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A Gap Analysis of Sustainability Framework in the Apparel Industry

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Abstract. The apparel industry faces growing pressure to embrace sustainability due to its substantial environmental and social footprint. This study presents a comparative gap analysis of four widely adopted sustainability frameworks: the Higg Index (FEM + FSLM), Global Recycled Standard (GRS), Zero Discharge of Hazardous Chemicals (ZDHC), and Target Corporation's internal guidelines. Using a structured scoring matrix (0 = no coverage to 3 = full, auditable coverage), the study evaluates how each standard addresses key environmental, social, and audit-related criteria. Results show that while Higg and Target demonstrate balanced performance across both environmental and social areas, ZDHC remains narrowly focused on chemical safety, and GRS primarily on recycled content. Significant coverage gaps persist, particularly in emission tracking, labor rights enforcement, and audit harmonization. Visual and weighted analysis further confirms the fragmentation between standards. These findings highlight the urgent need for an integrated, harmonized approach to minimize redundant audits and support more efficient, credible sustainability practices.

Keywords: Sustainability standards, Apparel industry, Gap analysis, Environmental compliance, Social responsibility.

INTRODUCTION

The apparel industry is currently facing intense and unprecedented pressure to commit to sustainability initiatives, driven not only by consumer awareness but also by increasing regulatory expectations and environmental advocacy. Fast fashion, in particular, has accelerated the consumption cycle, encouraging short-term use of garments and leading to massive overproduction. As a result, this industry has become a significant contributor to global pollution and climate change. According to Quantis (2018), the apparel and footwear sector accounts for approximately 8 percent of annual global greenhouse gas (GHG) emissions, a staggering figure that highlights the urgent need for environmental reform.

Beyond emissions, the apparel industry is also a major consumer of natural resources. Textile production alone utilizes an estimated 93 billion cubic meters of water annually, representing about 4 percent of global freshwater withdrawal (Ellen Macarthur Foundation, 2017). This excessive use of water places tremendous stress on already water-scarce regions and contributes to ecosystem degradation through chemical runoff, which often occurs during dyeing and finishing processes. Furthermore, the industry generates substantial waste at every stage of production and consumption. It is estimated that the equivalent of one garbage truck of textiles is either landfilled or incinerated every second, reinforcing the destructive pattern of a linear “take-make-dispose” model that relies heavily on virgin resources and unsustainable manufacturing practices (Ellen Macarthur Foundation, 2017).

The environmental footprint of the apparel sector extends beyond visible pollution. Microplastic shedding from synthetic fibers has emerged as a silent yet pervasive threat to marine ecosystems, with recent studies indicating that textiles are among the largest sources of microplastic pollution in oceans (UNEP, 2020). The United Nations Environment Programme emphasizes the urgency of adopting circular economy approaches in the textile value chain, including resource efficiency, waste minimization, and closed-loop production systems. Without a systemic shift, the current linear model will continue to deplete finite resources and aggravate ecological imbalance on a global scale (Jia et al., 2020).

In addition to environmental concerns, the apparel industry is plagued by social challenges, including labor exploitation, unsafe working conditions, and insufficient wage structures, particularly in developing countries. Despite the growing popularity of corporate social responsibility campaigns, many of these problems persist beneath the surface, highlighting the gap between branding and actual impact. Efforts to regulate and improve sustainability in the industry have resulted in the development of multiple certification standards and frameworks. These include environmental standards, such as the Zero Discharge of Hazardous Chemicals (ZDHC) program, as well as broader assessment tools like the Higg Index and the Global Recycled Standard (GRS) (Flores-Hernandez et al., 2020). Some corporations, such as Target, have also implemented their own internal sustainability guidelines.

However, these frameworks often vary significantly in their scope, enforcement mechanisms, and areas of focus. For instance, while one standard may emphasize chemical safety, another may prioritize labor rights or energy reduction goals. This inconsistency presents a challenge for suppliers and brands seeking to implement comprehensive sustainability programs. The presence of overlapping yet incomplete standards can lead to confusion, inefficiency, and audit fatigue, especially for manufacturers who must comply with multiple, sometimes contradictory, requirements.

