Clothing and Textile Sustainability: Current State of Environmental Challenges and the Ways Forward

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ABSTRACT

The global clothing and textile industry is facing immense criticism due to its enormous environmental pollution. While demonstrating a slow adoption, brands, retailers, and manufacturers are recognizing the unsustainable nature of the industry. Consumers, too, are also becoming more aware of the environmental issues of the industry. Policymakers are coming up with relevant regulations to set the industry into a sustainable direction. However, the plethora of information, ideas, suggestions, and strategies make it difficult to get a holistic idea of the environmental sustainability challenges that the industry is facing and the necessary actions it should take. This paper reviews the current state of environmental challenges, and the required actions articulated in the literature as related to the clothing and textile industry. Based on this review, suggestions are made for the key stakeholders of the clothing supply chain, and the profile of an environmentally sustainable clothing item is examined. The review revisits the complexity of the clothing supply chain and stresses the urgency of expediting actions.

KEYWORDS

clothing, textile, apparel, garment, sustainability

INTRODUCTION

The clothing and textile (CT) industry is one of the most polluting industries in the world. From raw materials extraction to the final disposal of garments, every stage of the clothing life cycle has a negative impact on the environment to some degree. Although many innovative ideas, thoughts, technologies, actions, solutions, and policies are available to minimize the negative impact of the industry, the industry is nowhere near to achieve a satisfactory environmental profile. The current sustainability score of the fashion industry is only 32 out of 100 [1]. If business-as-usual prevails, the fashion industry will use up 26 percent of the global carbon budget associated with 2 °C ceiling of global temperature by 2050, as targeted by the United Nations [2]. The fashion industry is responsible for 3-10 percent of global carbon emission annually [3-5]. Therefore, the industry must come up with green production strategies and innovative business models that can reduce its environmental burden and help achieve the desired climate target.

Although challenging to adopt by conventional businesses, such green production practices exist, such as eco-friendly fiber (i.e., organic cotton, lyocell, etc.), sustainable yarn (produced from recycled fiber or

consuming renewable energy), waterless dyeing (requiring no/little water), and sustainable packaging (made from recycled materials), etc. Similarly, many innovative business models are achieving popularity among consumer groups, such as circular fashion, subscription-based clothing (clothing rental), secondhand clothing, etc. However, these strategies and models are very inconsequential comparing to the scale and velocity of fast-fashion consumption (characterized by cheap price, shorter lead-time). This study investigates the environmental challenges of the CT industry and explores pathways towards a more sustainable production and consumption. In reviewing the literature, the following questions guided the researcher to synthesize the relevant information:

What are the environmental challenges of the CT supply chain?

What suggestions are articulated for creating a sustainable CT industry?

What makes a truly environmentally sustainable clothing product?

The review first outlines the CT supply chain and its environmental hotspots and then summarizes the key challenges in themes. Afterward, the required actions are discussed in light of those challenges and the recommendations are made for key stakeholders. Based on this discussion, the profile of a hypothetical sustainable clothing product is examined.

METHOD

In this study, a non-systematic literature review approach was applied, using searches in Google, and Google Scholar. The search terms included 'fashion sustainability', 'textile sustainability', and 'clothing sustainability'. The author made a conscious, joint, and iterative decision to consider an article as relevant. A non-systematic review often skips an organized method of identifying, compiling, and synthesizing the body of literature on a particular issue [6, 7]. Rather, the approach focuses on some key studies to summarize a particular issue and present the description of the findings from the studies reviewed. It is "largely based on a knowledgeable selection of current, high-quality articles on the topic of interest" [7, p. 2].

FASHION SUPPLY CHAIN

The fashion supply chain is globally stretched, complex, and fragmented [8]. Brands and retailers started exploring offshore production from the early '80s to take benefit of cheap labor cost and lax environmental regulations of the developing countries. Searching for new cheap manufacturing locations and "race to the bottom" (i.e., profit maximization and cost minimization) brought the businesses to the Far East, with China, Bangladesh, India, Vietnam, Cambodia, Myanmar, etc. being the leading suppliers currently. By implementing different trade policies, for example, Multi-Fiber Arrangement (MFA), North American Free Trade Agreement (NAFTA), and Generalized System of Preferences (GSP), the United States, and European Union (EU) regulated the industry for a while. However, once China joined the World Trade Organization (WTO) in 2001, global brands and retailers flocked *en masse* to China, gradually leading to the state of affairs today. In turn, developed countries like U.S., EU, Japan, etc. became the consumers (i.e., demand-side) and developing countries like China, Bangladesh, Vietnam, etc. became the suppliers (i.e., supply-side). For example, the U.S., EU (EU28), and Japan consumed 58.1 % of world apparel, whereas China, Bangladesh, and Vietnam together exported 43.8% of world apparel in 2019 [9]. From an environmental viewpoint, transportation, consumer use phase and the post-consumer waste-related negative impact became the burden of developed countries, whereas fiber production, materials processing, garment production, wastewater, solid waste and the related negative impact etc. became the burden of the developing countries. Although developed countries are managing negative impacts much better than the developing nations, the overall impact of the

