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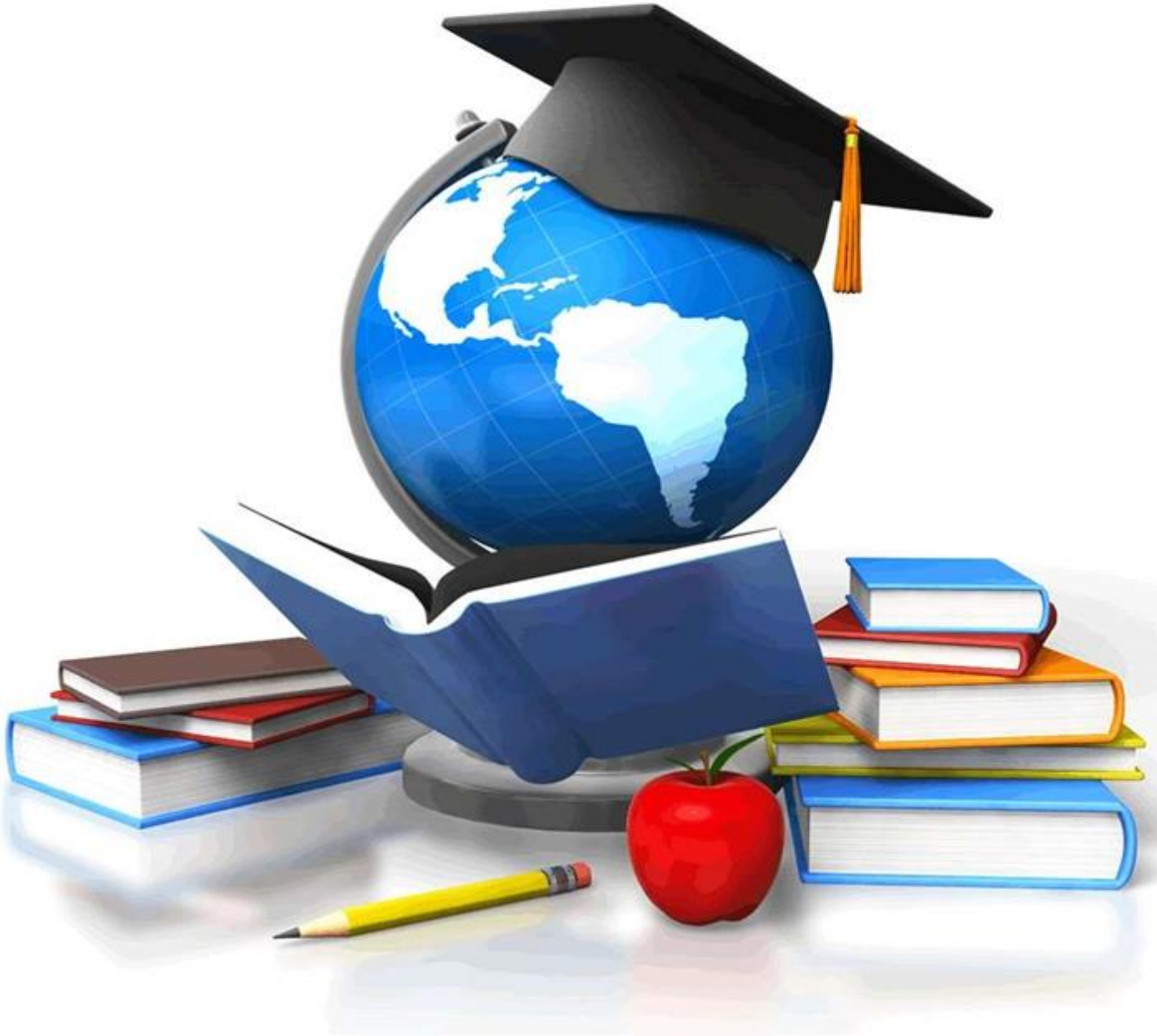

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The Performance of the Textiles and Apparel Sector and the Challenge of Environmental Sustainability in Ghana: A Qualitative Study

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Abstract

Purpose: The study assessed empirically how production and consumer behaviour can instigate the reduction of carbon footprint in the textiles and apparel industry to promote sustainable development.

Methodology: The study was predominantly qualitative with a sample size of 15 textiles and apparel manufacturers managers/owners were selected purposively from three regions of Ghana.

Findings: The results suggest that respondents hardly employ any strategy to facilitate environmental sustainability. Even though they are aware of the concept of carbon footprint, they lack the basic techniques to assess their environmental performance in terms of sustainability.

Unique Contribution to Theory, Policy and Practice: The study can significantly contribute to policy and practice in Ghana and elsewhere by shaping regulatory frameworks, encouraging sustainable business practices, enhancing education and training, guiding EIAs, and fostering consumer awareness.

Keywords: C*arbon footprints, greenhouse gas, textiles and apparel industry, environmental sustainability Ghana*

1. Introduction

The global textiles and apparel sector is a massive contributor to the climate predicament, and plummeting its effect is a necessity. The sector produces approximately 1.2 billion tonnes of CO_2 equivalent annually, more emissions than the freight and aviation industries combined (Peng et al., 2022; Chen et al., 2021; Ütebay et al., 2020). Consistent with a 2021 World Economic Forum report, the sector ranks third amongst eight (8) supply chains responsible for 50% of total greenhouse gas (GHG) emissions. The textiles and apparel sector contributed approximately 5% of global emissions in 2020 connoting the textiles and apparel sector's colossal effect on climate change.

In developed countries, corporate efforts are increasingly focused on understanding and addressing GHG emissions. As these efforts mature, more considerable attention is focused on GHG emissions throughout an organization's value chains and product life cycles, from the raw material extraction phase to disposal, as a complement to company-specific carbon footprinting (Brenot et al. 2019; Aivazidou & Tsolakis, 2019). Reasons for this focus include an interest among corporations in improving communications with consumers and other stakeholders and a desire to reduce GHG-related risks throughout the value chain.

