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Greening the Textile Industry: An Analysis of the Policy Landscape of Pakistan

Abstract

The textile Industry is considered the backbone of Pakistan's industrial structure, as it contributes 8.5% to national GDP, employs over 40% of the industrial workforce, and is responsible for approximately 59.53% of annual national exports (Pakistan Economic Survey, 2023). The textile industry has a long and complex value chain, making this industry a leading source of Green House Gases (GHG) emissions. Globally, this amounts to 7%-10% of global annual GHG emissions, and over 20% of annual industrial water pollution (European Parliament, 2023). Pakistan's contribution to global greenhouse gas emissions has increased over the past two decades from 0.68% in 2000 to 0.96% in 2020 (World Bank Group, 2024).

Pakistan is listed among the top 10 countries affected by climate change, and is a signatory of or achieving various international agendas and agreements related to climate change. To achieve these targets, the textile Industry needs to fast track implementation of various decarbonizing and GHG emissions reduction standards. Furthermore, with multiple binding agreements soon coming into force in leading markets, particularly the European Union (EU), the greening of the textile industry is also important for its own viability as a major exporter in the global market.

A key hurdle to greening the textile industry is the structure of the textile industry, comprising of large number of SME firms and small number of composite units, implying that a unified policy would be hard to create and enforce. Another key challenge is with the domestic power mix, which requires a swift move away from coal-based power plants in order to satisfy international GHG (Green House Gases) emissions standards. Pakistan has installed most of its coal-based power plants during the past decade, and has only recently developed technology to harness its domestic coal reserves for power generation.

Primary sources of textile industry-related pollutants are energy, water, and chemicals. This report presents climate change policy landscape related to the textile industry in Pakistan, and discusses the regulations aimed at restricting

the impact of the textile industry on climate. A snapshot of the relevant policy landscape is presenting, with special focus on the upcoming European Union policies. The Textile industry is the largest and oldest industrial sector in Pakistan, and its impact on the labor force is significant, which is presented to discuss the potential social impact vis-à-vis the labor force dynamics. A special section presents the potential impact of Carbon Border Adjustment Mechanism (CBAM) on Pakistan textile industry.

Contents

KEYWORDS: Green Transition, GHG emissions, Textiles, CBAM, Policy framework recommendations
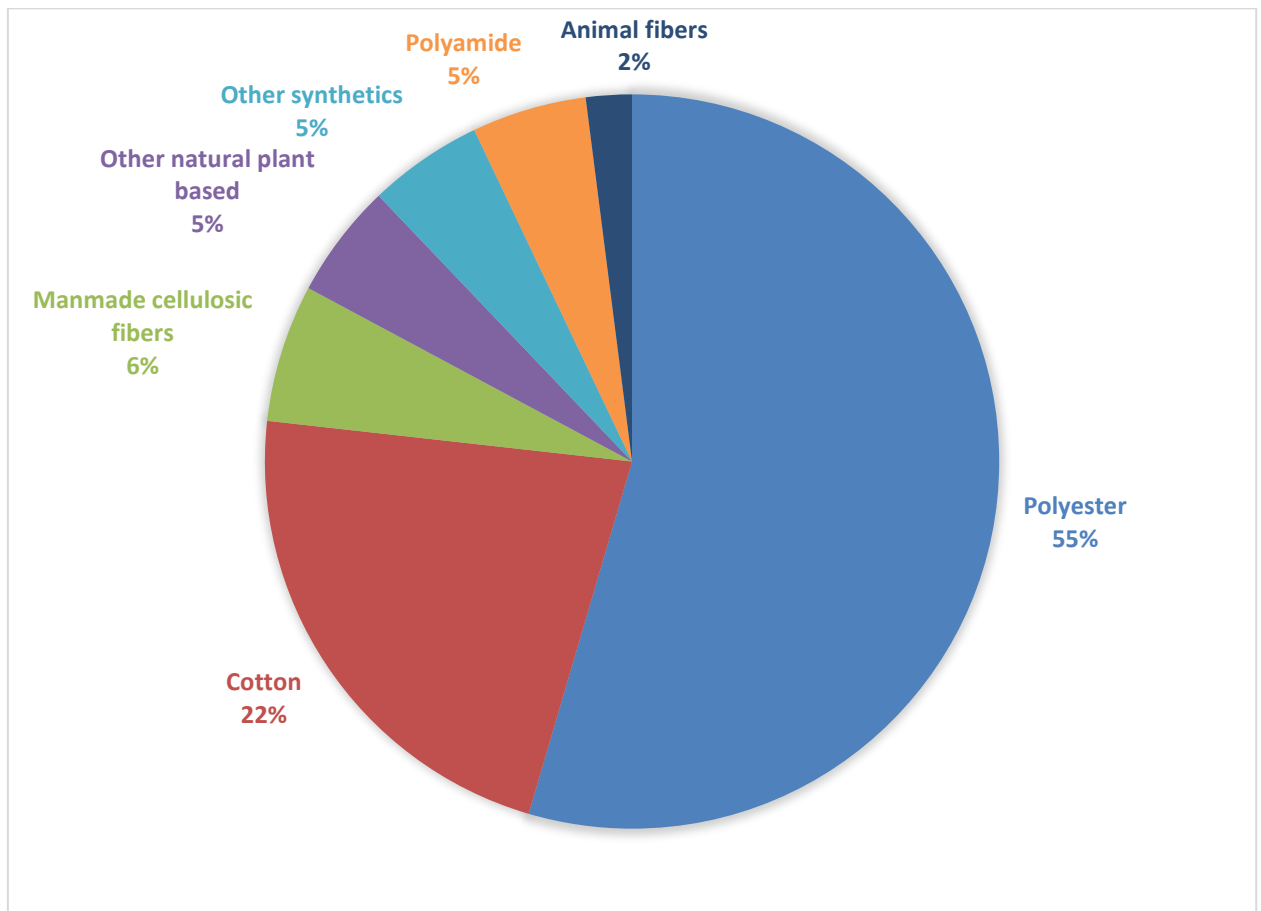
Introduction

