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Mapping the Environmental Impact Assessment Landscape in the Fashion and Textile Industries: Critical Gaps and Challenges

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Abstract: The environmental impact of the fashion and textile industry (FTI) is measured and communicated through several interrelated methods, tools and platforms. In this paper, scholarly and grey literature have informed the mapping of the sector's environmental impact assessment (EIA) landscape to identify key gaps and challenges in effectively quantifying and communicating environmental product performance. These preliminary insights informed the design of multiple focus group discussions where the on-the-ground challenges of EIA implementation were discussed with 85 FTI stakeholders, including industry professionals, academics, non-governmental organisations and local government. Key findings highlight the need for further refinement and harmonisation of assessment methodologies and approaches such as Life Cycle Analysis (LCA) to consider a wider range of impact categories to increase the comparability of results. Similarly, the communication asymmetries linked to a profusion of eco-labelling and ranking systems necessitates the development of better tools to communicate the environmental performance for the sector. Furthermore, as all EIA methods require the movement of data between various actors, there is a need for improvement and innovation in data-gathering and management systems to ensure greater quality and reliability.

Keywords: Life Cycle Analysis (LCA); environmental impact assessment; fashion and textile industry; circular fashion

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1. Introduction

There is an urgent and recognised need for the fashion and textile industry (FTI) to shift its operations from a take-make-waste model towards more sustainable and circular modes of production and consumption [1–3]. Sustainability incentives offered to a range of actors, including consumers, businesses, and policymakers, are evidenced most saliently by multiple ambitious target-setting initiatives. Voluntary guidelines such as the Waste and Resources Action Programme's (WRAP) Textile 2030 in the UK, the EU's Strategy for Sustainable and Circular Textiles and the UN's 2018 Fashion Industry Charter for Climate Action aim to enable the industry to move towards meeting such targets [4–6]. In addition to a range of environmental and social targets, these commitments have earmarked deadlines for reductions in greenhouse gas emissions in line with the 1.5-degree Celsius pathway

set out by the 2015 Paris Agreement. Fundamentally, they aim to create a shift towards circular design and production by 2030 and 2050, respectively. Though such initiatives are an indication of a positive shift in political will from decisionmakers and industry bodies to meet environmental impact reduction targets, there is still a long way to create actionable change that will mirror aspirations. For instance, at a meeting of the UN's Fashion Industry Charter for Climate Action held in February 2023, UN Climate Change Executive Secretary Simon Stiell called for the industry to move "further and faster", noting that after five years of signing the Charter, "less than half of active [charter] signatories are compliant with setting climate targets needed to limit global heating to 1.5 degrees Celsius". Stiell also pointed out that "by and large, their [signatories'] extensive supply chains aren't aligned with Charter goals either" [7]. While there are several complex reasons for such unsatisfactory rates of change and lack of industry alignment, one component critical to achieving real impact is the need for all action to be underpinned by a robust understanding of the triple bottom line including the environmental, social, and economic impact of the FTI [8]. The task of addressing all areas of the FTI's impact is beyond the scope of one paper; therefore, this paper focuses only on environmental impact. Within this context, there is a tendency to limit discussions of environmental performance to the confines of carbon emissions; however, this paper goes beyond this to consider how a range of environmental impact categories are measured. This, we argue, will better support wholistic approaches towards a circular transformation of the FTI. Though efforts towards quantifying the FTI's environmental impact have led to the development of a range of tools, methodologies and platforms, this paper argues that the efficacy of these tools is partly dependent on the inclusion of expertise, perspectives and suitable data from multiple stakeholders across the FTI value chain (and academia) in their design, implementation and assessment. In response to this, there is an urgent need to locate sustainability solutions to the industry's 'wicked problems' [9], with this research being positioned as a design-led intervention towards this end. Addressing these environmental issues via design involves building a hypothesis or more concrete understanding of the 'indeterminacies' of the problem space [10]. Therefore, in addition to critically mapping how EIA tools are currently positioned within an industry context, this study draws on primary and secondary data to identify key gaps and challenges in accurately assessing and communicating the FTI's environmental performance. To do this, the following questions are addressed:

RQ1: What are the most prominent methodologies and tools utilised to assess and communicate environmental impact?

RQ2: What relationships and connections exist between EIA tools and methods?

RQ3: What are the informational flows and processes in this system?

RQ4: What asymmetries and challenges, if any, exist in this system?

This paper develops a framework to identifying the problem space, or challenges associated with measuring and communicating the environmental impact generated by the fashion industry. This framework involved analysing secondary data to both map the EIA landscape and identify key gaps in accurate assessment and communication. The findings of this exercise were used to inform the collection of primary data via focus group discussions, which brought together 85 FTI stakeholders with diverse knowledge and experience. The paper is structured as follows: Section 2 presents an overview of the methodology. Sections 3 and 4 present the results of critically mapping the FTI's EIA landscape and highlight gaps and challenges identified in the literature. In Section 5, those results are contrasted with the findings of focus group discussions. Section 6 concludes with suggestions of future directions of inquiry and proposed action for multiple stakeholders.

2. Qualitative Methodology

The methodological approach adopted during this study encompassed a two-staged process in collating both primary and secondary data. The critical mapping of the FTI's EIA landscape began with an analysis of relevant literature, where a range of secondary data, including publications from non-governmental organizations (NGOs) and policy

bodies, online indexes, fashion brands and news outlets were reviewed. Following the identification of core gaps and challenges, five thematic areas (policy and governance, transparency, environmental measures, cross-disciplinary action and economic drivers) were developed as the focus of engagements with industry stakeholders during focus group discussions. The core aim of these discussions was to draw on industry knowledge to understand and identify measurable solutions through collective action. In total, 85 people participated in the focus groups, divided into sub-groups of approximately eight participants and facilitated by a member of the research team. Each participant was involved in two focus groups held on the same day, the first focused on understanding the fundamental challenges and barriers currently experienced with the implementation and engagement with EIA. Key questions posed to the group included: What is the current practice? What are the challenges and barriers to the implementation of, and engagement with, assessment methodologies relating to EIA? What are the key gaps in knowledge? The second group discussions homed in on the co-creation of potential solutions and development of collective action to locate effective tools to assess and communicate the FTI's environmental performance. The questions prompting discussions included: What are the key drivers that will enable change in the future? What will the outcomes or success of these actions look like? What positive impact will these actions result in? Each focus group lasted approximately 45–60 min each, with the resulting data recorded utilizing a pre-prepared template and audio recording devices. As the aim was to include a range of FTI stakeholders in the focus group discussions, participants were purposively recruited via targeted emails to relevant contacts. Additionally, the event was publicized on LinkedIn and circulated to relevant professional and academic networks. Participation was limited to 85 people due to practical considerations like venue capacity, the number of facilitators available and maintaining group sizes conducive to rich discussion (Table 1).