The impact of the textiles and apparel industry on the environment, nevertheless, goes beyond emissions. Because the sector is a significant part of the world's economy, and according to the World Trade Statistical Review (2019) released by the World Trade Organization (WTO), the current dollar value of world textiles and apparel exports totalled $315 billion and $505 billion in 2018 respectively depicting an increase of 6.4% and 11.1% from 2017. This has been the most accelerated growth of the world textile and apparel sales since 2012 (WTO, 2019). Again in 2018, consumers around the globe spent $1.34 trillion on these products. If footwear and other accessories are included, that value increases to around $2 trillion (Euromonitor International 2019). To place this in a better context, the amount of currency consumers spend on apparel, footwear and jewellery each year is the equivalent to the combined gross domestic product (GDP) of the 126 most impoverished countries in the world or just slightly larger than the size of the Italian economy.

This massive amount of money spent on apparel results in mountains of clothes and shoes. It is estimated that globally, approximately 107 billion units of clothing and 14.5 billion pairs of footwear were purchased in 2016. This equates to every individual on the planet buying roughly 13 garments and two pairs of shoes 3, although buying patterns vary considerably between countries. These figures are estimated to increase. The number of items produced for the textiles and apparel market increased by 13% by 2021, equating to approximately 13 billion extra units. Given that this outweighs the estimated 8% market value increase, this increase points to a continuing ongoing shift in production towards lower-value items (WTO 2019). This translates into more GHG-related risks throughout the value chain.

Since textiles and apparel production continues to satisfy the ever-growing consumer cravings for fashionable products at low prices, the environment continues to deteriorate every time new textile production processes are initiated (Stall-Meadows & Davey, 2013). The begging question that necessitates substantiality practices is how knowledgeable producers and consumers are. That said, Kleinhückelkotten & Neitzke (2019) and Razzaq et al. (2018) infer that it is not enough to produce sustainable apparel and make eco-efficiency improvements in manufacturing processes if aiming to reach a more sustainable future.

Instead, the focus must be on people's consumption behaviour, and a new radicalism is needed to stimulate a drastic change in consumption patterns (Vita et al., 2019; Norum, 2018). Consumers themselves do not clearly see the connection between their own consumption behaviour and the environmental impact of increased industrial production, particularly in the Ghanaian context. Mylan (2019) maintains that radical innovations are needed that depend on technological development and changes and stimulate new interactions and partnerships between different stakeholders and new sustainable relationships between consumers and products.

Studies including Khandual & Pradhan (2019) and Niinimäki (2012) highlight that human aspects are essential in changing toward more sustainable societies. To gain more knowledge about societies, groups and individuals, one needs to approach individuals, consumption, and consumer behaviour through a socio-psychologically enriched understanding. Furthermore, this knowledge must be used in sustainable development processes. New socio-psychological insights into human attitudes and behaviour are desired to redefine key factors in eco-design and to include these factors not only in design but also in sustainable business. With this approach and development, it is possible to encourage new value formation for all parties, producers, retailers, consumers and societies (McLaren & Goworek. 2017).

The fashion discipline is far behind architecture or industrial design in producing scientific, environmental knowledge for production use. On the one hand, consumers in the textiles and apparel arena in developing countries are largely unaware of environmental issues. On the other hand, environmental issues are critical in textiles and apparel production and are everyday issues with significant sustainable implications (Lang et al., 2018; Cimatti et al., 2017). The environmental and ethical issues in the textile and apparel industry are complex, and traditionally they have been seen through a minimal lens by focusing on eco-materials or ethical manufacturing principles, for instance.

A more holistic approach is needed in this area. Therefore, it is essential to generate further knowledge not only on eco-materials, eco-efficiency in production, and ethical manufacturing but also on the consumers' relationships with products in the context of sustainable development. Mylan (2019) infer that new knowledge about consumption and its connection to sustainability problems is desirable. Frezza et al. (2019) underscored the importance of this consumer-centred knowledge that must be applied to production to foster more sustainable tendencies in

consumption. Rissanen & McQuillan (2016) infer that one approach to co-design and production optimizes a product's initial lifetime through a robust product-user relationship.

Nevertheless, conducting sustainable business in the textiles and apparel sector is challenging due to the nature of constantly evolving fashions as well as production practices. This suggests that a lot requires to be done in achieving strictly sustainable textiles and apparel that can satisfy all environmental as well as ethical issues. Nonetheless, however trivial, any move towards achieving environmentally responsible textiles and apparel is a commendable step. This is what the study attempts to accomplish. The increase in ethical and environmental awareness, particularly in Africa, should not just be seen as a responsibility of non-governmental organizations (NGOs) but also as a responsibility of and within governments and among the general population and consumers (de Villiers & Duh, 2019; Taljaard et al. 2018).

It is expected that consumers with more accurate information on the environmental effects of their consumption habits are likely to make a change towards more sustainable consumption patterns and to persuade and/or pressure concerned authorities to enforce legislation governing environmental issues in the textile and apparel industries (Clune & Zehnder, 2018; Chan et al. 2012). In Africa and Ghana, particularly, existing policies are mainly applicable to packaging, vehicles and electronic goods. There is hardly any legislation specific to textiles and apparel relative to sustainability practices in production and consumption.

The World Business Council for Sustainable Development, initiated in 1992 at the Rio Earth Summit, formed a foundation for stern campaigns toward sustainability. European legislation termed the 'Waste Framework Directive' was subsequently introduced in December 2008 to encourage consumers and businesses to recycle more textile and clothing waste. In 2009 the British Fashion Council launched a sustainable clothing plan. In Sub-Saharan Africa and Ghana specifically, very little information is available regarding sustainable textiles and apparel production and consumption.

Furthermore, climatic change is one of the many persistent problems confronting civilization. It is progressively being acknowledged as a momentous challenge. It is universally accepted that the greenhouse gas emissions caused by humans are harming the environment. The most vital GHG rising from human actions are carbon dioxide. Granting numerous gases exist in the atmosphere, the most well-known term often linked to these climatic changes in the GHG; this is responsible for trapping the thermal radiation from the sun within the earth's atmosphere and leads to what is acknowledged as the greenhouse effect. The components of the GHG are water vapour (H_2O), carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), ozone (O_3), and much more (Zanu et al., 2018; Wahlen., 1993).