fashion industry only grew bigger. For instance, the impact of the global apparel industry on climate change increased by 35 percent between 2005 and 2016 and projected to increase by 49 percent between 2016 and 2030 if business-as-usual prevails [4]. Each stage of the clothing and textile supply chain, as shown in Figure 1, either deteriorates or depletes natural resources in order to prepare the input for the next stage. Only the end-of-life can potentially produce raw materials (from recycling) and energy (from incineration) to be used further in the value chain.

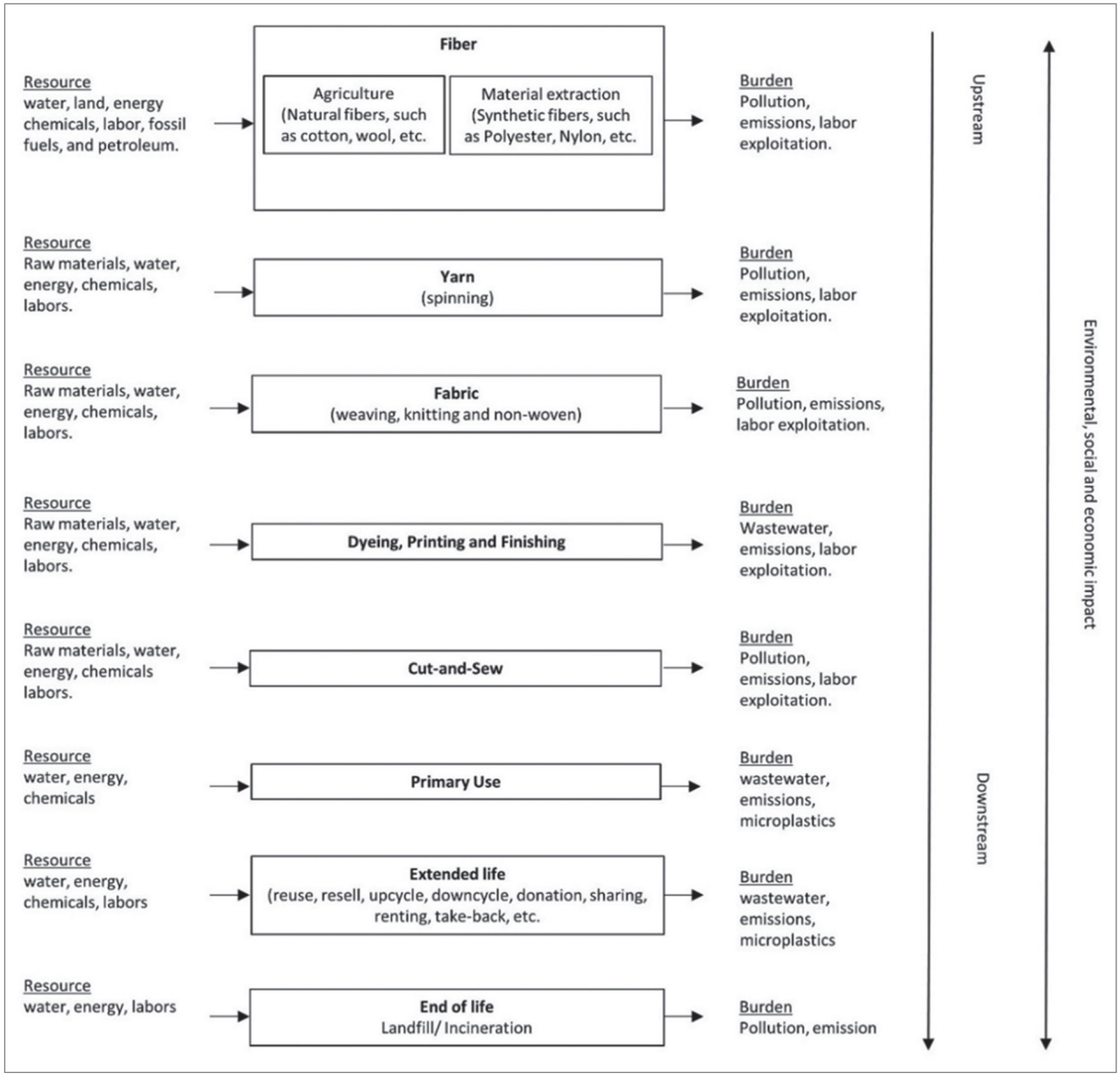

Figure 1. Resource and burden of clothing and textile supply chain

It should be noted that different stages of textile and clothing lifecycles have a different level of environmental impact (Table 1). For example, the cultivation of natural fibers consumes a large amount of freshwater, whereas yarn and fabric manufacturing consumes a vast amount of energy. Similarly, not all textile fibers have a similar level of life cycle impact. For instance, a cotton fiber consumes a vast amount of water to grow and be processed, whereas a polyester fiber consumes a significant amount of energy during its production. As a result, considering water issues, cotton is worse than polyester; however, polyester would be worse when considering energy issues. Considering all the life cycle stages, a polyester-made product