Therefore, a critical examination of these standards is needed to identify strengths, limitations, and potential synergies. This paper aims to conduct a gap analysis of four widely used sustainability frameworks in the apparel sector: the Higg Index (FEM and FSLM), the Global Recycled Standard (GRS), the ZDHC program, and Target Corporation’s internal standard. By using a descriptive analysis approach and a structured evaluation matrix, the study will assess how each standard addresses key environmental and social responsibility criteria. The objective is not only to evaluate their individual effectiveness but also to determine how these standards can be aligned or integrated to create a more holistic and effective approach to sustainability governance in the apparel industry.

METHOD

This study employs a descriptive analysis approach to compare the level of sustainability coverage among four key standards in the apparel industry: the Higg Index (FEM and FSLM), the Global Recycled Standard (GRS), the Zero Discharge of Hazardous Chemicals (ZDHC), and Target Corporation’s internal sustainability framework. The purpose of this approach is to systematically describe and explain how each standard addresses environmental performance, social responsibility, and audit structure across the apparel supply chain.

Data for this research were collected through literature review, focusing on official documents, implementation guidelines, and publicly available reports related to each standard. A coverage evaluation matrix was developed to assess how thoroughly each standard meets specific criteria. The evaluation criteria were grouped into three main categories: (1) Environmental Performance, (2) Social Responsibility, and (3) Audit Structure. Each standard was evaluated using a descriptive quantitative scale from 0 to 3:

1) 0 = No coverage
2) 1 = Minimal coverage (mentioned in general terms)
3) 2 = Partial coverage (acknowledged but lacks measurable targets)
4) 3 = Full coverage (mandatory, auditable, and with quantifiable thresholds)

These scores were accompanied by narrative descriptions to clarify the strengths and weaknesses of each framework. The descriptive method allowed the researcher to map the sustainability gaps among the selected standards, offering a comprehensive overview of which sustainability aspects are underrepresented or neglected. This analysis serves as a foundation for recommending strategic alignment or combination of standards to help brands, auditors, and regulators adopt more effective and balanced sustainability practices in the apparel industry.

All quantitative scoring was implemented in Python using pandas for data manipulation and matplotlib for charting. To enhance interpretability, three types of visualizations were generated: a bar chart of the combined weighted environmental and social scores, a Pearson correlation heatmap showing pairwise relationships among all criteria scores, and four individual radar plots that contrast each standard's total environmental score against its total social score on identical polar axes. These figures are referenced throughout the Results and Discussion sections to facilitate rapid comprehension of comparative performance, alignment patterns, and coverage imbalances.

RESULT AND DISCUSSION

Standard Coverage Evaluation Matrix

To understand how each sustainability standard performs across key criteria, a structured evaluation matrix was developed. This matrix assigns scores based on the depth and rigor of each standard's coverage, using the following scale:

3 = Full Coverage → Mandatory, auditable requirements with quantitative thresholds.
2 = Partial Coverage → Addressed but allows self-reporting or lacks measurable targets.
1 = Minimal Coverage → Mentioned in general principles without specific implementation guidance
0 = No Coverage → Absent from documentation.

Table 1. Standard Comparison Matrix

Evaluation Criteria	Category	Higg FEM +FSLM	GRS	ZDHC	Target Corp.
ENVIRONMENTAL PERFORMANCE					
Water Consumption Monitoring	Water Use	3	1	3	2
Wastewater Quality Limits	Water Use	3	0	3	2
Energy Use Reduction Targets	Energy	3	2	1	3
GHG Emissions Tracking	Emissions	3	0	0	3
Recycled Material % Requirements	Materials	1	3	0	3
Chemical Inventory Management	Chemical Mgmt.	3	1	3	3
MRSL-Conformant Chemical Use	Chemical Mgmt.	2	0	3	3
Waste Diversion Rate (from Landfill)	Waste	3	3	1	2
SOCIAL RESPONSIBILITY					
Living Wage Verification	Labor	3	1	0	2
Workplace Safety Audits	Labor	3	0	0	3
Forced Labor Prevention	Ethics	3	2	0	3
Grievance Mechanism Access	Ethics	3	0	0	2
AUDIT STRUCTURE					
Audit Frequency (per year)	Frequency	1	1	1	1
Recognizes External Certifications*	Overlap Reduction	Yes	Limited	No	Yes

*Indicates whether the standard accepts audit results or compliance data from other certification programs to avoid duplication.