Table 1. Focus group participants.

Stakeholders		No. Participants
Manufacturing	Textiles	7
	Garments	2
	Equipment	7
Academic	Fashion and Textiles	30
	Environmental Science	14
Small/Medium Enterprises (SME)		6
Non-governmental Organization (NGO)		7
Fashion Brands	Design	4
	Sustainability	5
Media		1
Local Government		2
Total		85

Participants included FTI professionals in creative roles; business owners; policymakers, academics; Corporate Social Responsibility (CSR)/Environmental, Social and Governance (ESG) professionals; consumers and representatives of multi-stakeholder initiatives (MSI). These MSIs included international and regional organizations focused on tackling the lack of transparency in the sector, reducing waste and establishing baselines of negative environmental impacts. The transcripts of these sessions were analysed using a "systematic procedure for analyzing qualitative data" [11] (p. 283) called the General Inductive Approach, which relies on forming theories or generalisations based on observational or data-driven methods. While this methodological approach is guided by "specific evaluation objectives", it also aims to allow "research findings to emerge from the frequent,

dominant, or significant themes inherent in raw data, without the restraints imposed by structured methodologies" [11] (p. 283). This analytical procedure begins with a close reading and re-reading of the text, identification of recurring codes/themes, followed by refinement in which initial codes are organized under superordinate themes and finally supported by the selection of extracts which illustrate the codes [11].

3. The FTI's EIA Landscape

The environmental impact of the FTI can be measured and communicated in several interrelated ways. While many of these tools and approaches are not unique to the FTI, this critical mapping aims to address RQ1–3 by highlighting some of the important relationships between them, as well as nuances in their application within the sector. To implement this mapping exercise, existing impact measurement tools used across the industry globally have been organised into four categories, as determined by the authors to best describe the primary purpose of each, including: 1. assessment tools and methods; 2. data sources; 3. communication tools and platforms; 4. proprietary tools and platforms.

EIA tools were categoried based on their primary function i.e., the quantification of impact, storing of datasets used to inform impact calculations or communicating impact to different stakeholders (see Table 2). Additionally, tools within the proprietary category were selected based on being marketed specifically to fashion and textile firms as unique services for calculating environmental performance and providing insights on impact reduction. Due to the interdependent nature of the EIA landscape, many tools are multimodal, meaning that one tool may be used for both quantification and communication; nevertheless, their primary function was used for categorisation of EIA tools in this paper.

Table 2. Criteria for the categorisation of EIA tools.

Category	Primary Function	Public or Proprietary	Examples
Assessment tools & methods	Quantification of environmental performance	Both	Footprint modelling, LCA
Data sources	Data of repository used to inform impact calculations	Both	Ecoinvent, Sphera (GaBi)
Communication tools & platforms	Communication of environmental performance	Both	EU Ecolabel, Global Organic Textile Standard (GOTS)
Proprietary tools & platforms	Quantification of environmental performance	Proprietary	Higg Index, Vaayu

3.1. Assessment Tools and Methods

The first category of EIA tools includes the various methods and approaches used by industry to quantify the environmental performance of products and services. Arguably, the most prominent set of assessment tools in common use is environmental footprint modelling, which is used to measure impact factors like, chemicals, greenhouse gases (GHG), emissions and water inputs/outputs [12]. Unlike footprint modelling, which assesses a single impact factor at a specific point in time, Life Cycle Assessment (LCA) is a suite of quantitative assessment methods used to measure impact across a range of factors over a product or material's entire life cycle, including raw material extraction, manufacture and distribution [13]. Depending on the scope and focus of an LCA study, footprint modelling data are inputted into calculations along with other relevant data. Though the LCA tool is typically used to assess environmental impacts, social LCAs (or S-LCAs) have their own distinct methodologies relevant to the geographic region and stakeholders [14,15]. Furthermore, the environmental assessment data from footprint modelling and LCAs can be further augmented by economic concerns via an eco-efficiency analysis. This

was introduced by the World Business Council for Sustainable Development (WBCSD) and further developed into a methodology by chemical firm BASF (Badische Anilin und Soda Fabric) in 1996 to assess "environmental impact in proportion to a product's cost-effectiveness" [16]. Environmental Profit and Loss (EPL) is another LCA-based method used to place a monetary value on environmental impact [17]. Finally, EPD (Environmental Product Declarations) and PEF (Product environmental Footprint) are LCA-based assessment and communication systems used to report on environmental performance in many industries, including the FTI. These systems have defined methodologies for calculating a range of impacts of different product categories: Product Category Rules (PCR) for the EPD and Product Environmental Footprint Category Rules (PEFCR) for the PEF [18,19]. In principle, this means that the results of a PEF or EPD based assessment for two products in the same category are comparable. While the PEF system, which covers 13 clothing and footwear product categories, was developed by the European Commission's Joint Research Center (JRC), EPDs and their associated PCRs are stored in an online repository, the EPD library, which is open to contributions of methodologies and results from commercial and public entities.

Understanding of the EIA landscape through secondary literature begins to build foundational knowledge in the critical understanding of prominent methodologies and tools utilised within an industry context, as detailed in Table 2. For instance, while various assessment tools differ in their scope and use context, it is apparent from the discussion above that footprint modelling and LCA are important methodologies forming the basis of many assessment approaches. The identification of subtle differences and comparable qualities of assessment tools facilitates robust comprehension of relational factors and contributes to addressing RQ1 of the study.