The textile industry is amongst the oldest industries known to mankind. Over time, it has evolved into an industry comprising multiple industries, employing a complex supply chain (detailed supply chain of the sector in appendix). Textile products have many uses, including clothing and home textiles, industrial textiles, hygiene products, etc. The primary use of textiles continues to be clothing of various categories. It is estimated that by 2025, over 73% of all fibers produced will be used for Apparel and Household textiles, with the remaining approximately 26% destined for industrial use. (Wood Mackenzie, 2016)

Globally, textiles demand is witnessing a boom, especially over the past decade. The demand for textiles has grown between 4% - 5% annually over the past decade. The global demand for apparel and footwear is expected to grow from 62 million tons in 2015 to 102 million tons in 2030, with an estimated value of $3.3 trillion (Boston Consulting Group, 2017). Consequently, clothing production has doubled between 2000 and 2020 (Leal Filho, et al., 2022). According to various estimates, the global textile industry is estimated to be valued between USD 1 trillion to USD 2 trillion worldwide in 2023 (Statista, 2024; MMR, 2024; ECON Market Research, 2024). This increase in demand and supply has detrimental effects on the environment, particularly climate.

Globally, the apparel and footwear industry contributed approximately 2.1 billion tons of carbon dioxide emissions in 2018 (Global Fashion Agenda, 2024), while the fashion industry alone is responsible for 10% of global greenhouse gas emissions annually (European Parliament, 2023). The textile industry footprint on climate change map depends on the total volume produced, as well as the product mix in demand by the market. Gschwandtner (2022) estimates that the global textile demand is expected to grow at an average annual rate of approximately 2-3% till 2030, of which roughly 1% growth can be attributed to population growth, while 1-2% growth is due to growth in per capita consumption. In numbers, global fiber demand is expected to grow to 142 million tons by 2030, from 113 million tons in 2021. These fibers can be broadly categorized into bio-based fibers (cotton, wood based fibers, etc.) and fossil based fibers or synthetic fibers. The bio-based fiber production is relatively stagnant, and is not expected to increase at the rate at which global fiber demand is increasing[1]. Therefore, the growing demand is expected to be met with increased production of synthetic fibers (Gschwandtner, 2022). This is in line with the standard assumptions in the related academic literature of no to little growth in production of natural fibers (see for instance, (Hämmerle, 2011; Eichinger, 2012). At present, approximately 70% of global fiber supply is manmade, of which approximately 54% is polyester.

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[1] International cotton advisory committee estimates global cotton production in 2026-27 season to be 27.9 million tons, which is approximately what it is in 2022-23.

Figure 1. Distribution of textile fibers production worldwide in 2022, by type

Data Source: Statista 2024

Synthetic fibers are produced using non-renewable inputs. For instance, polyester is produced from oil. They also contribute more to global warming (Polyester production produces 10.2 kg carbon dioxide equivalent per kg as compared to 9.3 kg carbon dioxide equivalent per kg for cotton. Moreover, polyester is not biodegradable, and since recycling textiles is still not common, with most of textiles ending in landfills, manmade fibers and textiles made from such fibers have a far more detrimental climate impact than natural fibers (Nikolay I., 2021).

Over the past two decades, fast fashion has emerged as the model driving the textile industry. This model is based on providing consumers new products at reduced prices, by building on consumer's sense of impulse buying. As a result, the average budget expenditure has decreased, while the number of items owned has increased. In USA, an average consumer is found to be purchasing an item of clothing every 5.5 days in 2020 (Ellen MacArthur Foundation, 2017), while in Europe, clothing purchases have increased by a factor of 40% during 1996-2012 period (Dahlbo, Aalto, Eskelinen, & Salmenpera, 2017).

This shift towards fast fashion over the past two decades has also given rise to a much larger recycling industry than before. The global textile recycling market was estimated at a value of USD 4.35 billion in 2021, expected to grow to USD 6.13 billion by 2030 (Spherical Insights, 2024). However, this growth is much smaller than the growth in

production, as already discussed. This has led to a new kind of landfill dumping: consumers in high income economies procure large quantities of textiles while their average use of a textile product is reduced in terms of time. These products are then shipped at throwaway prices to low-income countries, where the products are recycled, due to a growing pre-owned products market. The average use life of textile products is decreasing even in low income economies, primarily because of global fast fashion trends, as well as lower durability of the products. Thus, these textiles ultimately end up in landfills in lower- income countries, where laws related to climate protection – and their implementation – is generally lax. This has severe detrimental consequences for environment, and more so for the environment of low income countries as they are increasingly becoming dumping grounds for fast fashion products originally produced for – and consumed by – the consumers in high income countries.