has about double the carbon footprint of that of a cotton-made product [10]. However, there are other impact categories besides CO2e, for example, acidification, eutrophication, ozone layer depletion, toxicity to humans etc. Therefore, it is difficult to compare between different fibers and different stages without assessing their whole life cycle impact in a comparable system boundary, unit, and impact category.

Table 1. Environmental hotspots of various life cycle stages of clothing and textile supply chain

	Life Cycle Stage	Environmental Hotspots	Source
Fiber	Natural fibers (such as cotton, wool, etc.)	Water, land, and chemicals (such as pesticides, insecticides, fertilizers, etc.)	[11,12]
	Synthetic fibers (Such as nylon, polyester, etc.)	Petrochemicals (non-renewable) and energy	[13-15]
Textile	Yarn manufacturing	Energy	[14-16]
	Fabric manufacturing	Energy and chemicals	[4, 17]
	Dyeing and finishing	Water, chemicals, energy, and wastewater	[14, 18]
Clothing	Assembly	Energy	[19, 20]
Consumer use phase	Primary use	Energy and microplastics	[21-23]
	Extended use (Such as reuse, reselling, upcycling, downcycling, donation, sharing, renting, take-back etc.)	Energy and microplastics	[24,25]
	End of life (either landfill or incineration)	Emission and groundwater pollution	[26]

Although the CT industry pollution is not obvious like mining, oil, or the automotive industry, the environmental impact of its value chain is massive. It is argumentatively the second largest polluting industry in the world [27]. However, the global share of the greenhouse gas emissions of the industry is yet to be confidently established, ranging between 3 and 10 percent with a high degree of uncertainty [5]. Figure 2 presents a profile of the fashion industry that gives a gloomy picture of its supply chain. As seen in Figure 2, the industry is characterized by global diffusion and *race to the bottom* state, with the production and consumption side predominantly divided by the global East and West. In addition, the CT industry is one of the massive polluters in multiple areas, such as freshwater consumption, carbon emission, water pollution, microplastic release etc. Moreover, clothing consumers are fast fashion-oriented (i.e., driven by cheap clothing items and the throwaway culture) and often involved in overconsumption. Between 2000 and 2015, global clothing sales have been doubled [2] and it is estimated that global apparel consumption will increase by 63 percent by 2030 [1]. If this profile of the industry does not change and current practices go on, the industry will have 1.5 times more impact on climate change than what its impact was in 2005 [4].

CHALLENGES OF FASHION INDUSTRY

Lack of Transparency

The further away the brand headquarter is from the supplier, the less controllable (i.e. less transparent) it becomes. In absence of a fully transparent supply chain, suppliers can cut corners through subcontracts, creating pretty much an unmanageable supply chain. As long as there is leeway for suppliers to cut corners, brands and retailers continue enjoying reduced prices, engendering many environmental issues along the way. That is exactly what happened in the fashion business over the last few decades.

