

SUSTAINABILITY ISSUES IN TEXTILE AND APPAREL SUPPLY CHAINS

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ABSTRACT

Sustainability is a major concern for the textile and apparel industries, and although awareness has increased recently, more has to be done. Numerous detrimental consequences of the textile and apparel industries exist for the environment. They include an excessive dependence on water and energy resources, the use of dangerous chemicals in the production process, and the challenge of proper disposal. Fast fashion has made the problems worse because each year millions of tonnes of clothing are thrown away. There are several barriers in the supply chain, which makes it difficult for the industry to adopt greener practices. This study was able to determine the many obstacles that the textile and apparel sector encounters when trying to apply sustainability at various phases of the supply chain management process by using secondary data analysis. It also examined a number of best practices employed by businesses attempting to embrace sustainability in the face of these challenges.

Keywords: Sustainability, Textile and Apparel, Environment.

Introduction

The textile and garment business is one of the most polluting sectors of the global economy [1], therefore sustainability concerns have garnered a lot of attention [2]. Implementing sustainability in textile and clothing supply chains is difficult due to geographically extensive and complicated global manufacturing networks, as well as the competing demands of cost and lead time [1,3,4]. When manufacture is outsourced to nations with cheaper labour costs, the process of converting raw materials into completed clothing has major detrimental effects on the environment and society. These effects include pollution of the air and water and the exploitation of human resources. According to the triple bottom line method, businesses should evaluate their activities' social and environmental impacts in addition to their financial results.

Furthermore, there is evidence that some customers are prepared to pay extra for sustainable textile and garment products due to growing sustainability awareness [5]. A variety of strategies have been implemented by apparel companies across all market levels, including luxury brand Louis Vuitton, fast fashion brand H&M, and outdoor wear brand Patagonia, to increase the level of sustainability in their supply chain management in order to meet stakeholders' growing expectations and lower the risk of negative social and environmental externalities [6–8]. The development of the textile and apparel supply chain now depends on being more sustainable. Several innovations and issues related to this objective, such as product returns, low-carbon supply chains, corporate social

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responsibility, sustainable design operations, and sustainable competition, have already been studied in academic literature [3,4,8–19]. However, in today's global textile and clothing sector, a lot of additional contemporary challenges pertaining to sustainable supply chain management remain to be thoroughly and further investigated.

An environmentally friendly technique of producing materials and procedures that guarantee all inputs and outputs are safe and healthy for people and the environment throughout their entire life cycle is referred to as sustainable textile production. The garment and textile industry in India accounts for around 2.3% of the country's GDP, 13% of industrial production, and 12% of export earnings. India accounts for 4% of the global textile and apparel market. India's textile and apparel industry employs 100 million people in associated businesses and 45 million directly, making it the country's second largest employer. India is predicted to manufacture \$250 billion worth of textiles by 2030, with \$100 billion going towards exports.

Sustainability Issues in Textile and Apparel Supply Chains

In order to gain a deeper understanding of sustainability challenges, Köksal et al. [20] and Yang et al. [21] summarized pertinent research on sustainable supply chains for textile and apparel and conducted extensive literature reviews. A thorough map of the social dimension of sustainability was suggested by Köksal et al. [20] in their literature assessment on social issues in the textile and apparel supply chain. They maintained that in order to lower societal risks, clothing and textile corporations must work with their suppliers.

Yang et al. [21] conducted a comprehensive assessment of sustainable retailing in the fashion sector and discovered that the most popular topics covered in the literature are eco-labeling, fast fashion, slow fashion, green branding, and disposable fashion. They found potential for research in the areas of reverse logistics in fashion retailing, e-commerce emerging retailing, and second-hand fashion retailing.

Following the triple bottom line theory—which refers to the three pillars of profit (economic), people (social), and planet (environment)—will help develop a sustainable supply chain for textiles and apparel. The evaluation and selection process for green suppliers in the global apparel manufacturing industry was studied by Guo et al. [22]. Following the development of a methodological framework based on the triple bottom line for the assessment and selection of green suppliers, they put forth a fuzzy multi-criteria decision-making model for the assessment and selection of the top material suppliers. To confirm the efficacy of the suggested supplier evaluation and selection model, a sensitivity analysis was done.