Due to the aforementioned fashion trends-based model of the textile industry, the detrimental impact of the textile industry on climate is expected to increase, unless critical changes are introduced in the processes as well as practices to curtail the global greenhouse gas emissions footprint of the textile sector. Without immediate and effective intervention, the textile sector is projected to account for 25% of World Carbon Budget by 2050, consuming 300 million tons of oil as compared to 98 million tons of oil in 2017, and adding 22 million tons of microfibers in oceans (Ellen MacArthur Foundation, 2017). Preparation of yarn (28%) and dyeing and finishing (36%) contribute approximately two thirds of carbon emissions in the textile sector globally (Quantis, 2018)).
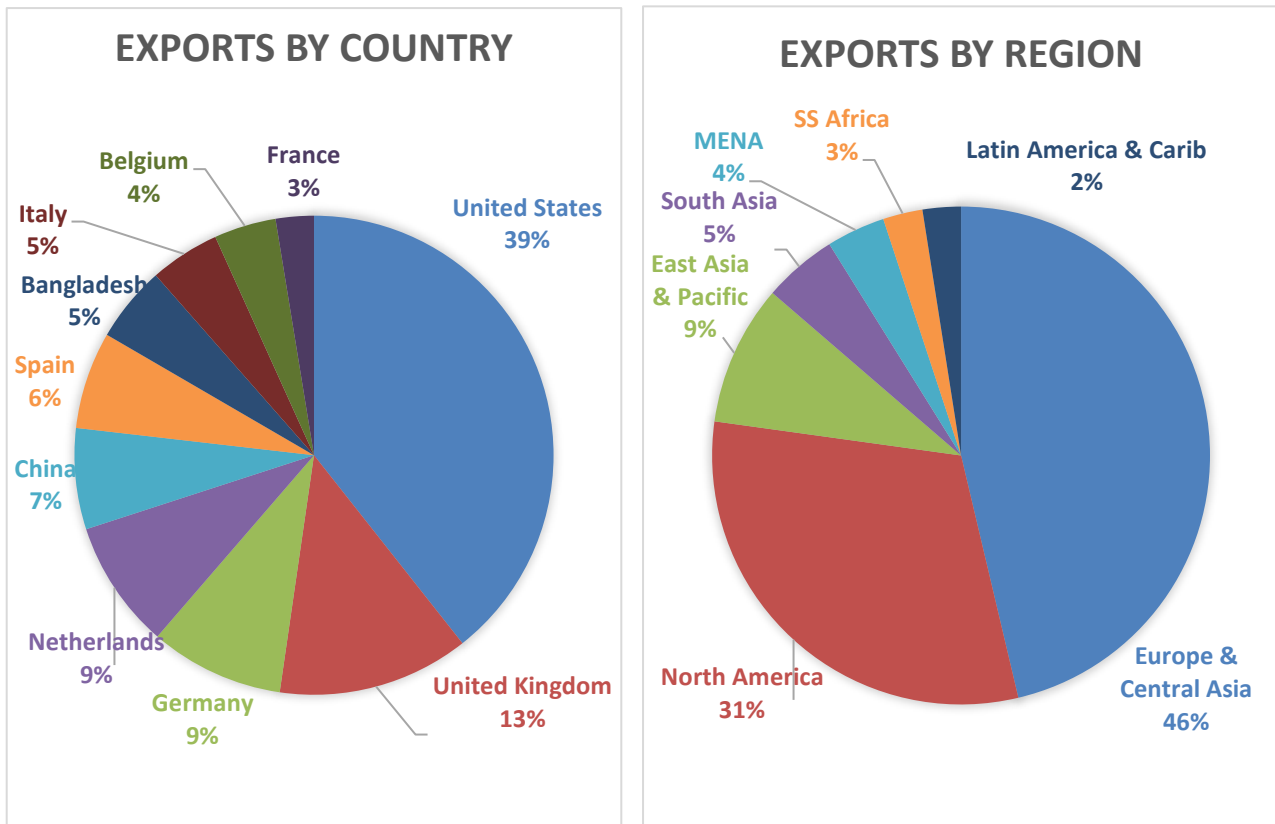
The textile industry's detrimental impact on climate is not limited to greenhouse gas emissions. The textile production process is water intensive, especially the finishing and dyeing part of the process. The textile sector is responsible for 20% of industrial wastewater pollution (Ellen MacArthur Foundation, 2017). The actual number is expected to be much higher, since less developed economies (with lax regulations and enforcements) produce a large proportion of the textiles globally.

2. Pakistan Textile Industry: An overview

Textile sector has long been the backbone of Pakistan's industrial sector. From the time of independence in 1947, families originating from present day Pakistan (then West Pakistan) were engaged in production and trading of textiles, especially Jute. This continued post-independence, with Jute being the major industry. The industrialization projects of 1960s and 1970s provided a major impulse to manufacturing of non-jute textiles through value addition, primarily in cotton. Initially, yarn production was the focus, with many spinning mills installed primarily in Karachi. This was expanded to the northern part of the country, with Faisalabad soon becoming the main yarn market of the country. Pursuing value addition, weaving industry soon followed, which is spread over various parts of Punjab, Karachi, and then few major units in the province of Khyber Pakhtunkhwa. Over the past three decades, the textile industry in Pakistan has invested in dyeing, finishing, stitching, and knitting, leading to more value addition. The last two decades have also witnessed a rise in the domestic fashion industry, leading to local branding and stitching for domestic purposes now being considered an important segment of the textile industry in Pakistan.

Figure 2. Exports by Country   Figure 3. Exports by Region

EXPORTS BY COUNTRY

United States 39%
United Kingdom 13%
Germany 9%
Netherlands 9%
China 7%
Spain 6%
Bangladesh 5%
Italy 5%
Belgium 4%
France 3%

EXPORTS BY REGION

Europe & Central Asia 46%
North America 31%
East Asia & Pacific 9%
South Asia 5%
MENA 4%
SS Africa 3%
Latin America & Carib 2%

Data source: WITS (2023)

Southern Punjab has been the main cotton-producing region of the country, due to its climate and soil. Hence, the ginning industry is primarily located in Southern Punjab. This ginned cotton then travels to various parts of the country for spinning, weaving / knitting, dyeing, finishing, stitching, etc. Interestingly, there are few large spinning and weaving mills in the Southern Punjab region, despite its historic status as the cotton hub of the country. This implies an increase in the length of supply chain. Despite being once categorized as a major cotton producing country, Pakistan is now a net cotton importer, due to a decline in cotton production as well as innovations in cotton varieties. Pakistan also has five major synthetic yarn producers, which primarily produce polyester fiber.