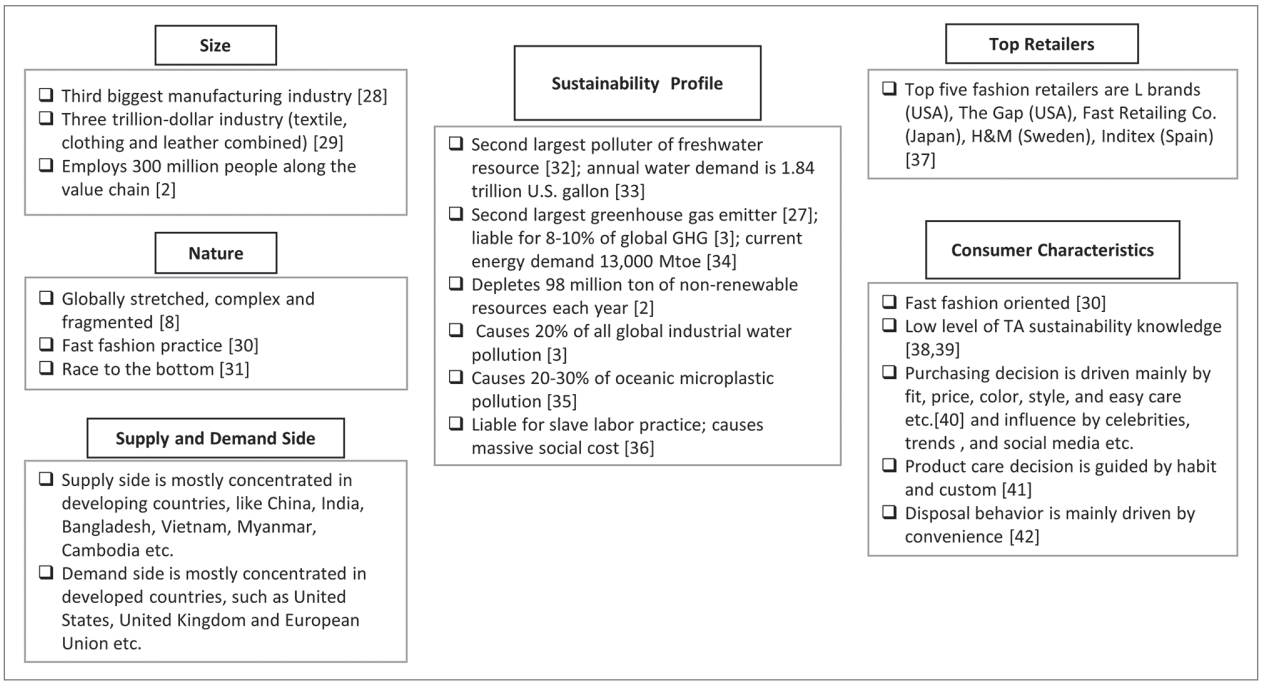

Figure 2. Profile of clothing and textile industry

The price of clothing dropped 53 percent in the UK market and 3 percent in the U.S. market between 1995 and 2014 [43]. This unrealistic push for cheap production with shorter lead-time from retailers led suppliers to press on employee wages and poor factory conditions in developing countries, culminating in a massive disaster like the Rana Plaza collapse in Bangladesh [36]. Yet, brands and retailers are still competing for cheaper products from developing countries, both in the existing and emerging markets, rather than offering suppliers a reasonable price and collaborating with them to build a sustainable infrastructure. For instance, between 2013 and 2018, five years period since the Rana Plaza collapse, lead retailer firms paid 13 percent less to Bangladeshi suppliers [44].

The fashion industry is cost-driven where the whole industry is competing to reduce the price. Any adoption of sustainable materials, processes, or technology immediately hits the economic bottom line of the brands. Although a narrow segment of consumers is willing to pay extra money for sustainable products, general consumers are not even aware of fashion sustainability [39, 45], let alone paying extra money. In addition, a holistic understanding and implementation of sector-wise sustainable practices are yet to be achieved because of the confusion, competition, resistance to change and complexity. On a local level, small-scale artisanal businesses, which are underpinned by craft skill, are thriving. These businesses use biomaterials, for example, natural dyes, and utilize local artisanal skills and are more transparent. Small groups of educated consumers wear their products to oppose the current trend of the unsustainable fast-fashion industry [46]. On a global level, due to the disjointed supply chain, most brands and retailers do not fully know who makes their products and in what condition. Many suppliers in developing countries execute orders with the help of subcontractors, making it difficult for the brands to ensure supply chain transparency [47].

Inadequate Collaboration

Since the fashion supply chain is globally stretched and complex, the responsibility of taking sustainable action is also complex and requires global collaboration. Both the supply and the demand-side actors of the clothing chain need to take responsibility. Neither is it possible to bring the desired change by the consumers

alone, nor is it possible by the brands and retailers alone. A combined effort from all parties is necessary with firm global and local public and private initiatives inspired by pro-sustainability ethics [8]. Without changing the current norm of production processes and patterns of consumption, the environmental cost of the industry will continue to increase [3].

Working towards a sustainable clothing supply chain needs massive collaboration of all parties involved. On one hand, brands and retailers need to push the suppliers to carry operations sustainably. On the other hand, suppliers need to be pushed by the local governments to conduct business within an acceptable sustainability guideline. In the same way, the local government needs to be guided by international bodies to align environmental regulations with global science-based targets (SBT). However, if the sustainability ethos is present at the individual level, nobody needs to push anybody to get something done in a certain way. For instance, if sustainability is ingrained in suppliers' business strategy, they do not need to wait for the buyers to tell them what to do and how to do it. Therefore, businesses need to be proactive in doing business sustainably. They should seek after and adopt the best sustainable strategies on their own, rather than have outside bodies telling them what to adopt.