Kim and Kim [23] examined information about sustainability in the textile and clothing industries from news stories and company annual reports. For textual and rhetorical analysis, they employed DICTION, a dictionary-based text mining programme, and Leximancer, a computer-based content analysis technique. In addition to identifying cross-cultural differences between North American and European sources—North American firms exhibit relatively high commonality, while European firms exhibit relatively high realism—they also found that the contents of their sources were consistent with the idea of the triple bottom line.

In order to better understand how organisational performance is impacted by the triple bottom line, Lee and Ha-Brookshire [24] looked at a number of characteristics related to fashion retail enterprises, such as the ethical climate, employee attitudes towards their work, and employee turnover intention. Using structural equation modelling, data from 278 fashion retail employees in the United States was examined. They discovered that all three aspects of the triple bottom line—as well as the work attitude of employees—can be improved by an ethical workplace culture. The findings suggest that an ethical workplace culture can enhance an organization's sustainability performance in addition to employees' attitudes towards their work.

The creation of a closed-loop supply chain is a crucial sustainability metric. Norum [25] used a qualitative technique to study the consumer garment disposal process, interviewing 24 female American consumers in-depth and semi-structured. The use of "compensatory" and "non-compensatory" choice heuristics in decision-making, a "usable life" and the "personal nature" of clothing as obstacles to non-trash disposal options, and the necessity of "creating awareness" and "providing assurance" to promote alternative disposal modes are just a few of the significant themes that the author identified.

Yang and Dong [26] studied the use of recycled materials in the partial production of sustainable fashion goods. Customers who were concerned about the environment and typical consumers were both taken into account. According to their analytical findings, a company will become more sustainable and make more money if customers place a higher value on sustainable products. Additionally, businesses should give consumers enough sustainability information if educating ordinary consumers to be environmentally conscious won't be too expensive. This would inspire all consumers to act sustainably.

Li and Wu [27] looked at how changes in a company's profitability, sales, and operational efficiency are impacted by the implementation of an environmental management system (EMS). Using an event research methodology, they examined 22 instances of EMS adoption in China and discovered that the use of EMS reduced the profitability, sales, and inventory productivity of businesses. It was discovered that the requirements of the EMS adoption were the cause of losses in operational flexibility and efficiency.

Le and Wang [28] employed window analysis to identify performance trend over 12 years (2010–2021) from a large number of inputs and outputs, and then used grey prediction to project productivity for the 20 largest firms over six years (2016–2021) based on actual data. They projected that the stability of textile firms' supply of raw materials for the industry as a whole will increase.

Sustainability performance is heavily influenced by supply chain leadership. An analytical model was created by Niu et al. [29] to investigate the effects of suppliers' loss-averse attitudes on the sustainability and profitability of the fashion supply chain. After analysing repurchase contracts and wholesale prices under different power arrangements, they discovered that buyback agreements can weaken the supply chain's sustainability. In the meantime, in the supplier-as-leader scenario, the sustainability index rises, but in the retailer-as-leader scenario, it falls. The sustainability level rises when the supplier takes the lead and the buyback price falls below a certain threshold.

From a power perspective, Shi et al. [30] assessed the fashion supply chain's environmental and economic performance. According to their analytical findings, the follower with less supply chain power is more likely to engage in sustainable practices and turn a profit. The ideal level of sustainable investment is typically higher in the case of the clothing maker than the retailer.

The process of adding value to the textile and apparel supply chain involves integrating sustainability. Through semi-structured interviews, LoMonaco-Benzing and Ha-Brookshire [31] investigated the moral values of individuals and companies involved in the textile and apparel supply chain. Three gaps were found: the kind of value gap, the irritation caused by the gap, and the methods for managing the gap.

Using Stella McCartney and her parent business Kering as a case study, Yang et al. [32] assessed the value generating mechanism. They expanded our understanding of value co-creation beyond co-creation with customers to include co-creation with many stakeholders by creating a revolutionary paradigm for sustainable value creation. Systematically and empirically, the components and particular practices of sustainable value co-creation processes are identified.