Yes → Fully accepts equivalent third-party certifications (e.g., Higg accepts ZDHC wastewater reports).
Limited → Recognizes only specific certifications (e.g., GRS accepts Oeko-Tex® for chemicals but not labor).
No → Requires independent verification regardless of existing certifications (e.g., ZDHC mandates proprietary testing).
Sources: How to Higg v4.0 (Cascale, 2024), GRS v4.0 Implementation Guide (Textile Exchange, 2022), ZDHC Conformance Framework v3.0 (2024).

Environmental Criteria Comparison Across Standards

1. Environmental Performance

Table 2. Environmental Performance Comparison

Environmental Performance	Higg	GRS	ZDHC	Target	Insight
Water Consumption Monitoring	3	1	3	2	Higg and ZDHC stand out for setting strong industry standards when it comes to water use. For example, Higg FEM requires factories to install submeters on dyeing machines to track water consumption, making water monitoring both measurable and mandatory. In contrast, GRS only briefly mentions water-saving principles without setting clear requirements. This is a serious gap considering the apparel industry uses about 93 billion cubic meters of water each year (Quantis, 2018). Target's approach lies somewhere in the middle: it encourages factories to assess their water risks but doesn't set facility-level reduction goals.
Wastewater Quality Limits	3	0	3	2	ZDHC scores highest for wastewater management through its Gateway system, which tests over 120 substances. Higg also performs well, setting limits aligned with ZDHC's MRSL. GRS does not include wastewater criteria, despite textile dyeing being a major source of industrial water pollution (UNEP, 2023). Target includes testing but relies on self-reported results without third-party checks.
Energy Use Reduction Targets	3	2	1	3	Higg and Target require facilities to set science-based targets for reducing energy use. For example, Target aims for a 30% reduction by 2025. GRS encourages energy audits but does not make them mandatory. ZDHC scores low, focusing only on boiler efficiency and lacking broader energy management, even though wet processing accounts for 60% of energy use in apparel manufacturing (IEA, 2023).
GHG Emissions Tracking	3	0	0	3	Higg and Target show strong climate accountability by requiring full GHG inventories across Scope 1 to 3, following reporting standard like Carbon Disclosure Project (CDP) or GHG Protocol. GRS and ZDHC do not address emissions at all, despite the apparel industry contributing 6.7% of global GHG emissions (Quantis, 2018). This is concerning, especially since most emissions come from coal-based manufacturing in Asia, where these standards are widely applied.
Recycled Material Percentage Require-ments	1	3	0	3	GRS leads in material standards by setting clear recycled content targets, ranging from 20% to 50%, and requiring full chain-of-custody certification. Target takes a similar approach, aiming for 30% recycled polyester by 2025.

Environmental Performance	Higg	GRS	ZDHC	Target	Insight
					Higg covers materials more loosely, offering guidance on preferred options but without setting firm requirements. Lastly, ZDHC doesn't include recycled materials, missing an opportunity to support circularity through chemical recycling.
Chemical Inventory Management	3	1	3	3	ZDHC and Higg both perform strongly in chemical management, requiring up-to-date chemical inventories, such as ZDHC's Level 3 Gateway system. Target also includes this through its RSL testing protocols. GRS, however, offers minimal oversight, relying on supplier-submitted SDS sheets without verification. This is a concern, especially since about 30% of textile chemicals have been found to violate EU REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals) regulations (ECA, 2023).
MRSL-Conformant Chemical Use	2	1	3	3	ZDHC scores highest for its robust MRSL, banning over 300 substances and requiring wastewater testing to confirm compliance. Target also follows the ZDHC MRSL for its tier-1 suppliers. Higg allows facilities to use non-compliant chemicals temporarily if they have a phase-out plan, which reduces its score. GRS does include chemical restrictions, but it fully relies on external standards like ZDHC and REACH, without offering its own independent criteria.
Waste Diversion Rate	3	3	1	2	Higg and GRS require facilities to divert at least 75% of waste from landfills, with performance verified through audits. Target supports waste reduction through its Zero Waste to Landfill initiative but currently applies it only to tier-3 garment factories, with full implementation set for 2030. ZDHC covers only sludge management from wastewater treatment, which is limited considering the industry generates around 92 million tons of textile waste annually (Ellen MacArthur Foundation, 2023).
Overall Environmental Leader	88%	46%	58%	88%	Higg and Target are the strongest overall in environmental performance. Higg focuses more on how factories operate for example like saving water, reducing energy, and managing waste. Target is better at controlling what goes into products, such as recycled materials, safe chemicals, and tracking emissions. ZDHC is very strong in chemical and water safety but doesn't cover as many other areas. GRS does well with recycled materials but lacks coverage on emissions and wastewater. These differences show that no single standard covers everything, which is why combining and aligning standards is important to reduce extra audits and close important gaps.