3.2. Data Sources

Any calculation or communication about environmental performance, including those mentioned in the previous section, requires the input of some form of data. Moreover, the reticular nature of the sector's EIA landscape is essentially dependent on the movement of data between actors, tools, methodologies and platforms. Therefore, it is important to understand the flow of data to better comprehend how EIA in the fashion and textile sector works. Although the discussion is this section does not capture all possible flows of data, it does address RQ3 by presenting some of its most relevant directions of travel. For instance, while suppliers can and do share/input data directly into assessment systems (e.g., when certifying their products or assessing impacts), clothing brands are increasingly tasked with gathering data further down the tiers of their supply chain (see Figure 1), which include raw material extraction, raw material processing, manufacturing, finished product assembly and distribution channels like retailers and warehouses. This information is used to provide a fuller picture of the impacts of finished products.

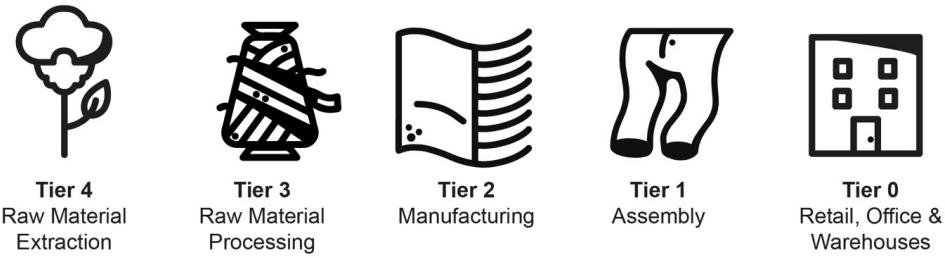

Figure 1. Tiers of the supply chain.

For example, a cotton grower seeking to certify fibres they produce in alignment with a particular organic standard will submit relevant data to a third-party certifier. Alternatively, if a brand is conducting an LCA on a cotton shirt in their range, then they are responsible for collecting relevant data from all collaborators further down the supply chain, including the cotton grower. Primary data from both suppliers and brands are

used across all assessment tools and methods to determine environmental performance in various categories. In addition, secondary data, which include global averages of emissions, as well as the findings of footprint modelling and LCA studies (from both academia and industry), are also used in calculations when primary data are unavailable. These data are typically accessed through databases that are locked behind substantial paywalls. In this way, there is somewhat of a cyclical relationship where the results of some LCA and footprint modelling studies are used to inform other LCA studies [20]. In addition to its use in quantification of environmental performance, primary data from suppliers, brands and secondary sources are also input into communication tools, including eco-labels and rating systems. Therefore, the inaccuracies of one EIA tool have the potential to be spread as data are shared and appropriated by various actors in the EIA landscape to support their own agendas. The understanding of the connections and informational flows between EIA assessment tools begins to contribute to addressing RQ2 and RQ3 from a secondary data perspective.

3.3. Communication Tools and Platforms

The assessment methods of footprint modelling and LCAs are typically engaged by sustainability/CSR teams, corporate managers, ESG professionals and policymakers. This is to establish organisational strategic sustainability frameworks and apply metrics to measure sustainability levels attained for shareholder and stakeholder scrutiny [21]. Additionally, the findings of these assessment tools along with primary and secondary data can then be fed into EIA tools that are more consumer-facing in nature. Rating tools include eco-labelling and certification systems that are commonly denoted on products and packaging via logo marks like Oeko-Tex Standard 100 and Global Organic Textile Standard (GOTS) [22,23]. In addition to being voluntary systems for indicating conformity and certification to a particular standard, these labels are used to create transparency and assist in decision-making at the B2B (Business to Business) and B2C (Business to Consumer) level. As eco-labels should indicate performance of products based on a consideration of all relevant life cycle stages, LCA methodologies commonly underpin many certification schemes [24]. In addition to labels focusing on a single issue, some cover a range of impact areas. GOTS, for example, focuses on the raw material extraction stage and certifies that garments are made from 70% organic fibre content and manufactured via environmentally friendly processes, while Oeko-Tex Standard 100 certification is focused on specific material characteristic, ensuring that textile products do not contain harmful substances.

Unlike eco-labelling, which typically communicates information about environmental and social performance at a material or product level, global rating systems focus on impact at the brand level. Systems such as Good On You, the Fashion Transparency Index, the Business of Fashion Sustainability Index or The Ethical Consumer, for example, rank brands in relation to various sustainability and ethical criteria to inform consumers and other stakeholders about the relative environmental and social impacts of brands and their suppliers [25–28]. Moreover, through the knowledge provided via websites, reports or apps, these public rating systems aim to assure transparency across the sector. While some rating systems are more explicitly aimed at informing consumer purchasing decisions [29], such as that provided by Good On You, others are aimed at informing a wider range of stakeholders. Irrespective of their target audience, all brand rating systems have the potential to impact decision- and policymaking by stakeholders as they all communicate various value judgments aligned with the triple bottom line (people, planet and profit) based on the data analysis provided in the rating system [30]. Lastly, as many brand rating systems aggregate publicly available data for their analyses, they rely on disclosures from brands, including information regarding eco-certification. Responding to RQ1 and RQ2, such relationships are further emblematic of the interdependency of EIA tools in the FTI as data are reappropriated to inform various metrics.