As Wuebbles and Jain (2001) pointed out, each gas has distinctive greenhouse consequences on a molecule-by-molecule basis. Methane has a much more complex greenhouse consequence than CO_2. However, CO_2 is found in far more large quantities in the atmosphere than methane. Water

vapour is the most copious constituent of the greenhouse effect; however, its influence is very insignificant, equated to CO_2. Moreover, humans do not have adequate control over water vapour as they produce CO_2 emissions. Thus, most climatic change reduction concentrates on CO_2 emissions (Aivazidou & Tsolakis, 2019; Zanu et al., 2018).

The term 'carbon footprint' has increased in popularity over the past decade due to the growing public awareness of environmental matters and climate change (East, 2008). This term is presently extensively used throughout the media, government as well as the commercial world. The popularity of this concept is intrinsically associated with concern about increasing levels of CO_2 in the earth's atmosphere and the belief that rising concentrations of CO_2 have and will continue to alter the earth's climate (IPCC 2007). A way to track one's greenhouse gas emissions is to be aware of their carbon footprint. Carbon footprint is the entire amount of CO_2 and other greenhouse gases emitted over the entire life cycle of a process or product (Zanu et al., 2018).

Environmental impacts transpire at every phase of the life cycle of a garment. The textiles and apparel industry has contributed to global warming from the phase of raw material acquisition to the manufacturing of the clothing, its distribution and transportation to stores and customers, its use by the consumers and ultimately, the disposal of the product after use. Thus, granting the textiles and apparel industry has been subject to pivotal trends over the few decades; the industry has evolved into a complex, disjointed, global system that, at its very core, is based on the concept of continual consumption of the 'new' and the discard of the 'old'.

The emergence of the 'fast fashion' business model has further increased the introduction of trends leading to premature product replacement and fashion obsolescence. It also has significant adverse environmental and social impacts, particularly those at the bottom of the supply chain (Köksal et al., 2017; Bevilacqua, 2010). Delocalized production in emerging economies has become a predominant choice because of the low-cost labour and less stringent standards and regulations surrounding social and environmental issues (Allwood et al. 2008). This necessitates a study to assess empirically how production and consumer behaviour can instigate the reduction of carbon footprint in the textiles and apparel industry to promote sustainable development.

2. Literature Review

2.1 Processes associated with the production of textiles and apparel products

Textile products afford an integral element in modern society and a physical structure known for human comfort and sustainability. Humans are friends of fashion in nature. The craving for improved clothing and apparel occasioned the advancement of textile fibre production and the textile manufacturing process (Nayak et al., 2015; Ribeiro et al., 2015; Connell, 2015). Principally textile products meet the requirements for human consumption regarding comfort and aesthetic trends. Textile and apparel activities present different sectors, each with its traits. The extent of the textile process, as well as the variety of its technical progressions, lead to the synchronicity of varied sub-sectors regarding their business structure and integration.

Expressed by its fragmentation as well as heterogeneity, the textile and apparel sector comprise primarily small and medium firms, some of them exceedingly focused on explicit processes. Among the factors of its intricacy are the vast number of raw materials utilized in the production of fibres as well as the multiplicity of manufacturing processes (Lou & Cao, 2019; Bingham & Hague, 2013). Besides, the textile and apparel sector can be categorized severally conditional on the production process; the final products realized, etc. In the case of textile fabrics specifically, the process begins with the assemblage of natural fibres or non-natural or synthetic production.

Then, after the spinning process, it continues with the dispensation into textile flat structures, fabrics, woven fabrics, knitted or mesh, nonwovens, etc. (Jin & Cedrola, 2019; Zhang et al., 2018). The fabrics are then treated in finishing processes, such as dyeing or printing, coating, rolling or mechanical finishing, affording innovative properties to the fabric before converting them into apparel products. Production planning is a multifaceted part of any engineering operation. In textiles, planning is complex as there are diverse categories of fibres, yam counts, spinning systems, preparation methods, and end products. All of these features, combined with the consumers' demands for appropriately filled orders as well as short delivery times, make any production planning process in the sector more complex.

Furthermore, effective production planning in the textile and apparel sector has become increasingly critical as intense foreign competition has impacted the market (Bullón Pérez et al., 2016). Fabric manufacturing activities are progressively based on computational models that aid the prediction of the properties as well as the performance of the fabrics under consideration. Dissimilar computational tools have been applied to denote the fabrics in a computational environment and predict their final properties. The textile and apparel sector is progressively emerging proficient system applications to upsurge production, advance quality and reduce costs. Such structures evolve in various areas throughout the textile and apparel manufacturing process.

Thus, textiles, textile products, as well as apparel manufacturing industries comprise businesses that process fibre into fabric and fabric into garments and other textile products (Saxena & Khare, 2019; Bevilacqua, 2010). While most apparel manufacturers globally depend on individuals to assemble pieces of fabric together, in other industrialized countries, manufacturing is highly automated. The formations in these industries produce various items, some of which are retailed to the consumer, while others are vended as inputs for manufacturing other products (Debnath, 2019). Both natural and synthetic fibres are utilized to produce threads and yarns that may be woven, knitted, pressed or otherwise bonded into fabrics.

Finishes and coatings are applied to the fabrics to improve the decorative patterns interlaced into the fabric or to make the fabric more robust, stain-resistant, or have other desired properties (Adanur, 2017; Nechyporchuk et al., 2017; Wickramasinghe & Perera, 2016). Fabrics are utilized to make several products, such as awnings, tents, carpets and rugs, as well as a variety of linens, curtains, tablecloths, towels, and sheets. Nevertheless, the significant use of fabrics is to make apparel. Institutions in the apparel engineering industry produce numerous knitted clothing

products, including hosiery and socks, shirts, sweaters, and underwear. They similarly manufacture several cut-and-sew fashion items such as dresses, suits, shirts, and trousers.