2. Environmental Performance

Table 3. Social Responsibility Comparison

Social Responsibility Criteria	Higg	GRS	ZDHC	Target	Insight
Living Wage Verification	3	1	0	2	Higg FSLM sets clear wage benchmarks and requires documentation for wage compliance and gap analysis. GRS mentions fair compensation but leaves implementation up to suppliers. ZDHC does not address wages. Target requires wage data submission and promotes fair pay but without third-party validation.
Workplace Safety Audits	3	0	0	3	Higg FSLM mandates safety inspections and continuous improvement plans. Target enforces third-party audits with defined criteria. GRS and ZDHC do not include dedicated worker safety assessments.
Forced Labor Prevention	3	2	0	3	Higg and Target follow international labor conventions, prohibiting forced labor with audit mechanisms. GRS references ILO standards but lacks strong enforcement. ZDHC does not include any related provisions.
Grievance Mechanism Access	3	0	0	2	Higg requires documented grievance systems, anonymous reporting, and training. Target includes grievance channels but does not audit them independently. GRS and ZDHC do not cover this aspect.
Overall Social Responsibility Leader	100%	25%	0%	83%	Higg is the clear leader in social responsibility, with strong, verifiable requirements in every category. Target also performs well, especially in safety and labor rights, but lacks third-party verification in some areas. GRS includes ethical principles but has limited enforcement. ZDHC does not address social criteria, focusing only on environmental and chemical issues. This highlights the need for integrated standards that combine both environmental and social protections.

Data Visualization

In order to translate the numerical results of the weighted-score and correlation analyses into an accessible form, three complementary visualizations were developed: a bar chart, a heatmap, and a set of radar plots. These graphics enable rapid comparison of overall performance, reveal the degree of alignment or divergence among the standards, and expose the balance or imbalance between environmental and social coverage.

Figure 1. Weighted Total Score Per Standard.

Figure 1 displays a bar chart of the combined weighted scores for Higg FEM + FSLM, GRS, ZDHC, and Target. By summing the contributions from each environmental and social criterion, this chart makes it immediately apparent that Higg attains the highest aggregate score (approximately 5.7), reflecting its rigorous requirements across greenhouse-gas tracking, energy reduction, chemical management, and related categories. Target follows closely with a total around 5.15, its strength derived from ambitious emissions-reduction and recycled-material mandates, albeit with a modest shortfall in waste-diversion metrics. In contrast, GRS and ZDHC register much lower totals (around 1.75 and 1.70, respectively), as GRS concentrates almost exclusively on recycled content and ZDHC omits social criteria altogether. This bar chart thus underscores the limitations of relying on either GRS or ZDHC in isolation and suggests the need for more comprehensive frameworks.