3.4. Proprietary Tools and Platforms

There are several proprietary impact assessment tools and platforms catering to the FTI and enabling corporate measurement of environmental and social responsibility. Owned and operated by a growing number of organisations and firms, they offer a range of services to brands and suppliers seeking to understand their performance. Some examples include the Higg Index, Carbon fact, Fairly Made and Vaayu (see Table 3). Additionally, firms offering access to databases also provide LCA software packages such as SimaPro 9.6 and Sphera's LCA for Experts, which can be used to measure various emissions, support reporting and provide strategic insights for product development and supply chain management. There are also bespoke LCA-based methodologies and tools developed for fashion companies, including Tapestry, Stella McCartney and ASKET. In addition to developing assessment tools based on common approaches like LCA and footprint modelling, these services boast of features such as AI-powered impact calculation and centralised data gathering across an entire supply chain. In addition to primary data provided by suppliers and brands, proprietary services like the Higg Index and Carbonfact use databases like Sphera 2023.1 (formerly Gabi) and Ecoinvent 3.10, respectively, for secondary data provision. The sources of these databases vary. Ecoinvent 3.10, for instance, includes datasets from research institutions, companies and industrial associations [31]. Focusing on either one or multiple impact categories, including land use, CO_2 and water emissions and eutrophication, such tools and services are used by brands and their suppliers to quantify and communicate their environmental and social performance with various stakeholders, including investors and consumers. In addition to the import of secondary data from commercial databases, the prominent use of LCA and footprint modelling as the methodological basis for proprietary EIA tools is illustrative of the dependencies within the system.

Table 3. Examples of proprietary tools and platforms.

Tool/Platform	Service Offered	Target Users	Provider
Higg Index	• LCA-based impact assessment of materials and products • Environmental impact assessment of manufacturing facilities	Suppliers Brands	Worldly (Cascale)
Carbon Fact	• LCA-based Impact assessment of products • Data gathering across supply chain • Traceability tools • Reporting software • Insights on how reduce impact	Brands	Carbon Fact
Vaayu	• LCA-based impact assessment of carbon emissions • Data gathering across supply chain • Traceability tools • Insights on how reduce impact	Brands	Vaayu Tech
Fairly Made	• Data gathering across supply chain • Impact measurement • Traceability tools • Insights on how reduce impact	Brands	Fairly Made

4. Identified Challenges with EIA

Although assessment methodologies, primary users/audiences, and dissemination/communication mechanisms of various EIA tools and systems may differ, one attribute they share is their increasingly significant role in influencing corporate and financial decision-making. EIA tools are fundamentally a means of enabling informed actions to be embedded

in sustainability initiatives while delineating and communicating sustainability claims. Evidence of the growing and urgent use of EIA tools by fashion brands is illustrated by the intensifying efforts of governing bodies to regulate claims derived from such tools often embodied in the profusion of sustainability reports. For instance, in March 2023, the EU adopted a proposal on a directive requiring large companies to substantiate any sustainability claims about their products and services. Failure to comply with EU measures may result in hefty fines or restriction of access to the EU market, which accounted for 24.3% of the world's apparel and textile import value in 2020 [32]. Similarly, the Competition and Markets Authority (CMA) in the UK also issued the Green Claims Code in 2021 to ensure that businesses promoting sustainability characteristics for their products should fully substantiate their claims [33], resulting in a number of high-profile fast fashion brands, including ASOS, George at ASDA and H&M, being called out by CMA for contravening the code and using greenwashing content in their promotional campaigns [34].

From 2015, the fashion, garment and textile sectors have been guided by policy directives steering environmental action, including the UN's legally binding Paris Agreement, to reduce greenhouse gas emissions and maintain average global temperatures below 2 degrees Celsius. The Fashion Industry Charter for Climate Change launched in 2021 at COP24 operates as a map towards implementing net zero emissions by 2050 across the global textile, fashion and garment industries [6]. In a European context, the European Union's (EU) Strategy on Sustainable and Circular Textiles, aligned with the commitments of the European Green Deal, the Circular Action Plan and the European Industrial Strategy, considers the complete life cycle of textile products, suggesting coordinated efforts to transform the current production and consumption of textiles. Additionally, the strategy aims to reduce their negative environmental impact by rendering textile products durable and reusable to extend their lifetime in a circular system ensuring longevity. Therefore, EIA tools and systems need to be robust and reliable to support both the actioning and monitoring of such initiatives by ensuring that ecological, sociological and economic imperatives for all industry sectors are considered.

The continued development and proliferation of EIA measurement tools and communication systems can be perceived as a positive step towards understanding and tackling the impacts of the FTI. However, these instruments are not without their issues and limitations. In response to RQ4, a review of the literature has categorised these issues into four key areas: LCA, eco-labelling and certification, brand ratings and data, which includes data gathering, analysis and management.

4.1. LCA

Environmental LCA methods conform to the International Organization for Standardization (ISO) 14044:2006 standard [35]; however, they have been called into question for being a "poorly defined method" [36] due to the lack of globally harmonised methodologies and variance in the scope of studies. For instance, although the term LCA implies a whole life cycle approach, some studies are limited to a cradle-to-gate or gate-to-gate approach, leaving out any consideration of impact during the use and end-of life phases of the life cycle. This, along with the high levels of subjective interpretation involved in the LCA process, result in the low level of comparability of results [37,38]. A systematic review of apparel-focused LCA studies revealed that many highlighted a limited range of materials, production processes and technologies [39]. Additionally, current LCA methods do not measure the full breadth of impact on the entirety of the natural world, with factors such as soil health, biodiversity and animal welfare often being overlooked [40]. Moreover, as a data-intensive assessment tool [20], the LCA has been criticised for a reliance on insufficient secondary datasets focused on Global North contexts and lacking applicability to the Global South where much of the production is situated [20]. Furthermore, checking and referencing secondary data (some of which are outdated, confidential or hidden behind a paywall) underpinning LCAs has also been cited as a problematic issue [41]. In addition to more generalised observations about LCA, the reliability of some of the FTI's most

influential LCA-based tools has been called into question. At the time of writing, the Higg Material Sustainability Index, a comparative LCA framework developed by the Sustainable Apparel Coalition (now rebranded as Cascale), was independently reviewed following criticism of its methodology. This was due to the use of secondary data and a limited focus on the production phase of product life cycles, in addition to accusations of its use by large fast fashion brands as a form of greenwashing [42–44]. While the Higg Index has since been relaunched by Cascale, it serves as an example of the need for greater scrutiny of the methodologies and data underpinning the various LCA-based tools and systems available in the market used by designers, suppliers and product developers. Aside from questions of reliability, the high financial and resourcing cost of conducting an LCA for even one material type needs to be considered [40]. Furthermore, because LCA results are often (mis)used to inform critical decisions about potential environmental risks, it is essential for their structure and role in the wider EIA landscape to be critically reconfigured. As LCA methods aim to quantify impact in various environmental (terrestrial, aquatic, atmospheric) and social contexts, it is essential that their design draws on a range of knowledge bases that are representative of key impact contexts to increase reliability and efficacy.