The textile sector contributes approx. 8.5% to the GDP, and employs approximately 38% of the national work force (State Bank of Pakistan). This sector contributes around 25% of industrial value addition (Pakistan Economic Survey, 2023). This low productivity is generally attributed to low investments in new technologies over the past decade and a half. After the 2008 financial crisis and change in the geo-politics in the same year, foreign direct investments to Pakistan declined fairly rapidly. This impacted the textile sector as well, which was already using old technologies in the small sized firms.

Textile products are exported as well as imported at all stages. For a foreign exchange starved country that is Pakistan, the textile sector has long been a major source of foreign exchange, due to its average share of approx. 60% in national exports (State Bank of Pakistan, 2023). The sector also is a major source of labor demand, employing approximately 38% of the labor force, mainly low skilled labor.

Historical Analysis of Textile Sector in Pakistan

During the first decade of Pakistan post-independence in 1947, the domestic economy was mainly agrarian. East Pakistan (now Bangladesh) was considered the world's largest producer of Jute, while West Pakistan (present day Pakistan) was a major producer of cotton. However, only a few cotton mills and no jute mills existed in Pakistan, so most of this natural fiber produce was exported at low value. Starting from early 1950s, the Pakistan government instituted five-year plans establishing a roadmap for economic growth. The first five-year plan (1955-60) had a public outlay of Rs. 7.5 billion, and chose six sectors for preferred investment, which included textiles. The plans included industrial policy of import substitution. With World Bank funding, development finance companies (Pakistan Industrial and Commercial Investment Corporation, Industrial Development Bank of Pakistan) were established to facilitate industrialization. Moreover, licensing was introduced providing protection from global competition. These development finance companies primarily targeted industries in which the private sector of the time was unwilling to invest. The policy led to establishment of small and medium-scale industry, like spinning and weaving mills. Investment as a percentage of GDP grew from 7.5% in 1950-55, to 9.8% in 1955-60, and 13.9% in 1960-65 (Brecher & Abbas, 1972). The export bonus scheme was introduced in 1959, incentivizing exports of manufactured goods. These set of policies led to an early shift towards medium- to large-scale manufacturing in Pakistan, including establishment of spinning and weaving mills, however, the productivity remained low under public management.

Later, many of these publicly established industries were privatized, leading to rapid productivity growth, especially in the textile sector (Cheema, 1978). However, this trend did not continue for long. The disintegration of Pakistan in 1971 and subsequent establishment of West Pakistan as an independent country named Bangladesh, implied that the supply of domestic jute stopped. Moreover, the nationalization policy of the mid-1970s scared investors away from establishing large industrial concerns. Pakistan textile industry continued to produce primarily low value added yarn and grey cloth. During the 1980s and 1990s, the share of global textile trade moved towards high-technology products, while the textile industry in Pakistan remained stuck to expanding low-technology exports (McCartney, 2014). This is in part due to the protected status of the textile industry in Pakistan, as well as due to various quotas and preferential treatment meted out to the Pakistan textile industry in North American and European markets.

Starting the mid-1990s, Pakistan's industrial policy has been oriented towards reduced protectionism, leading to the establishment of high value-added textile units including finishing, dying, stitching, and knitting units. Secondly, the history of linkages to export markets led some firms to orient towards export-oriented textile manufacturing.

In recent years, like many other countries in the global south, Pakistan is also feared to be witnessing premature deindustrialization. Rasiah (2011) defines premature deindustrialization as simultaneous instance of low productivity growth and falling share of manufacturing in GDP, when the manufacturing sector has not matured. Large scale manufacturing (LSM) dynamics are generally studied as a proxy for industrialization. During the 1970-2010 period, GDP contribution of LSM in Pakistan grew at an average rate of 8.3%, compared to 141% for South Korea or 46% for Turkey (Sattar, 2020). Textile sector has witnessed a few years of negative growth during the previous decade. The sector faces highest energy prices in the region, foreign exchange shortages, contractionary monetary and fiscal policies, and increased competition from other major global exporters. COVID-19 benefitted Pakistan's textile sector, as the pandemic was not as severe in Pakistan as it was in neighboring countries, and the economy was not fully shut down at any point. Resultantly, orders from competitors ended up with Pakistan

textile industry. Due to a lack of investments earlier, there isn't enough excess capacity, implying Pakistan couldn't fully benefit from window that opened up due to the COVID-19 pandemic.

A second issue is that some high value inputs to export quality products are not manufactured in Pakistan. This includes machinery, dyes, certain chemicals, various forms of fibers, etc. The ongoing foreign exchange crisis in Pakistan over the past three decades, implies high exchange rate pass-through into export prices. This erodes the domestic textile industry's competitiveness, and is leading to premature deindustrialization.

Pakistan is amongst the few countries with a fully developed textile value chain, i.e. from fiber to garment exports. However, the textile industry has underperformed its potential, despite its status as the largest industry in the country. (McCartney, 2014)

3. Structure of Pakistan Textile Industry

Pakistan has a fully developed textile value chain, and each sector contributes significant value addition at each stage of the manufacturing process. The significance is exemplified by the estimate that the Pakistan textile industry, as a whole, contributes approximately one quarter of total industrial value-added and contributes, on average, approximately 60% to national exports (Pakistan Economic Survey, 2023).