There are basically three (3) individual industries in the sector, specifically, textile mills, textile product mills, and apparel manufacturing (Ute et al., 2019; Hodges & Link, 2018). Textile mills afford the raw materials required to make apparel and textile products. They take natural and synthetic materials, including cotton and polyester, and transform them into fibre, yarn, and thread. Yarns are strands of fibre in a form ready for weaving, knitting, or otherwise intertwining to form a textile fabric (Gong, 2017). They form the basis for most textile manufacture and commonly are made of cotton, wool, or synthetic fibre such as polyester.

Yarns can also be made of thin plastic, paper, or metal strips. To produce spun yarn, natural fibres like cotton and wool must first be treated to eliminate impurities and afford products the needed texture and durability, as well as other characteristics (Ute et al. 2018; Wang et al. 2016). After this initial cleaning stage, the fibres are spun into yarn. Textile mills then continue to produce fabric employing weaving and knitting. Employees in weaving mills use complex, automated looms to transform yarns into cloth. Looms weave or interlace two yarns so they cross each other at right angles to form a fabric. Knitting mills use automated machines to produce fabric of interlocking loops of one or more yarns.

Several processes, such as finishing, may be performed on the fabric during the production process. These processes, which comprise bleaching, dyeing, and stonewashing, among others, may be executed by the textile mill or at a separate finishing mill. Finishing involves chemical or mechanical treatments performed on fibre, yarn, or fabric to enhance appearance, texture, or performance (Maiti, 2018; Shen & Smith, 2015). Textile product mills convert raw textiles into end products other than clothing. Some of the items in this division comprise household items, including curtains, sheets, towels, rugs and carpets, cord and twine, furniture plus automotive upholstery, and industrial belts and fire hoses. Since the process of converting raw fibres into finished textile products is complex, most textile mills specialize (Kılınç et al., 2017).

On the other hand, the garment industry's products have an ephemeral lifecycle, as they are designed mainly by trends that stimulate consumers to renew their clothes every season and, therefore, reinforce the capitalist system structure (Garcia, 2021). There is an increasing number of initiatives that reflect the sustainable apparel concept. The sustainability process drives changes in the apparel sector, which deliberates on ways to reduce clothing environmental impact, elevating the role of designers as systemic change facilitators (Martin & Economy. 2013).

Sustainability in the apparel sector is about developing products with low environmental impact and high social quality, analyzing the criteria, methods and investments in the garment's lifecycle (Wren, 2022; Gonçalves & Silva, 2021). This requires designers to increase their consideration in all phases of the product life cycle, from the raw material extraction stage to the final phase of use, which needs to be considered as early as the beginning of the project, named stage of its

decomposition or discard (Dissanayake, 2022; Alonso-Muñoz, 2022). Ordinarily, 15 to 25 % of the fabric required to construct a garment is wasted due to deep-rooted and multifaceted conventions of apparel design, cutting, and production practices (Carrico et al., 2022; Ramkalaon & Sayem, 2021). In the case of outerwear for adults, the fabric wastage fluctuates between 10 to 20%.

Approximately 10% of wastage occurs for trousers, and higher percentages of wastage occur for blouses, jackets, and underwear (Patnaik & Tshifularo, 2021). In any case, 100% utilization of the fabric is not possible with traditional fabric cutting methods as a result of the irregularity in the shapes of the pattern pieces. The variation in the amount of waste (10-20%+) is dependent on numerous variables. They may include: the style of the garment, which includes the number, size, and shapes of pattern pieces; the number of the garment sizes and the expertise of the fabric cutter. After scrutinizing probable factors contributing to the wastage of fabric during the construction of clothes, it came to the light that fabric waste is considered only at the cutting and production phase in the manufacturing process (Fletcher. 2014).

To eliminate wastage, fabric waste needs to be considered right from the start and throughout designing and pattern cutting: garment design and subsequent pattern cutting direct the entire manufacturing process. Fabrics are the product of using vast amounts of water, chemicals, technology and labour. Therefore, viewing them as disposable is the beginning of a long streak of issues. Approximately 15-20% of the fabric used in the production of clothes ends up discarded and earmarked for landfill. Once there, the fabrics disintegrate and release greenhouse gases and chemicals and dyes into the surrounding environment and waterways. In a landfill's low-oxygen environment, fabric waste can take up to 200 years to biodegrade, polluting soil in the process (Chen et al., 2021).

With the increase in conscious consumerism, more designers wonder what to do with fabric scraps besides throwing them away (Fletcher, 2016). What is leftover should be reused; however, it is cheaper for most designers to dump the scraps than to reuse them. There are many ways to break from the cycle of fabric waste, and amply creative upcycling ideas for repurposing fabric remnants and off-cuts are available (Khandual & Pradhan, 2019).