4.2. Eco-Labelling and Certification

Eco-labelling, like LCA, has also come under public scrutiny. For example, in their systematic review of fashion and textile-related eco-labels, Ziyeh and Cinelli [45] pointed out that rather than supporting decision-making, eco-labels often fall short of their intended use, leading to mistrust and confusion among recipients. Consumers seem to grapple with eco-label confusion at various levels due to an information overload [45,46]. There are currently over 100 FTI-related eco-labels listed on the Ecolabel Index covering a variety of sustainability aspects, ranging from organic content and GHG emissions to animal welfare and corporate practices. Consequently, the task of distinguishing between labels is further complicated by nuances in the categorisation of labels correlating to the verifiability and veracity of the claims they contain. For instance, according to ISO 14024 standards [47], Type 1 labels contain claims that cover a range of attributes that are verified by third-party assessment, which allows for comparisons between products. Type 2 labels on the other hand, are aligned to ISO 14021 [48] and are unverified and self-declared claims, while Type 3 labels aligned to ISO 14025 [49] use quantifiable LCA data that are third-party-verified but do not provide comparisons between similar products [50]. Typically, clarification of which category a given label falls into is not easily discernible on consumer-facing applications like product tags or corporate websites. This lack of clarity is especially challenging for consumers as the stakeholder group that is least likely to understand the intricacies of eco-labelling (or the FTI's EIA tools more generally). Furthermore, the high quantity of fashion and textile eco-labels also correlates to an elevated number of certification methodologies that are typically difficult for the uninitiated (non-sustainability experts) to understand. Additionally, some eco-labels fail to disclose their methodologies/criteria for certification. This is a challenge as the efficacy of an eco-label is dependent on a general awareness of the label, an understanding of the information it aims to convey [51] and the transparency provided on certification criteria [41]. The confusion created by a lack of these characteristics exacerbates the erosion of trust that consumers and other stakeholders have in eco-labels and their effectiveness. Aside from hampering informed discission-making, confusion and misperception of eco-labels by consumers can also have the adverse effect of incentivising green washing by corporate actors [52]. In addition, there is a high level of visual similarity between labels that often make it difficult for stakeholders to distinguish between them and their content [45]. Most eco-labelling is limited in scope, focusing heavily on environmental impacts without accounting for the social or economic aspects of sustainability [53], which arguably are requisite and related issues in informing action and practices that consider sustainability more wholistically by incorporating a triple bottom line approach. Lastly, there is a lack of standardisation and comparability of eco-labels that limits their efficacy with regards to supporting decision-making. For instance an analysis

of the sector's prominent eco-labels, including GOTS, Global Recycled Standard (GRS), Bluesign® and Blue Angel Textiles, highlighted a lack of comparability at a methodological level due to variances in life cycle stages considered [54]. Moreover, even when a life cycle perspective is adopted (as is the case with Type 3 labels), some certification methodologies lack a consideration of impacts during life cycles stages like use and distribution [54]. Although there is certainly value in having a range of eco-labels that are representative of the unique impact implications of different materials and product categories, it is also worth exploring how the necessary level of complexity in eco-labelling systems can be maintained while also introducing a level of simplicity and harmonisation that would make these tools more usable. As revealed in a study by Cervellon and Carey [55], consumers tend to lack a general understanding of sustainability and eco-labelling systems. Therefore, the transformation of the sector's eco-labels will require greater consideration by, and the inclusion of, various stakeholders in consideration of their development, dissemination and use [56]. Underscoring the challenges of accurate communication about sustainability due to proliferation of labels and lack of comparability, in January 2024 the EU parliament announced legislation aimed at curbing misleading product labels [57]. This law bans generic or unsubstantiated claims and limits the use of certification schemes to ones that are approved or established by a public body. Additionally, France's Climate and Resilience law [58] will make eco-labelling for products including clothing and textiles mandatory by 2025. The law aims to harmonise eco-labelling in France with its standardised methodology and dedicated LCA tool [59]. While these laws are a step in the right direction, at the time of writing, it remains to be seen how they will be implemented. Moreover, as discussed above, there is more action needed to address fundamental problems with eco-labelling at a global level.

4.3. Brand Ratings

While LCAs and eco-labels are generally aimed at communicating and assessing the impacts of materials, products and services, brand rating systems offer an assessment and ranking at brand level. Importantly, brand ratings cover a range of sustainability features and have criteria and methodologies that vary widely. For instance, Good On You, one of the largest consumer-facing rating systems of over 3000 brands, purports to examine "brand's practices throughout their entire supply chains from raw materials to products' end of use focusing on 3 key areas of people, planet, animals" [25]. Another popular rating system, the Remake Fashion Accountability Report, included 52 brands with revenues over USD 100 million in their 2024 measurement of progress across six categories: traceability, raw materials, commercial practices, environmental justice, wages and wellbeing, and governance [60]. In addition to differences in terms of scale and scope, the examples above indicate the high level of variance in logics and methodologies underpinning FTI brand-focused ranking systems. While variance is not inherently problematic, as with eco-labelling, there is certainly the potential for confusion and a mismatch between intention and effect. Indeed, there have been criticisms of popular rating systems like Good On You and the Ethical Fashion Guide [27] for their potential to be misleading due to their reliance on publicly available data [61], including unverified claims and flawed rating methodologies [62]. Moreover, some firms have devised their own rating systems. For example, the Kering Group has developed their Environmental Profit & Loss (EP&L) account that calculates the overall monetary cost to society of the production processes used by its constituent brands [63]. As many rating systems rely on information from LCAs, eco-labels, as well as public disclosure from brands (some of which may not be third-party-verified), the interlinked nature of the EIA landscape points to the multiplied effect that inaccurate data and ineffective tools can have. Therefore, it is imperative for any critical re-imaginings of EIA methods to consider ways for improving the reliability and usability of a range of tools to account for the environmental impact of production and consumption in a more wholistic and accountable manner.

