminology and Models. Available online: <https://www.iso.org/standard/72532.html> (accessed on 28 February 2021).
83. O’Byrne, D.; Dripps, W.; Nicholas, K.A. Teaching and learning sustainability: An assessment of the curriculum content and structure of sustainability degree programs in higher education. *Sustain. Sci.* **2015**, *10*, 43–59. [CrossRef]
84. Taylor, N.; Quinn, F.; Eames, C. (Eds.) *Educating for Sustainability in Primary Schools*; Sense Publishers: Rotterdam, The Netherlands, 2015; ISBN 978-94-6300-046-8.
85. European Commission Europeans’ attitudes towards the issue of sustainable consumption and production. *Flash Eurobarom.* **2009**, 256, 1–18.

86. Fashion Revolution. Consumer Survey Report—A Baseline Survey on EU Consumer Attitudes to Sustainability and Supply Chain Transparency in the Fashion Industry. 2018. Available online: <https://www.forum-csr.net/News/12741/Consumer-survey-report.html> (accessed on 15 April 2021).
87. Cerri, J.; Testa, F.; Rizzi, F. The more I care, the less I will listen to you: How information, environmental concern and ethical production influence consumers' attitudes and the purchasing of sustainable products. *J. Clean. Prod.* **2018**, *175*, 343–353. [CrossRef]
88. Tärneberg, S.; Lehmann, M.; Eder-Hansen, J.; Kruse, E.; Chalmer, C. CEO Agenda 2019. Available online: <https://globalfashionagenda.com/ceo-agenda-2020/#> (accessed on 4 July 2020).
89. Lehmann, M.; Arici, G.; Martinez-pardo, C. Pulse of the Fashion—2019 Update. 2019. Available online: <http://media-publications.bcg.com/france/Pulse-of-the-Fashion-Industry2019.pdf> (accessed on 15 April 2021).
90. Wang, H.; Liu, H.; Kim, S.J.; Kim, K.H. Sustainable fashion index model and its implication. *J. Bus. Res.* **2019**, *99*, 430–437. [CrossRef]
91. Fashion Revolution. Fashion Transparency Index. Available online: https://issuu.com/fashionrevolution/docs/fr_fashiontransparencyindex2020 (accessed on 24 June 2010).
92. Henninger, C.E. Traceability the new eco-label in the slow-fashion industry?-Consumer perceptions and micro-organisations responses. *Sustainability* **2015**, *7*, 6011–6032. [CrossRef]
93. Brad, A.; Lenikus, V. The False Promise of Certification: How Certification Is Hindering Sustainability in the Textiles, Palm Oil and Fisheries Industries. 2018. Available online: https://changingmarkets.org/wp-content/uploads/2018/05/False-promise_full-report-ENG.pdf (accessed on 15 April 2021).