Although various institutions, organizations, centers, and non-profits are working on an individual level or with some collaboration, a global-level industry-wide collaboration is missing. For instance, the Center for Sustainable Fashion based at London College of Fashion identified eight key issues to deal with as related to fashion sustainability. Ellen MacArthur Foundation (https://www.ellenmacarthurfoundation.org/) is working towards a circular fashion. UN Alliance for Sustainable Fashion (https://unfashionalliance.org/) commits to ensuring sustainable development through 'coordinated action in the fashion sector'. Fashion Revolution's, a non-profit entity (https://www.fashionrevolution.org/), campaign, #whomademyclohtes, has brought transparency to the forefront of discussion. Yet, a global-level industry-wide central monitoring and governing body is imperative to drive the industry to hit the desired target.

Need for Conscious Consumption

The consumer has a major role to play in making the fashion industry sustainable. They need to consume reasonably (i.e. avoid overconsumption), prefer durable apparels (i.e. avoid fast fashion), care for the apparels consciously (i.e. washing and drying properly) and dispose of in an appropriate way (i.e. reusing and recycling). Knowledge of the impact of their actions is the key to the consumers taking proper action [48]. However, due to the attitude-behavior gap in consumer behavior [45], providing them with increased knowledge of sustainability issues might not drastically change consumer purchasing behavior. Rather, brands and retailers can influence change in consumer purchasing behavior by offering different value propositions, changing the pace of product offerings, and utilizing their marketing expertise [2]. Besides, local governments, media (both traditional and social media), NGOs and non-profit and international organizations should disseminate relevant information in an accessible way to the consumers. There need to be appropriate measures to make an active fashion consumer, taking responsibility for their actions associated with clothing.

Responsible consumers need support from their cultural mechanisms as well, in order to act. In that sense, the ways to reduce consumer demand on fast fashion are debatable. There needs to be a cultural and behavioral shift. There also needs to be a paradigm shift. A circular production and economic system are needed in place of today's linear system. Technological innovation, supply chain transparency, and other such initiatives will not work if the industry produces more and more clothes in a linear system of business. Simply put, shifting towards sustainability is not a one-man task; it requires a concerted effort. Society needs to reevaluate the way economic growth happens and the natural resources consumed in the process of that

growth. Natural resources are limited, whereas economic growth is not. Does it mean we will continue enjoying economic growth until all the natural resources are gone? Then what?

Lack of Designer Engagement

About 80 percent of environmental impact and costs are the outcome of the decisions made in the design phase [49]. Increasing garment longevity lies in designers' hands. They decide on how emotionally attached consumers will be with apparel, what material to use, and how long the product lasts in terms of its appeal. The designer's knowledge of sustainability and a pro-environmental mindset is the key to this. However, working in a competitive market where designers follow the command of high-ups restricts them to follow their sustainable agenda.

In today's fast fashion culture, propelled by cheap price and shorter lead-time, designers are busy with making low priced trendy designs. Not all designers have sufficient knowledge and resources to design for the environment. Since the average number of fashion collections for European brands has doubled in the last decade [43], designers' productivity is presumably measured primarily by the ability to design intended products fast, not by how much environmental consideration is spent in designing. As a result, designer engagement in making sustainable fashion products seems to be enormously lacking.

WAY FORWARD

Renewable Energy and Energy Efficiency

Most of the environmental impact of the clothing supply chain comes from non-renewable energy-related greenhouse gas (GHG) emission. Fiber production, including polymer extrusion for synthetic fibers and agriculture for natural fibers, is the largest contributor to the clothing carbon footprint [15]. Textile production generates 1.2 billion tons of CO_2e annually, more than international flights and maritime shipping combined [2]. Considering the full life cycle, the annual carbon footprint of the fashion industry is 3.3 billion tons of CO_2e [44]. The textile industry depletes 98 million tons of non-renewable resources each year, including oil, in the production of synthetic fibers, fertilizers for growing natural fibers and chemicals for producing, dyeing, and finishing purposes [2], in order to produce about 80-100 billion pieces of clothing annually [50]. The impact of the global apparel industry on climate change is projected to increase by 49 percent between 2016 and 2030 if business-as-usual prevails [4]. Therefore, it is very urgent to identify energy-intensive hotspots in different stages of the clothing supply chain and make a transition to renewable energy. Especially, current oil-based synthetic fibers (i.e., polyester, nylon, etc.) need to be replaced by alternative sustainable fibers offering similar properties. Similarly, energy-intensive stages, for instance, the spinning and weaving sector should reduce their dependency on non-renewable energy and make a hasty transition to renewable energy. However, it is worth noting that this transition is not going to be easy considering the limitations of energy alternatives in various geographical locations.