4.4. Data

As stated above, the reticular nature of the FTI's EIA landscape means that the impact of inaccuracies can be multiplied as data are shared across different platforms, especially when they are not linked or benchmarked and are voluntary. Therefore, it is essential not only for assessments and communication methods to conform to reliable design protocols, but also for the data that are inputted and shared to be robust, reliable and applied appropriately. Several challenges in relation to the data quality of these measurement tools and platforms have been identified. One fundamental issue is the difficulty in collecting data across the complex supply and consumption networks of the FTI, especially considering lengthy production lead times and extensive product ranges [20,56,64]. In essence, the desegregated nature of the supply chain (see Figure 1) can lead to a lack of visibility, with brands and retailers unable to fully trace the origins of their products. Such a lack of traceability and transparency can result in reputational damage [65] and inhibit accurate assessments and communications of environmental performance. Furthermore, the use of 'zombie data', which are unverifiable, false or lacking credibility, has been identified as a key challenge in the FTI's EIA [66]. For instance, The Transformers Foundation's report on the impact assessment of cotton pointed to the prevalent use of outdated and inaccurate data by users [67]. One reason cited in the report in defence of this accusation was the expense associated with gathering data. Additionally, extreme variances in figures cited in an attempt to communicate the scale of an environmental issue often creates confusion. For example, the amount of water used in the production of a t-shirt has been calculated by several organisations, with rates ranging between 600 and 20,000 L [66]. Such variances are due, in part, to the varied approaches when calculating the impact of production processes which all have different assumptions built into them, including for instance the functional unit used (i.e., 1 kg of fabric, one t-shirt or a pair of jeans). However, variances can also be reflective of the diverse supply chain routes taken by each individual garment, meaning that generalisations across multiple identical products from different brands, cannot be compared meaningfully. The sharing and use of this type of data leads not only to an erosion of credibility but can also contribute to miscalculations of environmental performance. The issue of zombie and misleading data is further exacerbated by the lack of context or nuance when data are presented in the public domain or directed at selected stakeholder groups [67].

5. Focus Group Findings

The results of critically mapping the FTI's EIA landscape pointed to interdependencies as data are used across of different tools (RQ2 and RQ3). Moreover, the review of literature identified key gaps and challenges with regards to LCA, eco-labelling, brand rating systems, as well as mechanisms of data collection and analysis (RQ4). The focus group discussions were developed to build a greater level of understanding of the identified challenges from a multi-stakeholder perspective, addressing further RQ4. The findings were used to formulate five thematic areas which focus group discussions were oriented by, including policy and governance, transparency, environmental measures, cross-disciplinary action and economic drivers. Following an inductive analysis of the transcripts, four key areas emerged from the data and are discussed further in the following sections. In addition to the themes highlighted from the literature (excluding brand ratings), policy and legislation were also identified as important areas requiring transformation to address the inefficiencies of the FTI's current EIA approaches and to inform the transition towards circular models and practices.

5.1. Assessment Tools and Methods

In addition to calls for more standardised/harmonised methodologies that have comparable results (i.e., a system akin to the EU's Product Environmental Footprint (PEF)), there was an emphasis on the need for further research regarding the impact created during the use and disposal stage of the life cycle. Participants highlighted the need to build a

more robust understanding of environmental impacts relating to a wider range of materials (i.e., more research about natural fibres) and the need for a greater focus on emerging impact areas. As two participants discussed:

> "The use of product impact is something that's really fuzzy, there's very little research, very basic methodologies used... we don't know much about microfiber shedding, how much happens in use, the amount of energy going into it etc."

> "You also have multiple number of various different test methods depending on what you're measuring, and each different brand might follow a different test method and then all of a sudden it's not comparable at all"

One fundamental question raised during the focus group discussions concerned how sustainability in general is defined and understood by FTI stakeholders. This applies not only to the conceptual framing of the term itself, but also to how it is understood to be manifested and subsequently quantified by the industry, and for what purposes and outcomes. This idea was emphasised through repeated references to the lack of baselines for impact assessment in the industry across all discussion groups. The absence of clear thresholds was characterised as a critical challenge for companies, even when they actively engage in impact assessments, due to the ambiguity regarding the level of sustainability of any particular result they find. This was detailed by a participant:

> "I can really say a lot of things about challenges and gaps in impact measurement. . . the fact that we really lack primary data collection. . . I really struggle a lot like to see what is the baseline, so what is the actual impact of cotton, synthetics, polyester, etc? We rely on data sets that are quite old, and they are not transparent"

Although benchmarking can be and is often done within individual business' or within sectoral/regional clusters via multi-stakeholder initiatives, achieving the critical mass of action required for transforming the FTI towards circularity requires coordination and collaboration by participants working across the supply and value chains at a global level. Participants also discussed that the lack of baselines creates a challenge when attempting to benchmark material innovations within the sector:

> "I think that's one of the things that's difficult with innovations is not having something that is like, measurable and comparable. . . there not being like a standard, like a benchmark, to compare against"

Participants also noted that some actors in the FTI were unsure of what to assess and where to focus their limited resources. These perspectives echo and build upon findings presented in Section 4 on the need for approaches like LCA to be reimagined in consideration of a wider range of environmental impact categories and towards a greater level of comparability [36,38–40].