Oelze [33] conducted research on the consensuses that exist on the obstacles and facilitators to the implementation of sustainable supply chains in the textile sector. Through a case study involving 23 interviews with ten different textile companies, the author demonstrated how cooperation can facilitate the implementation of sustainable policies and lower obstacles. External pressure might also encourage proactive adjustments and supply chain transparency.

Lastly, Chen et al. [34] gathered information from both blue-collar and white-collar workers to investigate the issues, satisfaction levels, and attitudes towards decent work in the Chinese garment manufacturing business. The findings show that attitudes towards decent labour are highly influenced by age, education level, and duration of service. Their research offered valuable perspectives on the advancement of social responsibility within the Chinese apparel manufacturing sector.

Best Practices in Textile Industry

The utilisation of natural resources has increased within the last few years. The chemicals used in the textile industry are currently causing rising water contamination, which is the cause of the current water shortage. The wet treatment of textiles makes substantial use of fossil fuels. The

high carbon content of fossil fuels causes them to react with oxygen to produce carbon dioxide, which is one of the main causes of global warming. The garment industries must also eliminate environmental dangers and improve production efficiency. Numerous businesses have received recognition for their efforts to maintain sustainability in the supply chains for textiles and clothing.

Here are some companies that were known for their commitment to sustainability in the textile and apparel industry:

- **Patagonia**
 - Known for its strong commitment to environmental and social responsibility.
 - Focus on using organic cotton, recycled materials, and fair labour practices.
- **Eileen Fisher**
 - A leader in sustainable and ethical fashion.
 - Emphasis on organic and sustainable fibres, responsible manufacturing, and recycling programs.
- **Adidas**
 - Implementing sustainability initiatives, including the use of recycled materials in their products.
 - Commitment to reducing carbon emissions and water usage in their supply chain.
- **Nike**
 - Engaged in sustainable practices, including the use of recycled materials and reducing environmental impact.
 - Focus on innovation for sustainable products and transparent reporting.
- **H&M**
 - Working towards a circular fashion model, with initiatives like garment collection for recycling.
 - Commitment to using sustainable and organic materials.
- **Levi Strauss & Co.**
 - A pioneer in sustainable denim production.
 - Focus on water conservation, reducing chemical usage, and promoting worker well-being.
- **PUMA**
 - Implementing sustainability initiatives across its supply chain, including using more sustainable materials.
 - Commitment to environmental and social responsibility.
- **VF Corporation (owner of brands like The North Face and Timberland)**
 - Focus on responsible sourcing, reducing environmental impact, and promoting fair labour practices.
 - Commitment to sustainable materials and supply chain transparency.
- **REI**
 - Commitment to sustainability and environmental stewardship.
 - Emphasis on responsible sourcing and reducing the environmental impact of products.
- **Wrangler**
 - Known for its sustainable denim initiatives, including water conservation and responsible cotton sourcing.
 - Commitment to improving the environmental impact of the denim industry.

Initiatives by Fashion Brands

Here are the initiatives implemented by fashion brands in the realms of recycling, reuse and repair (Table 1).

Table 1: Selected fashion brands’ recycling, reuse and repair initiatives

Category	Brand	Content
Recycling	<ul style="list-style-type: none"> Patagonia Puma Salomon On 	<ul style="list-style-type: none"> Collaborate with Carbios SA, a French enzymatic recycling startup, to recycle polyester with various yarn compositions
	<ul style="list-style-type: none"> Adidas 	<ul style="list-style-type: none"> Launched “Made to be Remade” line of recyclable single-fiber products
Reuse & Repair	<ul style="list-style-type: none"> H&M 	<ul style="list-style-type: none"> Established Looper Textile Co., selling unwanted garments to second-hand businesses and recyclers Launched rental and repair services
	<ul style="list-style-type: none"> Nudie Jeans 	<ul style="list-style-type: none"> Offers free repair service Offers a 20% discount for trading in old jeans
	<ul style="list-style-type: none"> Levi’s 	<ul style="list-style-type: none"> Has tailor shops worldwide and DIY videos for repair, alteration and repurpose
	<ul style="list-style-type: none"> Eileen Fisher 	<ul style="list-style-type: none"> Launched its take-back programs for repairing, reselling, remaking, or down cycling them

Recycling

Fashion firms that do not provide priority to quality, durability, and recyclability during the product’s design and manufacturing stages face criticism from the European Commission [37]. Less than 1% of clothing materials are recycled into new clothes, despite the fact that recycling is one of the essential steps for the fashion sector to move to a circular economy [36]. Mixed-material clothing is challenging to recycle [40], which highlights the need for the creation of cutting-edge recycling technology.