Pakistan's textile industry spans raw produce to final branded products. Cotton agriculture in Pakistan still employs traditional methods, which require high water input and produce comparatively lower yields compared to modern farming techniques. Pakistan produced 6.79 million bales of cotton during 2023 (The Express Tribunue, 2023), making Pakistan the 8th largest cotton producer in the world (Statista, 2023). Pakistan also produces a modest amount of wool, which is generally of coarse quality with short staple length. In 2022-23, Pakistan produced 49,000 tons of wool (Pakistan Economic Survey, 2023). In the manmade fiber category, Pakistan mainly produces synthetic fibers nylon, polyester, acrylic, and polyolefin, with polyester being the main produce. Almost the entire domestic polyester market is captured by three players. Approximately 70% of polyester is supplied to the textile sector (PACRA, 2022). There are presently five producers in this sector, with total capacity of 636,000 tons per annum (Pakistan Economic Survey, 2023).

The fibers, primarily cotton are acquired by the ginning industry. Pakistan ginning industry almost entirely comprises of Small and Medium sized (SMEs) units. In Pakistan, the ginning industry is represented by the Pakistan Cotton Ginners Association, which has over 1300 members (Pakistan Cotton Ginner's Association, 2024). Most of these ginners are not registered as corporate entities.

Figure 4. Production split by yarn count - FY 2021 '000 Kgs'
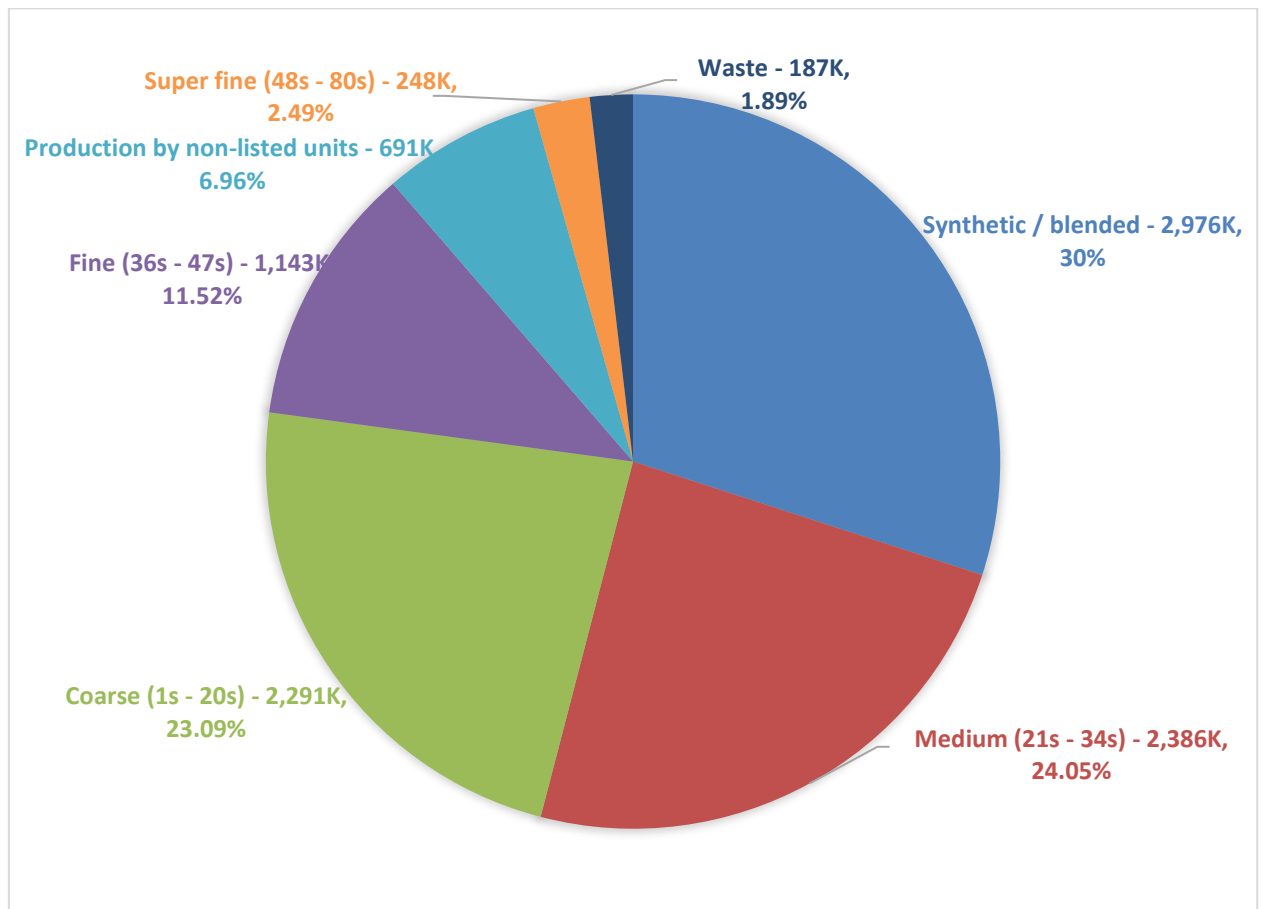
Source: Board of Investment, 2023

The ginned cotton, along with manmade fibers, are procured by the spinning sector. As per the most recent data of 2023 released by the Textile Commissioner's Organization, there are a total of 408 textile units in the spinning sector, of which 368 are spinning mills and 40 are composite units. They have a total of 13.414 million spindles as well as 140,000 rotors installed (Pakistan Economic Survey, 2023).