5.2. Eco-Labelling and Certification

Eco-labelling schemes were once perceived to have potential value from a B2B perspective in supporting sourcing decision-making and in mitigating risks associated with multi-tiered, globally dispersed supply chains by affording the opportunity to verify claims via a third party. However, many felt that the costs associated with engaging in certification were prohibitive. For instance, some cited the high cost of obtaining multiple certifications/eco-credentials, contracting/hiring experts to analyse and interpret data, as well as the cost of gathering and managing data from a decentralised supply chain. Moreover, the cost involved in the time needed to gather data was also identified as representing a problematic issue for small and large firms alike. Referring to their challenges as an SME, one participant stated:

> "We produce organic cotton but for us to have it certified, it's gonna cost money. So, it's not having a certification. . . we can give you it (the fabric) but can't certify it, because the corporates are making a lot of money from certification. That's the dilemma, and that's the battle"

There was a level of scepticism expressed with participants from the FTI regarding the actual return on investment (ROI) of certification schemes due to confusion of which schemes increased consumer awareness or influenced their decisions and habits. Indeed, some questioned how and when consumers used these data during their retail journey. Coupled with the inherent costs of certification, this sense of doubt tended to disincentivise industry stakeholders and notably SMEs, as they have limited funds and resources with which to engage in EIA activity. Aside from the uncertain ROI, participants noted a perceived risk of inauthentic certification due to inadequate methodologies and unverified data underpinning some of the eco-labelling schemes. Moreover, participants felt that the profusion of eco-labelling schemes covering a variety of environmental and social concerns leads to confusion among consumers:

> "You need standardization as well, because I think there are so many certifications and so many organizations and from a consumer perspective, it's actually really difficult to understand, you know BCI cotton, organic cotton, but which one do you value?... there needs to be like a much simpler, more straightforward set of criteria of how you label"

This confusion is further compounded by the need for consumers to be conversant with eco-certifications from other industries in addition to the FTI's:

> "I read recently that I think it was around 450 different kind of brand logos have been identified for sustainable practices across consumer goods now, that total lack of clear, single or short order grouping of sustainable practice identification"

These findings are in line with the results of the critical mapping and literature review discussed earlier [45,50,51,53,55] as they point to the need for greater consideration of what a truly meaningful eco-labelling and certification system(s) constitutes. For instance, it could be questioned if the quantity schemes are needed and if a co-ordinated effort should be prioritised. Additionally, consideration of how eco-labelling can be designed to better accomplish the critical aim of supporting decision-making for all stakeholders, including consumers to accommodate their specific needs and assist in enabling responsible decision-making. Moreover, how companies at every scale can be incentivised and supported to engage in certifications that are appropriate, reliable and transparent must be explored.

5.3. Data Quality and Authenticity

One of the key themes which emerged across all discussion groups was the lack of data quality and authenticity. In line with the findings in Section 4.4, participants pointed to the use of zombie data, the persistence of misinformation [66] and a lack of transparency [56,64], leading to erroneous claims and communications about the sector's environmental performance by brands. Such issues were linked to the lack of established or standardised mechanisms and approaches to gathering, sharing and authenticating data. In particular, the need for systems and tools that would support greater traceability was emphasised by a participant:

> "I was trying to find stats in like levels of waste last year. And literally, I found 10 different sources stating a different number. And I don't want to be putting a number if it's wrong, and you know, how do you know what's true and what's not? I guess there's misinformation. And whereas I know that many of the companies disclosing that have research to back that up, others don't"

Participants felt that clothing brands and other stakeholders are disincentivised by the high cost of third-party data assurance services, especially where such assurances do not necessarily guarantee the quality of data provided. Aside from issues relating to the systems and procedures of gathering, sharing and authenticating environmental data, concerns were raised about the costs that such activities carry. While the temporal and financial cost was acknowledged by multiple stakeholders, many participants asserted that the burden was disproportionally placed on actors in the supply chain, many of whom lack

the human and financial capital to engage in the labour of detailed data gathering. This aligns with the findings of a report by the Transformers Foundation, which calls for true collective action in which responsibility and the burden of investments shared equitably across the value chain [68]. As one participant said:

> "There's a financial imbalance as well. Because, to maybe create a sustainable supply chain, the cost isn't actually with the design house"

Noting the burden of time and lack of capacity typical within supply-side operations, another participant detailed:

> "I think it's the time involved in that kind of thing as well, particularly if we're going right back to raw material producers... it's reasonable that it could be like a one man, like a one farmer operation. It's like, they don't have time to do that kind of stuff like so it's that time and money"

From a clothing brand perspective, the burden of gathering impact data is further complicated by the challenges associated with collecting information for large product ranges, especially when production lead times and globally dispersed supply chains are considered. As noted by a participant:

> "Even the products that are being used, how many have been bought wholesale from a producer? but there's no transparency. . . or when you're buying a garment, just because you bought it from one factory, how many components of that garment have travelled from elsewhere to get there. . . there's so many trails that you just; you couldn't investigate all of them"

Similarly to findings from the literature [67], the prevalent reliance on global averages and aggregated data in assessment was also cited by participants as a critical issue responsible for impairing the reliability current of impact assessment for the FTI:

> "It comes back to primary data, because so much of the data is based on an agglomerated number for the whole industry, you know, depending on which country its coming from, that will have a massive impact. But also, one farmer to another farmer, the individual practice of those farmers can make such a difference to whether it's a good, you know, net benefit"

As Jestratijevic et al. [69] also pointed out, there was an acknowledgement by participants that some brands were collecting primary data but unwilling to share them publicly for various reasons, including fears about losing their competitive advantage or attracting unwanted scrutiny. This suggests that in addition to encouraging the collection of more primary data, there is need for greater emphasis of the importance of pre-comparative spaces and initiatives where firms can safely share data to contribute to building a better understating of the FTI's environmental performance.

5.4. Policy and Governance

As explained earlier (see Section 3.3) standards, certification and assessment within the FTI's EIA landscape are largely voluntary and left to the discretion of the companies involved. Echoing findings in literature, which highlight how the lack of unified legislation impedes sector's the transition towards circularity [64,70,71], the role of and need for mandatory policy were discussed across all focus groups. While voluntary agreements such as Textiles 2030 driven by WRAP were viewed by participants as a positive step in inspiring some level of action and providing a proof of concept for sustainability initiatives, mandatory legislation was disclosed as the key catalyst to encourage greater engagement with implementing EIA consistently across the FTI value chain. This aligns with findings by Dissanayake and Weerasinghe [72] as well as Hetherington et al. [73], which position policymakers as drivers of action. While the mechanisms suggested by participants for developing and enacting such policies ranged from existing regional government agencies to independent global organisations, participants overwhelmingly perceived policymakers as key drivers in introducing globally harmonised standards and methods:

> "That comes from the government, they can enforce that as well. And that's probably where this has to go at some point there has to be: 'this is the standard' and one of these bodies, whichever one is the one we're gonna go with, you all need to have at least this one that's the only way it works really, isn't it?"