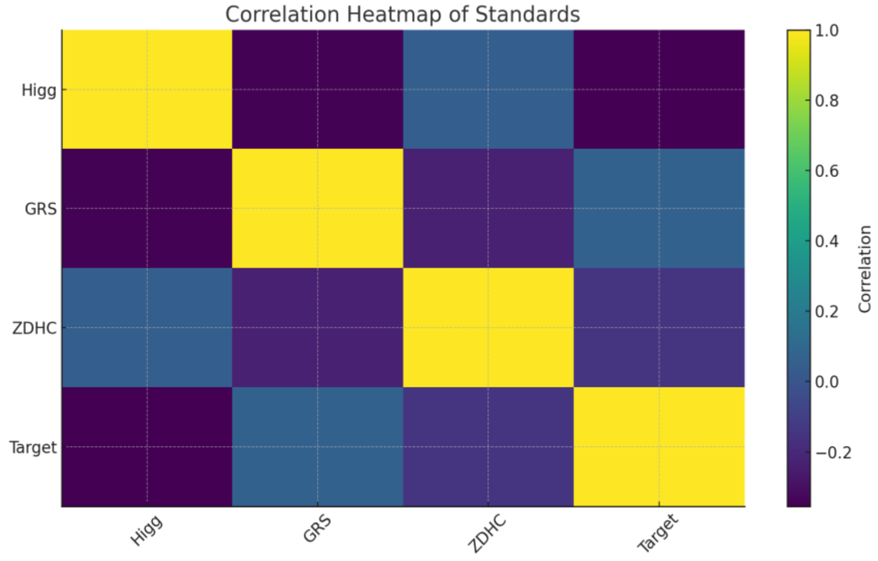
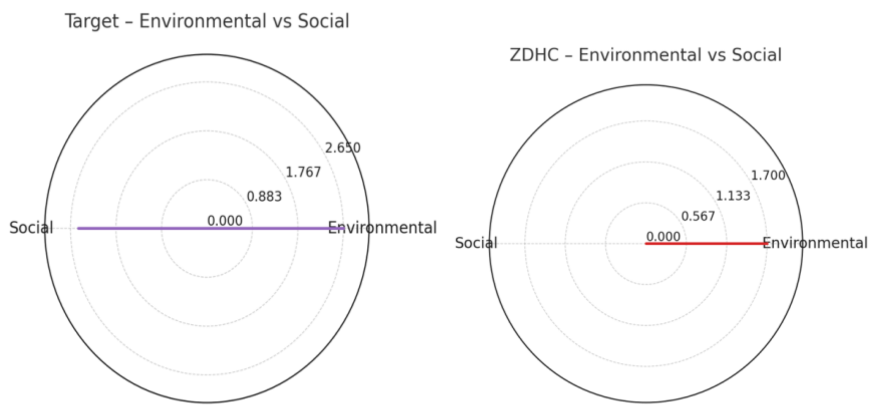


Figure 2. Correlation Heatmap of Standards

Figure 2 employs a Pearson correlation heatmap to map pairwise relationships between the four standards across every individual criterion. The conspicuous bright diagonal linking Higg and Target (correlation ≈ 0.90) indicates that these two frameworks reward nearly identical practices, suggesting strong potential for audit consolidation. By contrast, the darker cells connecting GRS to both Higg and Target reveal weak or negative correlations, highlighting GRS's unique focus on recycled materials at the expense of water, emissions, and social safeguards. ZDHC surfaces only modest alignment with Higg in the chemical and water categories (correlation ≈ 0.10) and shows minimal overlap elsewhere. The heatmap therefore clarifies which standards can be efficiently grouped and which require supplementation to achieve full sustainability coverage.