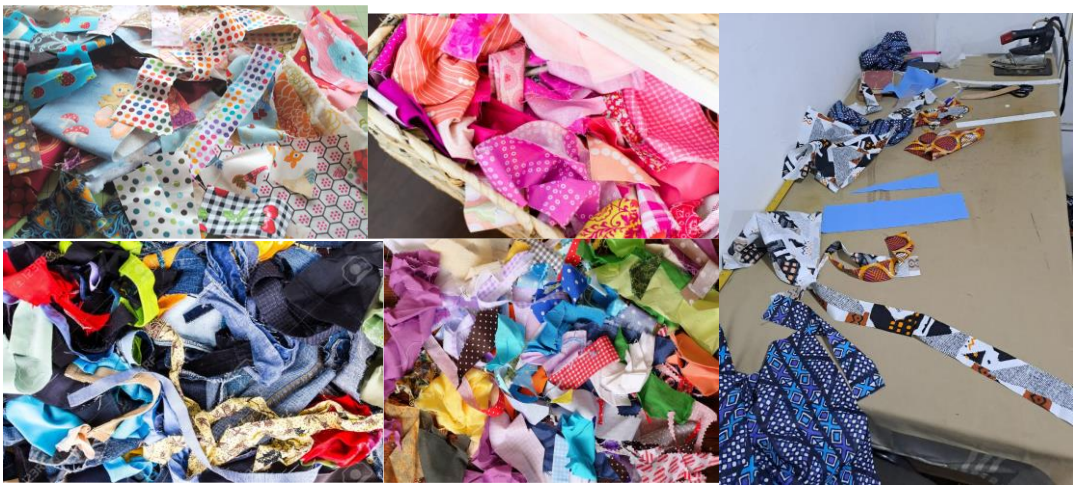

Plate 1: leftover fabric scraps

Like all wastes, fabric waste originates from the community via several streams, including the fibre, textile and apparel manufacturing industry, consumers, and the commercial and service industries (Jordeva et al., 2020; Rani & Jamal, 2018). These are defined as pre-consumer, post-consumer and production textile waste (Sinha et al., 2021; Bukhari et al., 2018). The characterization of fabric waste in the context of this thesis connotes fabric waste and garment left-overs from the production and sale of clothing (pre-consumer waste). Overall, a 'scrap' is a leftover piece of fabric which is too insignificant, on its own, to be utilized in another project by itself. The size of something that is considered beneficial may vary from seamstress to seamstress; nonetheless, on the whole, there are a few rules of thumb that can qualify a scrap for everyone.

Fabric waste suitable for redesigning or reusing can be separated into three categories based on its source, pre-consumer waste, production waste and post-consumer waste; (Leal Filho et al., 2019; Leonas, 2017). They each have different characteristics and potential for being reused.

Pre-consumer waste - Pre-consumer fabric waste is manufacturing waste generated by processing fibres, producing finished yarns and textiles, technical textiles, nonwoven garments and footwear, including off-cuts, selvedges, shearings, and rejected materials and/or B-grade garments. Whilst cabbage which is over-estimated fabric metres and off-cuts of saleable size, has for many years been resold into markets or made up into smaller items, most pre-consumer fabric waste is usually sent to landfills. Pre-consumer fabric waste is usually clean waste. Businesses either arrange their own waste disposal services or use council managed services and pay landfill fees according to how much is dumped.

Production waste - Production waste consists of left-overs from garment production, such as trimmings, proofs, leftover fabric, off-cuts, ends of rolls, etc. Production of a garment from fabric waste is difficult to use in upcycling because the volume produced is generally relatively small and irregular. Production waste that comes from the garment industry itself is a potential input for upcycling, meeting the requirement both in terms of quantity and quality (Ütebay et al., 2019).

Post-consumer waste - post-consumer fabric waste consists of any type of garment or household textile that the consumer no longer desires and resolves to discard, either because they are worn out, damaged, outgrown, or have gone out of fashion. This category has typically been likened to superior quality clothing that can be recovered and recycled by other users, like second-hand clothing, much of which is sold to developing nations. A garment that is unlikely to be worn again is hypothetically functional as it may be shredded into the fibre to be used in products similar in nature to those manufactured from pre-consumer textile waste.

2.2 *The carbon footprint of the textiles and apparel industry*

Currently, textile production is the world's second most contaminating sector after the oil sector. The total GHG emissions from textile production alone currently stand at 1.2 billion tonnes yearly, which is higher than all the international flights and maritime shipping collectively. It is also projected that the apparel sector is responsible for 10% of the global carbon emissions, and according to UNFCCC, the textile sector's emissions are expected to rise by more than 60% by 2030 if the shift toward a sustainable textiles and apparel industry fails to emerge momentarily (see Li et al. 2019; Fu et al. 2019; Saxena & Khare, 2019).

Again, the apparel sector epitomizes a yearly global turnover of about 160 billion Euros. It manufactures approximately 60 million tonnes of garments annually, which could reach approximately 100 million by the year 2030. The number of fashion seasons that have moved from two annually to as many as 50-100 micro seasons will be a vital influence behind the anticipated growth, which comprises production as well as consumption (Wu & Li, 2019; Fletcher, 2008). This segment, which engages about 60 million individuals worldwide, mostly in emerging economies, may celebrate this anticipated development. Nevertheless, the surge in appetite for fast, disposable fashion in developing countries will contribute substantially to unsustainable production and consumption of apparel (Lou & Cao, 2019; Calamari & Hyllegard, 2016).

In order to withstand itself in this competitive global market, the industry may compromise on sustainable production to curtail the production cycle and dump markets with innovative but cheap designs. Thus, the textile and apparel sector utilizes copious quantities of two things: water and chemicals, which is the leading industrial polluter of water in the world. Wet treatment of textiles, such as desising, prewashing, mercerizing, dyeing, printing etc., comprises loads of chemical applications on the fibre or fabric (Gulzar et al., 2019; Maiti, 2018).

Water is utilized at each phase in fabric manufacturing to soften chemicals used in one stage, to wash and cleanse those same chemicals to be prepared for the subsequent phase. Some fibres have to be bleached with chlorine before dyeing (Zhang et al., 2018; Ozturk et al., 2016). This causes organo-chlorine composites to be discharged, which are hazardous to the environment (Gong, 2017). It takes about 10% and 100% of the heaviness of the fabric in chemicals to produce that fabric. From dyes to transfer agents, about 2000 different variations of chemicals are employed in textile industries.

During the process of wet treatment, large quantities of fossil fuels are expended, and these have carbon content that reacts with oxygen to form carbon dioxide (Gulzar et al., 2019). This results in acidification, fossil fuel depletion and eventually global warming. Textiles need loads of energy to produce fabrics. In 2008, annual global textile production was estimated at 60 billion kilograms (KG) of fabric. The projected energy and water required to produce that amount of textile was a gargantuan 1,074 billion KWh of energy or otherwise 132 million metric tons of coal and between 6-9 trillion litres of water (Kumar & Joshiba, 2019; Zhang et al., 2018; Bevilacqua, 2010).

Consistent with approximations, textiles and apparel typically constitute around 4% of the secondary carbon footprint of an individual in the advanced world. Over 1 million tons of textile products are thrown away annually, out of which 50% are recyclable (Rathinamoorthy, 2018). These excesses necessities a landfill, and they do not decay fast. Woollen fashions, while decaying, create gases like methane which results in global warming. Apparel is accountable for almost one ton of each individual's CO_2 emissions.