Eco-friendly Raw Materials

As stated above, using eco-friendly raw materials can reduce a good share of negative impact along the supply chain. Oil-based synthetic fibers should be replaced by plant-based materials because of their comparatively low carbon footprint. For instance, the projected demand for polyester fiber by 2030 is about 70 million tons [51] and polyester has double the carbon footprint of that of a cotton shirt [10]. In the case of other innovative sustainable fibers, this number might go lower. Therefore, plant-based alternative fibers need to

be explored more. Anyway, the cultivation and processing of those natural fibers should also include eco-friendly strategies in order to reduce the overall environmental footprint. For instance, cotton cultivation consumes 11% of all pesticides and 24% of all insecticides produced globally [52]. There are about 3,600 different types of textile dyes in the market and the textile industry uses 8,000 different chemicals in the dyeing and finishing activities [18]. Most of these dyes and chemicals are harmful and have a tremendous environmental cost. Therefore, plant-based fibers might not be the best case if agriculture and processing are not managed well. Sometimes, the majority of the negative impact happens in later life-cycle stages of certain fiber types [21]. As a result, life-cycle impact assessment is important to understand the holistic impact of each fiber type, take the right action, and chose among alternative material options.

Circular Fashion

There is an ongoing movement to make the fashion value chain circular. Circular fashion is based on the 'closed-loop' or 'cradle-to-cradle design' principle, which requires a complete overhaul of the current linear (i.e. take-make-waste) system. In order to make fashion circular, the major contribution needs to come from the designers. Most of the environmental impact and costs are the outcome of the decision made in the design phase [49]. Therefore, designers need to be circular fashion-minded. In addition, purchasing and consumption patterns of consumers need to be changed to make circular fashion succeed. This could be achieved through education, such as including curriculum on circular fashion in academic programs offering fashion studies or instilling a sustainability mindset early in the age. For instance, the *Amsterdam Fashion Institute*, the largest fashion institute in the Netherlands, collaborated with *Circle Economy* (https://www.circle-economy.com/) and *Fashion for Good* (https://fashionforgood.com/) to offer the world's first master's program in circular fashion [53]. Likewise, the University of Arts in London created the *Center for Circular Design* in order to accelerate circular technologies, economies, and communities worldwide [54]. Many other programs incorporated circular design in the curriculum, such as the MA Fashion Futures course at London College of Fashion, Sustainable Fashion Academy's online course on The Sustainability Fundamentals, etc. Apart from educational programs, there are other initiatives, such as Redress Design Award (https://www.redressdesignaward.com/), a sustainable design competition, which educates emerging designers to drive a global circular fashion system. Similarly, *Friday's for Future* campaign (https://fridaysforfuture.org/) encourages school students to take time off on Friday to participate in a demonstration, demanding action from policymakers to fight climate change. Besides, a robust infrastructure is needed in order to close the loop of fashion. However, if the CT industry does not switch to renewable energy and the consumption pattern of consumers does not change, circular fashion alone will not bring a tangible outcome [4]. Therefore, the CT supply chain needs to become circular as well as shift to renewable energy consumption.

Product longevity

Product longevity and a longer use of fashion clothing items can reduce environmental impact significantly. Allwood et al. [21, p. 40] reported, "Extending the life of clothing so that demand for new products is reduced by 20% leads to a reduction of about 20% in all measures in the producing country". Other studies also reported the benefit of a direct reuse of clothing [55, 56]. Using second-hand clothing that can reduce the need of 1 kg of virgin cotton fibers might save 65 kWh and up to 90 kWh for polyester [57]. However, a longer use of quality products is in direct conflict with fast fashion, which promotes throwaway culture. Therefore, for driving the consumers to use their clothing for longer there needs to be a major cultural, habitual, behavioral and economic shift. In order to extend the garment's useful life, the physical durability

of the products might not be the only solution. There needs to be some type of consumer attachment to the product. Designers might approach two strategies: emotional durability and co-creation. Emotional durability can be achieved by offering the right fit, transparency of production, brand loyalty etc., while co-creation is the strategy of involving consumers in the designing of their own clothes [58]. Co-creation provides a consumer with a unique opportunity to make the products they will keep longer by collaborating with brands through some kind of a platform.

Supply Chain Transparency

Supply chain transparency is crucial for multiple reasons. It gives brands and retailers good control over supply chain optimization, helps improve brand loyalty of consumers, and identifies risks, to name a few. The most important aspect of supply chain transparency of the CT industry is that it will drastically reduce the undocumented subcontracting, and thereby those less visible social and environmental costs of the business. In many of the developing countries, subcontracting is prevalent among suppliers. There should be a proper guideline for subcontracting and transparent disclosure of it. Apart from subcontracting, supply chain transparency is needed to ensure proper identification of what materials are being used and who is making the products. Ensuring these two aspects is the key to take care of many social and environmental issues.