Figure 5. Fabric Production Breakdown
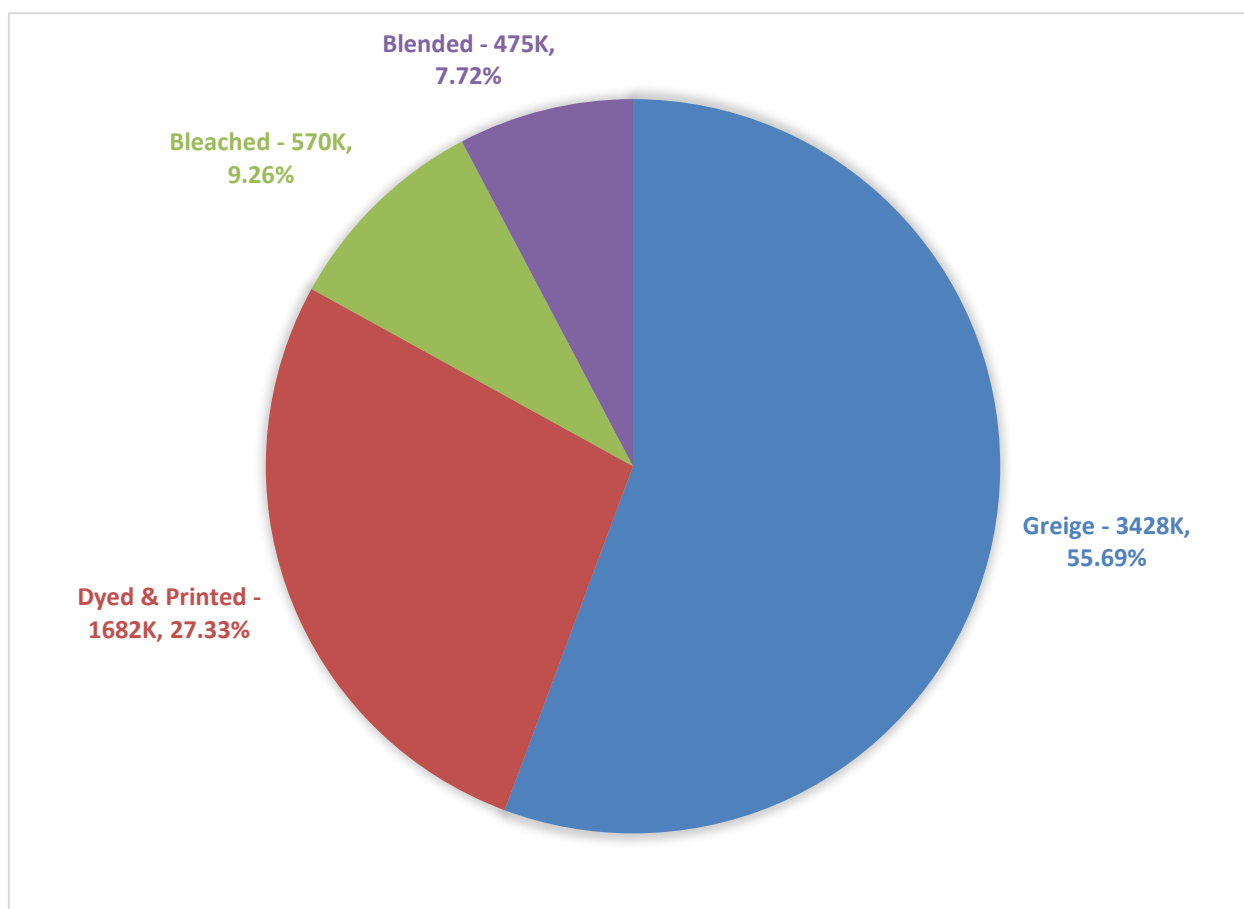
Source: Board of Investment, 2023

The yarn is exported as well as used by the local weaving and knitting industry. There are 124 large and 425 small weaving units, with 28,500 shuttle-less looms and 400,000 power looms installed in Pakistan (Pakistan Business Council & Consortium for Development Policy Research, 2018). The latter are old technology, which require more energy and is less efficient. This sector has an annual producing capacity of 9,177.3 million square meters. This sector primarily produces low value greige cloth, though more recent units have installed modern machinery producing multi-color woven cloth. During financial year 2020-21, 1,048 million square meter fabric was produced, of which 92.5% was cotton fabric (Board of Investment, 2023).

The dyeing and finishing of grey cloth either take place in SMEs units, or a few large modern units. The latter are recent additions, and primarily focus on the export market. The former sector is much larger in number, but due to its SME nature, uses older technologies which are high in emissions as well as water pollution. There are 10 large and 625 small firms in this sector.

The yarn is also picked up by the Hosiery & Knitwear industry. Until recently, this industry was predominantly export-oriented producing medium- to high-quality products for leading brands in the world. Due to increasing competition from China and Bangladesh, some of these highend brands have reoriented their sourcing strategies, negatively

affecting exports of this sector from Pakistan. In recent years, the domestic market for hosiery and knitwear has picked up, allowing this industry to direct their product towards the local market.

There are other smaller sectors in the Pakistan textile industry, including the woolen industry and jute industry. The woolen industry in Pakistan primarily deals in rugs and carpets, while the jute industry mainly produces sacks and hessian cloth used for grain storage.

The textile made-up sector in Pakistan comprises readymade garments, towels, tents / canvas, bed wears, etc. The readymade garments industry can be further divided into export-oriented sector, and domestic consumption-oriented sector.