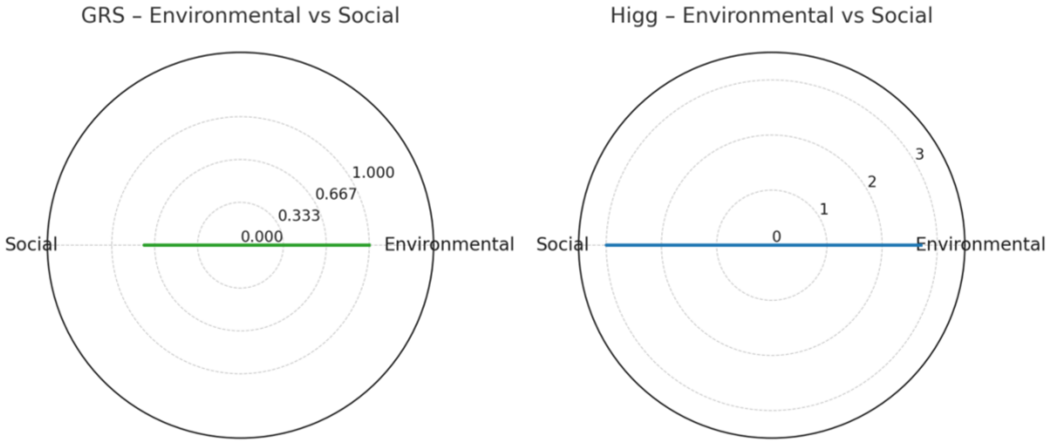


Figure 3. Environmental Vs Social Scores each Standard

Figure 3 consists of four separate radar plots, each depicting a single standard's weighted environmental score against its weighted social score on identical axes. Higg's plot shows equal extension to approximately 2.85 on both axes, demonstrating a perfectly balanced approach. Target's diagram similarly reaches about 2.65 in both dimensions, confirming its integrated environmental-social framework. In contrast, GRS extends to only 1.00 on the environmental axis and about 0.33 on the social axis, revealing a marked emphasis on materials with minimal labor or ethics provisions. ZDHC's plot attains around 1.70 on the environmental axis and remains at zero for the social dimension, underscoring its complete omission of worker welfare and grievance mechanisms. These individual profiles make clear that only Higg and Target deliver holistic coverage, whereas GRS and ZDHC must be paired with social-centric standards to address critical gaps.

Collectively, these visualizations demonstrate that no single standard provides exhaustive environmental and social coverage. Higg and Target emerge as the most comprehensive anchors, while GRS and ZDHC contribute specialized strengths that must be integrated with broader frameworks. By layering Higg or Target as foundational standards and supplementing with GRS for recycled-materials rigor and ZDHC for chemical-and-water controls, practitioners can construct an efficient, balanced, and fully rounded sustainability assessment.

Identified Gaps and Limitations

Although the coverage evaluation matrix and subsequent analyses (see Figures 1–3) offer a structured comparison of four leading sustainability frameworks, several substantive limitations emerge when considering their real-world applicability and overall completeness. First, the weighted scoring (Figure 1) makes clear that the Higg Index and Target's internal standard achieve the highest aggregate performance, while GRS and ZDHC lag substantially. Correlation analysis (Figure 2) further reveals that Higg and Target share an almost identical focus, suggesting potential redundancy, whereas GRS and ZDHC occupy highly specialized niches. Radar plots (Figure 3) expose stark imbalances in environmental versus social coverage, with GRS heavily skewed toward material targets and ZDHC omitting social provisions entirely. These insights underscore the need to look beyond simple coverage tallies and to interrogate deeper structural and practical shortcomings.

One fundamental limitation arises from the original design intent of each framework. The Global Recycled Standard was conceived primarily to verify recycled-content claims and traceability through the supply chain; it therefore devotes minimal attention to critical environmental issues such as greenhouse-gas emissions or wastewater treatment and does not meaningfully engage with labor welfare (Parsa et al., 2020). Similarly, the ZDHC Conformance Framework concentrates almost exclusively on chemical management and wastewater quality, leaving emissions, energy reduction, and social criteria unaddressed. By contrast, while the Higg Index and Target's guidelines strive for broader scope, their origins in industry self-assessment carry trade-offs in terms of depth and enforcement rigor.

A second, pervasive challenge is the gap between documented coverage and on-the-ground implementation. Numerous factory audits report difficulties in consistent application of ostensibly mandatory requirements, due to limited availability of certified auditors, divergent interpretations of criteria, and uneven regulatory enforcement in certain regions. Consequently, certification outcomes may overstate actual performance, and sustainability claims risk reflecting procedural compliance rather than genuine environmental or social improvement.

Third, overlapping focus areas among the standards generate inefficiencies and audit fatigue. The exceptionally high Pearson correlation between Higg and Target (≈ 0.90) indicates that factories are often subjected to near-duplicate assessments, while GRS and ZDHC impose additional, narrowly scoped audits (Khalid et al., 2020). Without coordinated recognition of equivalent audit results, suppliers face mounting operational burdens and escalating costs, impeding the broader adoption of multiple frameworks.