Conscious Consumer

Above all, there is no better way than consumers being conscious of their purchasing, care, and disposal behavior. A popular approach to making conscious decisions in clothing consumption is *Slow Fashion*. The movement focuses on informed and careful consumption by consumers [59]. In a slow fashion mindset, consumers value the quality over quantity, tradition over speed, and ecological well-being over resource-depleting growth. The consumer purchasing decision is the biggest driver of product demand. In today's social media era, electronic word of mouth (eWOM) goes viral in no time. Therefore, by creating market demand for sustainable fashion through objective communication and spreading knowledge in social media, consumers can drive the brands towards sustainable fashion [60]. Various social media platforms, like Facebook, Twitter, Blogs etc. can make a great impact in this regard. Especially, bloggers and other opinion leaders can disseminate relevant information over these media [61].

The use phase (washing, drying, and ironing) is an important stage of the clothing life cycle. For certain fabric, for example, cotton, the use phase contributes most of the carbon footprint [21]. Therefore, consumers need to be educated regarding the proper care of the garments. In addition, a more sustainable washing machine needs to be promoted. Another great problem associated with the clothing use phase is microplastic pollution. Each year half a million ton of plastic microfibers, equivalent to 50 billion plastic bottles, are released into the ocean from textile washing activities [3]. About 20-30% of the primary source of microplastic pollution is synthetic clothing [25]. One washing of 6 kg load might release about 700,000 fibers [22]. Three interventions were suggested by the House of Commons Environmental Audit Committee [44] to reduce microplastic release from apparel washing:

a) Change in the yarn and clothing design/construction
b) Modification in the washing technology, for example, improved filtering system and
c) An improved filtration system in the wastewater treatment process.

SUGGESTIONS FOR KEY STAKEHOLDERS

One can easily understand that making fashion sustainable requires a massive level of global collaboration, as well as a cultural and economic shift. A plethora of information and strategies is available, which makes it even more confusing to come up with a unified goal for both the supply and the demand-side stakeholders. There is an urgent need for a central governing body, which would set up global guidelines, frameworks, and targets, as well as hold accountable different supply chain players. As such, the following suggestions can be made for various authorities:

International bodies

- Impose a tax on natural capital usage through a standardized framework. This way, brands and retailers as well as manufacturers will be careful in using natural capital.
- Impose carbon tax on the emission of GHG gases. This way, manufacturers would be careful about their emissions.
- Accelerate the circularity of the business, because a 1% increase in the market of the circular model has the potential to reduce GHG emissions by about 13 million tons [5].
- Set up a framework on social media marketing strategies centering on fashion advertisements. Nowadays, social media is playing a big role in accelerating fast fashion, thereby overconsumption and waste [44].
- Ensure responsible consumption and production.
- Ban burning of unsold stocks of textile and clothing goods.

Buyer countries

- When imposing taxes, make a clear distinction between the brands and retailers who do the business sustainably and those who do not.
- Hold brands and retailers responsible to take care of the clothing waste they generate. Retailers should have a transparent account of the afterlife of the garments they are selling. The government should impose a tax on them in order to manage textile waste in a better way. For example, a charge of one penny to producers can generate a huge amount of money to take care of textile waste responsibly [44].
- Make it mandatory for brands and retailers to make their supply chain transparent. Brands and retailers must know which factory is making garments for them.
- Make it mandatory to publish corporate sustainability reports annually.
- Ensure an air-dry facility for the consumers on a community basis.
- Implement a door-to-door garment collection system on a community basis.

Supplier countries

- Ensure that factories are operating in a standard environmental and social framework.
- Discharge wastewater after treating it well (as per set standard).
- Offer solid waste treatment comparable to international standards.
- Ensure that factories are safe and the employees work in a safe condition.
- Ensure that factories are offering the employees a minimum wage set by the local laws.

Consumers

- Avoid overconsumption.
- Understand how overconsumption affects the environment and the society.
- Understand where the garments you buy were made and in what condition.

- Wear items for longer. If consumers do not want to use items that still have their useful life left, they should donate or sell them to their family, friends, and community through different channels, such as social media groups, thrift stores, secondhand stores, by swapping etc. Clothing reuse substitutes new purchases, leading to the reduced need for virgin material consumption and thereby potentially saving the environment [62].
- Care for the garments sustainably. In other words, they should follow the following steps during the care phase [23, 63]:
- Wash less if you can
- Utilize the full load of the machine
- Use cold setting (30 degrees or less)
- Use liquid detergent (because it is less abrasive)
- Use softener (because it reduces friction)
- Reduce spin speed (it provides less agitation)
- Dump lint fibers into the bin, not in the sink

WHAT MAKES A TRULY ENVIRONMENTALLY SUSTAINABLE CLOTHING PRODUCT?