The domestic consumption oriented sector ready-to-use garments sector has emerged over the past two-three decades. Historically, Pakistan households tended to favor made to order clothing as well as bed linen. A typical consumer would purchase finished unstitched cloth, and either stitch it at home or get it stitched from a tailor. This was due to availability of low cost tailors, as well as due to the absence of local designers. At the turn of the century, a fashion design school was set up in Pakistan, which created skilled designers. They in turn setup their design houses, which for the first time in Pakistan, satisfied the domestic demand for readymade garments and household textile items. This is roughly the same time when the fast fashion model emerged in the global high income markets. The fashion trends changed, and over the course of the past two decades, led to high growth of the readymade garments industry in Pakistan. However, this industry is still small-scale industry, mostly comprising of non-corporate entities, with few large units. According to All Pakistan Textile Mills Association (APTMA), there are 50 large and 2500 small units producing three quarter of a billion pieces per annum. Since the garment sector is high in terms of value addition, Pakistan is underperforming as compared to its potential. This is in large part due to incentive structure, reflected by the fact that during the period 1999-2009, only 12% of the investments in textile sector went towards the garments industry. Most of the production takes place in small shops, or home-based units. The garment industry hires approximately 2.5 percent of the labor force (Pakistan Economic Survey, 2023). It also hires comparatively more semi-skilled labor and has a better gender balance compared to other textile sectors (Pakistan Bureau of Statistics, 2023). Since a large number of these units producing garments are small and non-corporate, it is observed that the labor laws and climate related best practices are seldom implemented.

Towels manufacturing picked up in the 1990s and early 2000s, with some large scale units installed to service both domestic and foreign demand. Tents / Canvas has been produced in Pakistan since long, but the size of the industry is fairly stagnant.

In terms of market structure, the entire industry cannot be studied as a whole. Instead, individual sectors are generally studied and categorized. Following is a snapshot of various market structure indices computed for various sectors that constitute the textile industry in Pakistan:

Industry	C4[2] (Percentage)	Herfindahl-Hirschman Index[3]	Rothschild Index[4]
Spinning, Weaving	31	498	0.00
Finishing	40	735	0.01
Made-up and Other Textile Articles	49	872	0.01
Source: (Abbas & Sheikh, 2021)			

The data in the table above shows that various sectors comprising the textile industry generally depict an industrial sector which can be categorized as monopolistically competitive.

4. Climate-related footprint

According to the World Bank's World Development Indicators (2024), Pakistan is responsible for less than 1% of global GHG emissions. Within Pakistan, the textile industry is responsible for approximately 6% to 9.5% of country-level GHG emissions. Mitigation Action Facility (2024) estimates that the textile sector of Pakistan contributes 6% of the country's greenhouse gas emissions. Sattar & Akhtar (2022) estimate that the textile industry contributes 9.5% for both gate-to-gate and cradle-to-gate categories. The textile sector affects the environment in a variety of ways, of which the main concerns are discussed below:

Energy

The energy sector is responsible for 46% of country-level GHG emissions, and textile industry is a major energy user. Most of the world's leading textile industry hub countries (China, India, Bangladesh, Pakistan) have a heavily fossil fuel (coal and gas) based energy mix. Of the 41,557 MW of installed capacity as of July 2022, over 45% is fossil fuel based (RLNG, Coal, Gas). Many of the textile conglomerates have captive power plants, most of which are RLNG or Gas based. Thus, the overall environmental impact of the textile sector includes a significant portion of environmentally unsustainable energy being consumed, estimated at approximately 44%.
Pakistan's energy mix was predominantly hydroelectric after the installation of a few mega dams during 1960s and 1970s. Privatisation during the1980s brought in Independent Power Producers, mainly producing electricity using furnace oil and gas. Later iterations of this policy led to a rise in gas-based power plants. During the first decade of the 21st century, coal-based power plants were introduced, that primarily used imported coal. Policy at the time promoted the use of local coal reserves, which has led to development of plants on domestic coal. This trend is expected to continue, due to the efficiencies of scale that the power producers of local coal are targeting.

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[2] Measures the market share of the four largest firms. Less than 40 implies monopolistically competitive industry
[3] HHI is the sum of the square of the market share of each firm. Less than 1500 is considered competitive.
[4] Closer to 0 implies competitive industry.
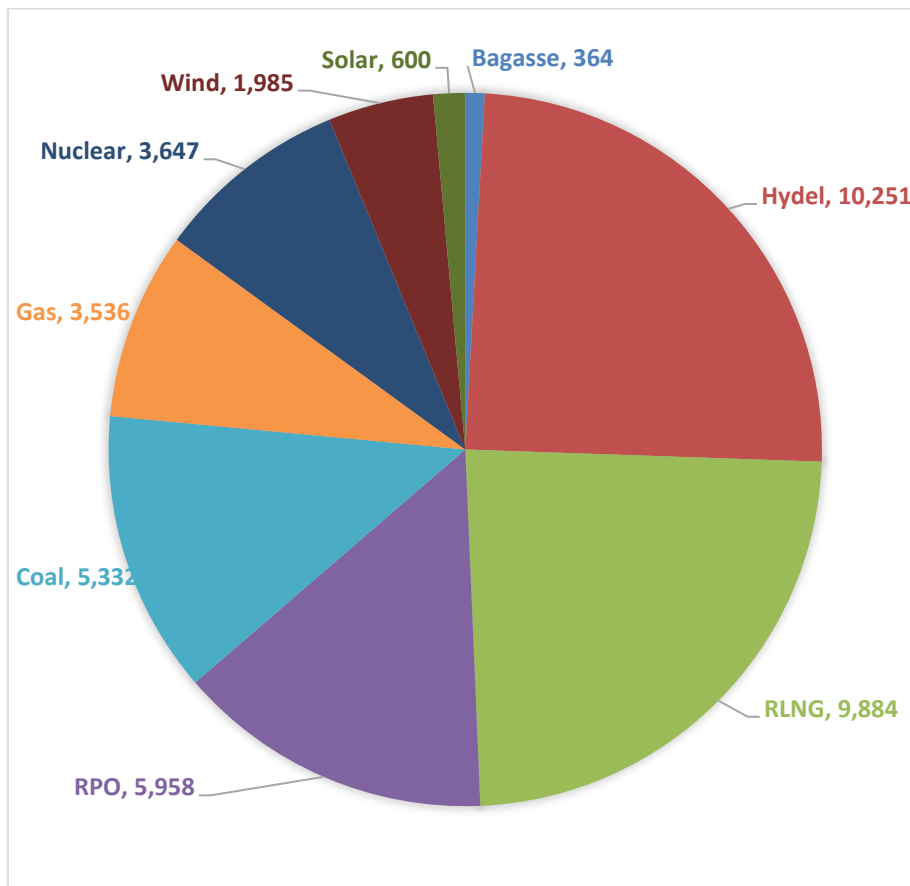
Data source: Pakistan Economic Survey, 2021-22