2.3 The challenge regarding business and sustainability

The problem of sustainability is profoundly rooted in the Industrial Revolution. Businesses and industries have, for ages, taken advantage of natural resources to meet their requirements for energy and other raw materials. Prior to the Industrial Revolution, however, the pre-modern development situations were controlled by ecological factors (Bergquist, 2017). The post-industrial growth was positioned in an organic energy regime, based on human as well as animal muscle strength for mechanical power and on wood and other biomass for heat (Bergquist, 2017).

With the Industrial Revolution, the pre-modern development limitations were crossed when coal replaced firewood and charcoal. The primary technology that brought coal into the energy structure was the steam engine, which laid the basis for deepened industrial development, the growth of large organizations and exponential economic development based on fossil fuels (Bergquist, 2017). Essential inventions of the Second Industrial Revolution like energy, the combustion engine, and developments in the chemical industry incited economic growth driven by the development of large businesses (Bergquist, 2017). However, this correspondingly urged forward further ecological degradations, which from the 1950s started to accelerate enormously.

Various natural scientists proposed that the planet has entered a novel environmental phase, the supposed Anthropocene, as an effect of accrued human economic activity (Bergquist, 2019). The preceding phase, the Holocene, began 10,000 to 12,000 years ago when the climate became warmer and much more stable. It is argued that the Anthropocene began around 1800 with the inception of industrialization, with fast expansion in the usage of fossil fuels being its core feature (Ruddiman et al., 2016; Borzenkova et al., 2015). The 1950s, therefore, marked the commencement of the second stage of the Anthropocene. A phrase termed the Great Acceleration.

The Anthropocene plus Great Acceleration debate fundamentally draws attention to the explosion of population growth and unsustainable and exponential energy usage after 1945 and its negative

impact on the Earth system, most notably, climate change, the rate of biodiversity loss and phosphorus and nitrogen loads (Goudie, 2018). Fossil fuel-based capitalism, with its deep roots in the nineteenth and twentieth century, is integrated with this debate.

The concept of sustainable development has been copiously discussed, and unlike climate change, sustainability and sustainable development did not arise as a scientific concept. In the literature, the notion of corporate sustainability is still emergent (Whiteman et al., 2013; Bowen et al., 2019). Jones (2017) has proved that sustainability must be appreciated as a concept that has been socially as well as politically constructed, also by businesses and has mirrored the interests and principles of those entrepreneurs, social groups as well as involved firms.

For example, when sustainable development became extensively deciphered into business strategies in the 1990s, one crucial issue appeared regarding how to 'measure' sustainability, how to estimate and claim that a firm's practice or a product is 'green' and what standards should be utilized in weighing such claims (Jones, 2017). In responding to the sustainability challenge, corporate practices with climate change as its central issue involve an understanding of how a business has captured and constructed the concept.

3. Methodology

The study is predominantly qualitative, which focused on obtaining data through open-ended and conversational communication. Given that qualitative research is characterized by flexibility, openness, and responsivity to context, data collection and analysis steps are not as separate and consecutive as they tend to be in quantitative research (Busetto et al., 2020). Sampling, data gathering, data analysis and interpretation are related to each other in an iterative manner, instead of following one after another in a stepwise approach. The purposive sampling technique was used to select textile and apparel manufacturers in the Greater Accra, Ashanti and Northern Region of Ghana. A total number of 15 textile and apparel manufacturers managers/owners were selected. The purposive sampling technique was used because of the need to select unique cases that would be exceptionally informative and specialized because of the need to identify particular types of cases for in-depth investigation for a deeper understanding.

Concerning ethics, the study was based on the principle of protection of its participants. It was also vital to establish trust between participants and the researchers and to respect their rights, thus enabling them to provide the appropriate data required. Ethical consideration was an essential aspect of this study due to its nature. Essentially, access to information regarding a specific respondents and their businesses may result in some level of insecurity if revealed to others. Thus, the study adhered to the ethical principles outlined in the Declaration of Helsinki and received written informed consent from all participants.

4. Results and Discussions

4.1 Carbon footprints in the textiles and apparel industry and how it impacts the environment

The interview results have been presented in the order of questions asked on the interview protocol used. The respondents were asked to explain what they understood by carbon footprints are in the textile and apparel industry and how they impact the environment. The responses to that effect show that most of the respondents have an appreciable understanding of the meaning of carbon footprints. Selected comments have been given below;

> *"Synthetic fibres have comparatively high GHG emissions as a result of the energy use needed for raw material production and that Garments requiring washing, drying and possible ironing require the most substantial energy inputs during the use phase."*

> *"In my understanding, carbon footprints have to do with the number of greenhouse gases that are generated and released into the environment as a result of the production of garments and the treatment of same…."*

Relative to the impact of carbon footprints on the environment, the majority of the respondents indicated that, to a greater extent, carbon footprint harms the environment. The respondents understand that the actual waste generated from the processing of garment and textile-related materials has long-lasting consequences on the environment. Excerpts from the respondents have been outlined below;

> *"…all I know is that the carbon stuff we release into the atmosphere increases global warming, which means a lot of bad things happening, more rains and harsher weather conditions…."*

> *"I do not really know the extent, but I think of late, there has been much talk about reducing carbon emissions, and thinking about that makes me believe that it has some negative effect on the environment…."*

From the responses, it can be concluded that most of the respondents interviewed at least know something about the carbon footprints and are also aware of their impact on the environment.

4.2 Assessment of the environmental sustainability of textile and apparel industries

The respondents were asked how they assess their environmental sustainability in the industry. The responses suggest that they hardly employ any strategy to facilitate environmental sustainability. Even though they are aware of the concept of carbon footprint, they lack the basic techniques to assess their environmental performance in terms of sustainability. However, the respondents suggested efforts they are taking to reduce the emissions they release into the atmosphere. Selected remarks have been given below;

> *"seriously! How can I measure something like this? No, that is for the science people, but from the layperson's view, I can say I try to do things that will*

conserve the environment; as you can see, I have planted trees around my shop, and I ensure that there is no or less waste…."

"Ok am not sure about it, but I have put into practice certain things I believe will protect the environment. I have stopped burning materials openly. I incinerate them, and I make sure when there is no need, all electrical gadgets not in use are turned off…."