Although the industry can follow many different strategies to do things in the right way, the question becomes what a truly sustainable clothing product is. It is almost impossible to produce a clothing item that is a hundred percent clean and green. A truly sustainable item does not exist in the market. What exists today are partially sustainable products. For instance, a clothing item might be made of organic cotton, but did not take care of the harmful production processes involved. Similarly, an item might be produced with zero-waste in mind, but with the usage of harmful chemicals in the dyeing stage. Therefore, it is important to look at the key steps that need to be in place to make a product fully sustainable. Looking at these steps again demonstrates how complex the supply chain is and how challenging it is to make sustainable clothing. Although it is not an exhaustive list, the key steps for producing a fully sustainable clothing item are the following:

- Made of 100% natural fibers, grown organically with the best available water and land management, locally produced and sourced if possible.
- The major stages (i.e. spinning, weaving, dyeing, and cut-and-sew process) are 100% renewable, energy-based and efficiently managed water, chemical and solid waste resources; carried out in a LEED-certified facility.
- Utilizing bio-based chemicals and dyes in dyeing, printing, and finishing operations. If synthetic dyes are used, only certified chemicals are used and managed properly. The wastewater is treated well before discharging.
- During the assembly process, zero-waste fabric cutting is adopted. Solid waste is managed properly.
- All the accessories' materials (i.e. buttons, threads, zippers, lace etc.) are sustainable.
- Utilizing a cradle-to-cradle design approach. The durable and emotional element is incorporated within the product by properly researching consumer data.
- The most sustainable shipping route is used (for exporting items). For instance, maritime shipping instead of airfreight.
- The final price of the product is calculated based on materials' cost, manufacturing cost, cost of natural capital, a penalty for resource depletion, and margin. The final price does not disregard the cost of externalities. A proportionate share of the profit made is spent in recompensing depleted natural resources.

CONCLUSION

This study conducted a review of the main body of literature concerning the current state of the CT environmental sustainability and the recommended ways forward. Through a non-systematic review, the study made a synthesis of the key studies and offered an insightful discussion regarding the CT environmental sustainability. The study also summarized the initiatives that various stakeholders may take and offered an ideal profile of a truly environmentally sustainable clothing item. The discussion revisited the complexity of the CT supply chain and stressed the need for an industry-wide collaboration as well as a central monitoring authority.

Understanding the environmental impact of the clothing life cycle and the associated processes is important to take corrective actions. The current understanding is very limited, as we do not have a comparative understanding of different textile materials. Only cotton and polyester fiber-related life- cycle studies are abundant, whereas other fiber-related studies are not comprehensive. With COVID-19 disrupting all aspects of life in 2020, there is no better time to take stern climate actions than now. This pandemic should make the world conscious about the impact of climate change. While in the case of COVID-19, society can continue to function to some extents, there would be a complete standstill in case of a climate-related disaster. Therefore, it is high time both the supply and the demand-side actors became conscious of the impact of their actions on the environment and the society. Brands and retailers should reduce the environmental burden from the top impactful areas, such as fiber production, spinning, dyeing and finishing, fabric preparation, and assembly [4]. In order to align with the industry-wide 1.5-degree climate target, the industry needs to cut its current level of emission in half [4, 5]. One of the potential pathways is to switch to either 78 %-renewable energy or 72 % energy efficiency to achieve the emission reduction target by 2030 [4]. Hence, there should be a coordinated effort to set industry-wide global targets and hold stakeholders accountable to align with that target.

Overall, the CT industry needs to resort to renewable energy, minimum use of fossil fuel, energy efficiency, and circular economy. Consumers need to consume consciously. Businesses need to value labor forces and should treat them fairly. Designers need to emphasize the durability of the product and map the possible materials required to make the product. They should have enough knowledge to choose from sustainable materials. In order to extend the garment's useful life, the physical durability of the products might not be the solution. Designers need to incorporate some types of consumer attachment to the product. Two strategies might be emotional durability and co-creation. Emotional durability can be achieved by offering the right fit, transparency of the production, brand loyalty, transparency of the place and the people making the products etc. Co-creation can be achieved by customers designing their products through some kind of a platform, adding their valuable input into the product so that they celebrate the product for a long time. However, any solution that compromises with the hedonistic and psychogenic pleasure consumers derive from clothing will not be viable. Potential solutions should be able to offer these opportunities to consumers as well as tackle the environmental impact. At the same time, any quick fix of the problem will create a problem shift, meaning somebody somewhere along the supply chain will pay the price. A new economic model needs to be in place, one that will support both sustainability and growth.

This study offers insight into crucial research directions. For instance, future studies should focus more on identifying the evidence of the environmental benefit of various strategies discussed in this study, such as the impact of different pathways of circularities on climate target, potential scenarios of modified consumer clothing-care behavior etc. Studies should also emphasize understanding the challenges and opportunities of supplier countries in coping with the accelerated climate targets. Furthermore, future studies should inves-

tigate how the social and economic dimension of sustainability evolves with different routes of achieving climate targets. Only a comprehensive benchmarking of the GHG emission of the CT industry, backed by scientific evidence, and coordinated actions will be able to put the industry on the right track.

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