Furthermore, the efficacy of placing the responsibility primarily on consumers to lead efforts to mitigate against the FTI's negative impacts was challenged by participants:

> "There's lots of research going on at the moment from an academic perspective on the behavior attitude gap. . . but again, it's putting that onus on the consumer that we are responsible for brands to be more sustainable and it's not, it should be top down. It should be government enforced"

Moreover, participants noted that the implementation of mandatory policies not only incentivises action by providing clarity on the relevant measures to take, but it can also give a clear business case for ROI where compliance has implications for profitability and access to wider markets:

> "They [fashion and textile companies] want policy, because they need it to level the playing field, you know, to put the case to their decision makers"

Additionally, it was noted that mandated policy could also serve as a means of funding and driving improvements in key infrastructures, such as recycling through the use of modulated EPR schemes and fines like those proposed by the European Commission [74]. However, calls for action on mandatory policy frameworks were also accompanied by cautioning against the introduction of 'sensationalist' or ill-planned legislation that lacks adequate consideration in reflecting the realities of the industry. For instance, one participant questioned the efficacy and feasibility of mandatory reporting policy which failed to account for the financial costs of engaging in EIA:

> "My question is what's going to happen when we sort of require all these businesses to disclose all of this, and they don't have the budget to pay for the assessments. . . I mean, you're not going to in a small brand, it's not going to be able to say a product is sustainable if they don't have an LCA to back that up"

Lastly, participants noted that the absence of a mandated policy or set of EIA policy guidelines create a vacuum often filled by the FTI actors with the largest influence, as is the case with the data provided for proprietary assessment platforms. While such industry-led action was viewed as valid, there was concern that the EIA landscape would be shaped to suit the interests of a few powerful firms at the expense of smaller participants. As such, legislation was viewed as a way of levelling the playing field that would be more inclusive of firms at all market levels.

6. Conclusions and Limitations

The findings from the review of secondary literature and analysis of primary data generated by the focus group discussions indicate that there are several areas in the FTI's EIA landscape that need to be addressed if ambitious environmental targets are to be achieved. The key findings from each dataset have been discussed at length in previous sections; however, as demonstrated in Table 4, there are numerous similarities identified across the qualitative findings.

The primary data contributed significantly to creating an evidence base for the need of baselines and standardized methodologies in EIA and have substantiated the development of recommendations to enable action and progress, reflective of the industry's diverse business models and scales of operation:

1. Standardization of EIA tools and platforms to accommodate the nuanced characteristics of different companies and production processes across the FTI supply chain. This would allow for greater comparability to better support decision-making at both the B2B and B2C levels. While collaboration and coordination between industry stakeholders is needed to achieve this, the participation of policymakers is critical to

support the creation and implementation of assessment and communication frameworks that are inclusive and usable at a global scale.

2. Expanding assessment methodologies to cover more impact categories like biodiversity or microfiber pollution, there is a need for further investigation of under researched topics such as the use and disposal phase of product life cycles. Academic stakeholders need to work with other stakeholders to develop more refined assessment methodologies to fill critical gaps in knowledge.
3. Continued innovation and harmonization of data-gathering systems across supply chains to support the increased use of primary data in assessment, preventing the use of generic secondary data to fill gaps.
4. There is a need to critically reconsider the prominent funding structures as the high financial costs associated disincentivize engagement with meaningful environmental impact assessment for many stakeholders.
5. Refinement and innovation of the FTI's assessment and communication tools needs to be underpinned by greater consideration of the interdependencies that exist in the EIA landscape.

Table 4. Summary findings from literature and focus groups.

Secondary Data	Primary Data
LCA: • Lack of globally harmonised methodologies & variance in scope • Lack of comparability • Existing studies focus on limited range of materials • Need for more impact categories to be covered • High financial cost of assessment • Reliance on limited secondary datasets	Assessment Methods: • Lack of globally harmonised methodologies & variance in scope • Lack of comparability • Existing studies focus on limited range of materials • Need for more impact categories to be covered • High financial cost of assessment • Lack of baselines
Eco-labelling & certification: • Confusion due to profusion of labels • Lack of clarity about different types of labels • Lack of transparency of methodologies • Lack of consumer awareness	Eco-labelling & certification: • High financial cost of certification • Unclear return on investment (ROI) • Inadequate methodologies and data • Confusion due to profusion of labels • Lack of consumer awareness
Brand rating: • Confusion due to varied scope and methodologies • Reliance on publicly available (often unverified) data	
Data: • Difficulty of collecting data across dispersed, complex supply chains • Varied functional units • Unverified data	Data quality & authenticity: • Lack of standardised methods for gathering sharing & authenticating data • Difficulty of collecting data across dispersed, complex supply chains • High financial cost of data collection • Data collection burden placed largely on supply chain actors • Reliance on aggregated data/global averages
	Policy & governance: • Largely voluntary, standards, certification & assessment schemes • Lack of globally aligned policy • Policy as an incentive/driver for action

Limitations

This study contributes to an understanding of the gaps and challenges limiting the efficacy and reliability of the fashion and textile sector's environmental impact assessment through a critical analysis of the literature and stakeholder perspectives. Although

there was a good spread of individuals from different stakeholder groups, focus group participation was limited to people who could attend the discussion event in person in the United Kingdom. This may limit the representativeness of the study. Therefore, further studies could be conducted in different contexts and regions (especially those that host or are more accessible to more supply-side stakeholders), or in a manner that could enable geographically dispersed participation.

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