From the responses, it can be concluded that respondents try as much as possible to control the waste they release into the environment. Additionally, the respondents were asked about the processes associated with producing textiles and apparel products that positively or negatively impact the environment. Find below-selected comments from the respondents;

"…making a pair of jeans generates as much greenhouse gases as driving a car more than 80 miles while discarded clothing made of non-biodegradable fabrics can sit in landfills for up to 200 years…."

"As they say, it takes about 2,700 litres of water to make one cotton shirt, sufficient to meet the average individual's drinking requirements for two-and-a-half years. The farms that grow raw materials used to make fabrics, including crops like cotton, flax, and hemp, require much water…."

"Synthetic fabrics or human-made fabrics like nylon and polyester are made from petrochemicals and fossil fuels, and engineering them involves lots of water and energy. Synthetic textiles are not biodegradable, which implies that anything made of nylon can take years to rot…."

A summary of the responses shows that many aspects of the textile and apparel production processes generate materials that impact the environment. It is pretty apparent that most activities instead negatively affect the environment.

4.3 Environmental management strategies

The respondents were asked to indicate the practices adopted by the textiles and apparel industry in Ghana to confront the challenge of environmental sustainability and to improve their environmental performance. Analysis of the responses suggests that they are aware they need to engage in activities that will help reduce the effect or impact of global warming. Selected comments have been provided below;

"You know what we do is to ensure that advance standard as well as practices for designing clothes that can be effortlessly recycled or reused and also offer repair services so customers can extend the lives of their garment…."

"We only admonish that there should be finance in the development of innovative fibres that will reduce the environmental impacts of manufacturing and garment construction while also encouraging consumers to care for their

garments in low-impact processes. Laundering clothes in hot water as well as drying at extraordinary temperature or for protracted periods than required utilizes much energy…."

The respondents believed that focusing on activities that positively impact the environment is a sure way of helping to manage the impact of the textile and apparel industry on the environment in Ghana. To a large extent will help to reduce the level of carbon footprints of textile and apparel production on the environment.

4.4 Benefits of sustainable textiles and apparel production and consumption

When the respondents were asked what the key benefits of sustainable textiles and apparel production and consumption are, the majority of the respondents indicated that it would eventually reduce the level of carbon footprints on the environment. Excerpts of their comments have been given below;

"Reduces the number of pesticides released into the environment and also reduces toxic waste while ensuring that they produce long-lasting quality apparel…."

"…For me, I believe that the textile industry has many reasons to emphasize sustainability, which includes reduced costs, protection of the environment and sustained goodwill from its customers for eco-friendly practices…."

From the responses, it could be detected that the respondents know that efforts to reduce waste that is released into the environment will go a long way to reduce the level of carbon footprints from textile and apparel production and consumption on the environment.

4.5 Relationship between textiles and apparel production and consumer behaviour

Furthermore, the researcher sought to assess respondents' understanding of the relationship between textiles and apparel production and consumer behaviour. Analysis of the responses suggests that respondents have an appreciable understanding relative to the relationship between textiles and apparel production and consumer behaviour. Selected remarks have been given below;

"…I think from the consumer's point of view, the launch of environmentally friendly products is inspiring them to play more active roles in sustainability via their apparel purchasing…."

"…because of the increased awareness, consumers are more likely to purchase sustainable products, but knowledge is the critical issue triggering the consumers towards sustainability in apparel purchasing. If consumers know more about sustainability, they are more likely to purchase sustainable apparel products…."

I know for sure that to a greater extent, the motivation for environmental responsibility is strongly correlated with the consumers' attitude toward sustainable products, and it is in Ghana that people do not regard those things, but elsewhere the knowledge of consumers about environmental issues have a significant impact on purchasing intention.

The trend of the responses revealed that respondents are fully aware of the relation between textiles and apparel production and consumer behaviour.

4.6 Policy Recommendations

The respondents were further asked what policy recommendations they would make regarding carbon footprint in the textiles and apparel industry and consumer behaviour to promote sustainable development. Responses show that respondents expect more efforts from the government regarding policy directions on reducing the carbon footprint on the environment. Selected comments have been outlined below;

"…the Government must collaborate with the sector to adequately trace the sources of raw materials as well as tackle social and environmental violations in the textiles and apparel supply chain, and also the government and the industry must expedite investigation into the relevant environmental performance of various raw materials, especially concerning measures to reduce microfibre pollution…."

"…the government should facilitate collaboration between producers, water companies, and washing machine manufacturers to tackle microfibre pollution. The government should investigate whether tax should be applied to textile products containing less than 50% recycled PET to inspire the market for recycled fibres…."

"…The resources, as well as waste strategy, must incorporate eco-design systems and give incentives for design for recycling, design disassembly as well as design for durability. It must further establish an innovative investment fund to spur demands for recycled fibres…."

The responses focused on the government's efforts at putting policies in place to curtail the effects of industrial activities on the environment.

5. Conclusion, implications and limitations

Relative to the impact of carbon footprints on the environment, most of the respondents indicated that to a greater extent, carbon footprint harms the environment and that respondents at least know something about carbon footprints and are also aware of their impact on the environment. Textile and Apparel production houses try as much as possible to control the waste they release into the environment, and there are many aspects of the textile and apparel production processes that

generate materials that impact the environment. It is evident that most activities negatively affect the environment.

The respondents believed that focusing on activities that positively impact the environment is a sure way of helping to manage the impact of the textile and apparel industry on the environment in Ghana. To a large extent this will help to reduce the level of carbon footprints of textile and apparel production on the environment. The knowledge that efforts to reduce waste released into the environment will go a long way to reduce the level of carbon footprints from textile and apparel production and consumption on the environment and that respondents are fully aware of the relation between textiles and apparel production and consumer behaviour. Relative to policy recommendations, a greater responsibility lies in the government's efforts at putting policies in place to curtail the effects of industrial activities on the environment.

The environmental effects of textile and apparel are diverse across the stages, challenging to measure for different garments, and subject to the category of raw material applied, dyeing, as well as laundering. It was not until the 1990s that there was a profound awareness of the brutality of the adverse environmental impacts of textile and apparel production. The key environmental impacts linked to the production and use of textile and apparel during its lifecycle consist of wastewater emissions from dyeing, finishing, and the washing processes, an upsurge in pollution, solid waste production, as well as substantial depletion of resources from the consumption of water, fossil fuels, and raw materials.