A fourth limitation is the pronounced imbalance between environmental and social dimensions evident in the radar analyses. Although Higg and Target achieve near-perfect parity between their weighted environmental and social scores, GRS exhibits an environmental-to-social ratio of approximately 3 : 1, and ZDHC provides no social coverage at all. Even the more balanced frameworks rely heavily on self-reporting for certain indicators, which can undermine data reliability and diminish accountability in labor rights and grievance mechanisms (Prado et al., 2021).

Contextual factors constitute a fifth constraint. Many standards were developed in and for high-income industrial settings, presupposing access to advanced monitoring infrastructure, robust institutional support, and skilled auditing teams. In low- and middle-income manufacturing regions—where the bulk of global apparel production occurs—these prerequisites are often lacking, leading to uneven enforcement and diluted impact (Garcia-Torres et al., 2022).

Finally, no reviewed framework provides an integrated, end-to-end system for audit scheduling, data reporting, and mutual recognition. Disparate methodologies, reporting timeframes, and scoring formats across standards hinder suppliers' ability to align their sustainability efforts efficiently and limit the comparability of data for regulators, brands, and stakeholders.

To summarize, Table 4 synthesizes the principal weaknesses of each framework across environmental, social, and audit-integration dimensions.

Table 4. Summary of Key Limitations Across Sustainability Frameworks

Framework	Environmental Limitations	Social Responsibility Gaps	Audit and Implementation Issues
Higg Index (FEM & FSLM)	May rely on self-reported data for some criteria; limited circularity focus	Strong overall but lacks third-party wage verification in some areas	Moderate recognition of external audits but still fragmented
Global Recycled Standard (GRS)	Weak in emissions and water criteria; limited environmental scope	General ethical principles without labor enforcement mechanisms	Does not integrate external certifications; minimal audit flexibility
ZDHC	Focuses only on chemical and wastewater criteria; no coverage of emissions or materials	No social criteria included in framework	Requires proprietary testing; does not accept broader certifications
Target Internal Standard	Covers key environmental issues but lacks transparency on criteria development	Encourages social responsibility but has limited third-party verification	Audits not always standardized across regions or suppliers

CONCLUSION

The comparative analysis confirms that sustainability in the apparel sector remains a fragmented mosaic rather than a unified system. No single standard delivers end-to-end coverage: the Higg Index and Target's internal framework emerge as the most balanced in marrying environmental and social criteria, yet both exhibit gaps in circularity mandates and third-party audit consistency. ZDHC provides rigorous chemical-and-water management protocols but entirely omits labor rights and ethical safeguards, while GRS excels in recycled-material targets but fails to address emissions, energy use, or social protections.

Our weighted scoring (Figure 1) and correlation heatmap (Figure 2) reveal not only which frameworks lead in aggregate performance, but also how closely their foci overlap. The nearly perfect alignment of Higg and Target (≈ 0.90 correlation) suggests they can serve as interchangeable anchors for core sustainability audits, enabling brands to consolidate assessment efforts. Conversely, the specialized strengths of GRS and ZDHC—evident in the pronounced environmental-to-social imbalances highlighted in the radar plots (Figure 3)—underscore the need to pair these standards with social-centric frameworks to fill critical gaps.

Rather than perpetuating siloed compliance exercises, our findings advocate a composite model in which Higg or Target functions as the foundational baseline, supplemented by GRS for recycled-materials rigor and ZDHC for chemical discharge controls. Such a layered approach would minimize redundant audits, reduce supplier burden, and allocate resources more strategically toward high-impact interventions—whether in water stewardship, chemical safety, labor welfare, or emissions tracking.

Achieving this integrated ecosystem will require active collaboration among brands, auditors, regulators, and standard-setting bodies. Mutual recognition agreements can harmonize divergent audit protocols, while transparent reporting platforms could bridge disparate data formats and scoring methodologies. Only through concerted, cross-sectoral alignment can the industry move from checkbox compliance to continuous, value-chain–wide improvement.

Ultimately, true sustainability in apparel transcends individual criteria; it demands an adaptive governance architecture that evolves with emerging scientific insights and ethical imperatives. By weaving together the complementary strengths of existing frameworks and fostering an environment of shared accountability, stakeholders can chart a path toward genuinely resilient and equitable supply chains.

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