Several fashion firms have joined with startups that specialise in recycling technologies in order to improve their recycling process. In the case of sportswear, for example, four American, German, French, and Swiss brands—Patagonia, Puma, Salomon, and On—have partnered with Carbios SA,[35] a French start-up that provides an enzymatic recycling process for polyester [38]. By depolymerizing the polyester included in the materials, the method makes it easier to recycle textile waste with a variety of yarn compositions[35]. These initiatives align with the businesses’ plans to transition to a more circular business model. Puma intends to increase the utilisation of recycled polyurethane, cotton, rubber, and leather by 2025.

As evidenced by Adidas’s introduction of a single-fiber product line under its “Made to be Remade” slogan, products using a single material can also be considered recyclable [38, 40]. Adidas has successfully discovered technology to make 100% reusable thermoplastic polyurethane (TPU) footwear and apparel after ten years of research and development [38, 40].

Reuse & Repair

Another strategy to reduce textile waste is to reuse and repair textiles. One fashion company that has started offering reuse and repair services is H&M. In order to collect, classify, and resend worn and unwanted clothing, H&M and Remondis SE, a German waste management firm, teamed up to form Looper Textile Co. (Holger, 2023). The joint venture intends to sell textiles and old clothing to different recyclers and secondhand stores[38]. As part of its circularity promise, H&M has added repair and rental services in addition to selling old clothing to other companies [38, 40].

Similarly, Swedish denim jeans company Nudie Jeans sets itself apart from the competition by giving away free repair services and giving consumers who trade in their old denim products a 20% discount off their new purchases [41].

Levi’s, another denim manufacturer, allows customers to extend their denim items through alteration, repairs, or reuse of old ones through its tailor shops worldwide and DIY tutorials. Last but not least, since 2009, the American fashion designer Eileen Fisher has collected two million products through its take-back programme, of which one million have been donated, resold, or used for other purposes. Clothes can be worn more times before being thrown away as waste if certain practices are followed, such as renting, selling, and mending [39].

It’s crucial to remember that sustainability programmes are dynamic and that businesses may change their methods over time. It’s best to consult a company’s official sustainability reports, websites, or other reliable sources for the most up-to-date and comprehensive information on their sustainability

initiatives. Furthermore, industry rankings and certifications can provide light on a company's sustainability performance. Examples of this are the Fashion Revolution's Fashion Revolution Index and the B Corp accreditation.

As the discussion above makes clear, different fashion businesses are using different strategies to meet their circularity objectives. Like their European counterparts, many American fashion companies are leading the way in implementing strategies to improve the life cycle of their products and, as a result, lower the amount of trash generated by garments. There seems to be a growing trend among American fashion manufacturers and shops to embrace circular fashion in the near future.

Challenges and Future Research Direction

Using green technology enhances a company's standing with the environment, but it still poses difficulties for the producer, who requires outside funding and technical assistance.

A manufacturing company's implementation of a recycling programme faces a number of challenges, such as poor consumer demand for recycled items, a dearth of technology and equipment, and high production costs. Further investigation is necessary to ascertain methods for enhancing the financial advantages of gathering pre-owned garments and the effectiveness of collection within the clothing supply chain. In the green design movement, there should be more emphasis on the idea of redesigning to reduce barriers to eco-design, reuse, and recycling.

Life cycle assessment (LCA) depends on players in the supply chain exchanging honest and cooperative information. Future manufacturing and service industries may find ways to use Web 2.0, cloud computing, and the Internet of Things to overcome problems with supply chain information sharing. Compared to popular things, green clothes products are harder to find and more difficult to get in the mass market.

A lot of the time, a product's features are difficult for clients to understand or do not expressly indicate green product information. A green marketing strategy is based on a top-down approach that gives minimal consideration to suggestions and input from customers. Retailers have the power to compel producers to release environmentally friendly goods.

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