Energy is further utilized for laundering, transportation, operations of machinery for the various processes, the construction of primary materials, particularly human-made fibres and yarn production of natural fibres like cotton. Chemicals are similarly discharged in water from processes including pre-treatments, dyeing, finishing, as well as laundry. These substances are disruptive to both the environment and aquatic-based life. Solid waste is further generated during natural fibre yarn, textile, as well as apparel production and disposal of textile and apparel products at the end of their life.

Thus, attaining zero net GHG emissions will involve far-reaching shifts in human activity, which in textile and apparel terms comprises shifting both the way firms produce garments and how consumers consume them. It is further estimated that about two-thirds of the damaging climate impact over the lifespan of attire comes at the raw materials phase. Beyond the raw materials phase, the energy utilized in production, transporting, packaging as well as retailing a piece of garment all contribute to the emissions of footprints. However, the climate impact does not halt at the retail outlet; what transpires throughout a dress's lifetime of usage further contributes to the end of the garment's life.

Presently, less than 1% of garments are made into novel apparel, with only 20% of textiles being recycled as the remaining go into landfills or get burnt. The fast fashion trend currently worsens the issue. Individuals are purchasing more apparel products than ever before, wearing the garments

fewer times, mending them less, and throwing them away sooner. Additionally, the textile and apparel sector consume many other valuable resources due to its carbon-intensive supply chain and production processes. Cumulatively, the textile and apparel sector generate approximately 20% of global wastewater.

The current study discovered that the textile industry impacts the environment in several ways, including its use of resources, its impact on global warming, and the amount of pollution and waste it generates. Again, it was discovered that the impact of the textiles and clothing industry on the environment goes beyond emissions. These include dyes used to produce toxic chemicals that pollute waterways. Gathering the materials for wood-based fabrics like rayon, modal and viscose also contribute to deforestation. The results indicate that the main problem is the volume of clothing produced right now, which is driven mainly by consumption habits, and thus, every product has an impact. The current study shows that Ghana's textiles and apparel industry does not assess their environmental performance in sustainability.

Regarding the textiles and apparel firms, with raw materials taking up the mainstream of a textile and apparel climate impact, efforts to reduce it are logically focused here. However, switching fabrics could help. A shift from virgin polyester to recycled fabric made by either mechanically or chemically breaking down plastic bottles can reduce polyester's carbon footprint by approximately 40%. Thus, production efficiency must be increased by utilizing higher quality materials deprived of compromising quality and cost. Furthermore, material substitution connotes replacing existing materials with some more ecologically friendly ones. For instance, swapping dyes containing dangerous substances with an environmentally friendly one implies removing the purification requirements and costs triggered by the harmful substance.

Again, the 3Rs – reduce, reuse, and recycle – which categorize waste management methods according to their desirability, can be adopted by the firms. This connotes that, ideally, waste generation ought to be prevented or reduced and that generated waste must be recovered utilizing reuse, recycling, and other recovery possibilities, therefore plummeting disposal and landfill operations. In the garment sector particularly, the waste hierarchy scheme aims to extract the maximum practical benefits from garments while generating the minimum amount of waste and causing the most negligible environmental impact. Thus, the concept of zero waste in fashion design, which is about designing clothes where no scraps are left after the pattern is cut out, can be adopted. Again, equipment modification, which implies the development of contemporary equipment to produce less waste and guarantee more efficient production processes, is necessary.

Also, new process technology, which involves the application of contemporary as well as efficient technologies, necessitates a higher preliminary investment than other methods. However, to achieve sustainability in apparel production, this is crucial. Thus, with the developments of quality and savings, this investment can be recompensed within a concise period, and with these applications, apparel firms can more effortlessly switch to more up-to-date production processes. These applications further afford enhancements in product and production quality. Finally, it is

anticipated that the future of fashion may be a service that substitutes possession with a fast on-demand rental of clothes from an infinite global pool of clothes. This could make the world a better place and fashion no longer a murky word.

Regarding the limitations, it is frequently implied that small sample size characteristic of qualitative studies limits generalisations as well as the external validity of research findings. In terms of circumventing this limitation, key questions were open-ended questions, where the emphasis in this study was on depth as against breath. Again, self-reporting bias is a major concern for most researchers when utilising self-report survey data, where study participants may reserve evidence or offer responses they think the researcher wants to acquire. Moreover, the process of recording, coding, and analysing the data was labour-intensive and human error could contribute to error or omissions. However, a conscious effort was made to counter this through various peer debriefings and re-checking transcripts. Regardless of these limitations, the study has generated a resource that can be utilised by all.

6. Recommendations

Understanding the performance of the textile and apparel sector, as well as the challenge of environmental sustainability, can guide policy direction. Hence, the government could devise policies to promote sustainable practices in the industry. Such policies might include regulations to control water pollution, incentives for adopting environmentally-friendly technologies, and measures to manage waste effectively. Again, encouraging the adoption of green manufacturing practices can reduce the sector's environmental impact. This may include the use of energy-efficient equipment, the minimization of waste, and the recycling or proper disposal of waste. Policies could be established to provide incentives for businesses that adopt these practices, which would also enhance the sector's overall performance. Furthermore, the findings from this study could be used to develop education and training programs for workers in the sector. These programs could focus on teaching environmentally sustainable practices and how these can be integrated into the daily operations of businesses in the industry.

Also, the information on environmental challenges can contribute to more comprehensive and sector-specific Environmental Impact Assessments (EIAs). These EIAs can then be used to formulate policies that strike a balance between industrial development and environmental protection. Understanding the environmental challenges in the textile and apparel sector can further guide the establishment of sustainable supply chains. This could involve sourcing raw materials responsibly, reducing emissions during transportation, and ensuring that products are recyclable or biodegradable. Finally, this understanding can be used to foster consumer awareness regarding the environmental impact of the textile and apparel sector. This could lead to increased demand for sustainable products, pushing firms in the industry to adopt greener practices.

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