There is immense room for improvement in this sector. According to Pakistan Economic Survey (2022), the estimated total hydropower potential for Pakistan is around 60,000 MW – over 44% more than the entire installed capacity in 2022. Similarly, the wind energy potential is estimated at 50,000 MW. The last of the three main sources of clean and sustainable energy is Solar. For Pakistan, the annual horizontal irradiance in Himalayas and Karakoram is 2300 kWh/m2 (the highest of any region in the world). This implies that even though the exact measures of potential power generation using solar are not available, the solar potential is expected to be more than wind energy potential. A move towards cleaner sources of energy can significantly eliminate the GHG emission from the energy sector, in turn reducing Textile sectors GHG emissions footprint. In 2019, the Alternative and Renewable Energy policy was introduced by the Pakistan government, which targeted increasing the share of green energy to 20% of energy mix by 2025 and 30% by 2030.

Water

Textile production is a water-intensive process, which is responsible for approximately 20% of all clean water pollution globally. The textile industry is estimated to use approximately 80 billion cubic meters of water worldwide, which is roughly equal to the total water usage in the EU in 2017. The World Resources Institute estimates 2700 liters of water is used to produce one cotton t-shirt (equivalent to 2.5 years of individual water consumption).

Renewable Water Resources Per Capita in Pakistan, Bangladesh, and India (m^3/inhabitant/year)			
Year	Pakistan	Bangladesh	India
1962	5,238	24,045	4,085
1967	4,605	20,580	3,683
1972	4,024	18,152	3,295
1977	3,479	16,376	2,938
1982	2,958	14,266	2,618
1987	2,509	12,477	2,340
1992	2,170	11,032	2,109
1997	1,912	9,907	1,916
2002	1,706	8.982	1,754
2007	1,539	8,339	1,620
2012	1,387	7,879	1,513
2017	1,253	7,451	1,427
Source: *Worldometer*			

The trend is similar in Pakistan, where the domestic textile industry uses 49% of total industrial water. According to the All Pakistan Textile Mills Association, less than one 1% of industrial water is treated. The position on the ground may be even worse than these statistics, since much of the textile industry's water usage is unregulated. Small and medium textile units, in areas where underground water is accessible, pump underground water and pumps back chemically polluted water. Since this activity is illegal, even though widespread, an estimate is hard to come by.

Chemicals Use

The textile industry uses over 80,000 types of chemicals in various processes, out of which over 20,000 are commonly used. Some of these chemicals used are VOCs (volatile organic compounds) that evaporate in the air. Some inks and dyes used are toxic heavy chemicals (e.g. cadmium). Microfibers and micro plastics are found commonly in the chemicals used, which ultimately end in various water reservoirs. Some examples of hazardous chemicals include:

- Formaldehyde – linked to leukemia, lung cancer, various skin and eye diseases, etc.
- Fixatives (e.g. ammonia) – cause damage to plants and animals, especially fish.
- Polybrominated Diphenyl Ether – linked to liver diseases and thyroid malfunction.

5. Policy Landscape

Pakistan is among the top 10 countries that are expected to be negatively affected by climate change. This is why Pakistan has been amongst the most vocal proponents of a globally coordinated action towards environmental protection.

Brief History of Environmental laws of Pakistan

During the colonial era, The Canal and Drainage Act, 1873, was established, which was later amended in 1952, 1965, 1968, and 1970. This act, along with Punjab Minor Canals Act, 1905, are the earliest regulations governing water pollution in the Indus Basin, and later, in all rivers and Canals. The Factories Act of 1934, governed the "disposal of waste effluents" by factories in the region.

The first national framework regarding environmental preservation was instituted in 1983, through a Presidential ordinance called the Pakistan Environment Protection Ordinance. In 1992, Pakistan signed the Rio Declaration. In the same year, the cabinet of the Federal Government approved the National Conservation Strategy, which became at the time, the primary legal framework for environmental protection. Later in 1997, the Pakistan Environment Protection Ordinance was made into an Act called the Pakistan Environment Protection Act. This act comprises of 10 notified and 2 draft rules, and set up the National Environmental Quality Standards, Pakistan Environmental Protection Agency, as well as rules regarding self-monitoring and reporting by industries, along with a host of other initiatives. In 2005, the National Environment Policy was finalized, focusing on conservation, restoration, and management of natural resources. In 2010, the 18th amendment to the Constitution was approved by legislative bodies, delegating certain Federal concerns to the provincial control, which led to Provincial Environmental Protection Acts and Strategies. (For a detailed review of Pakistan's laws related to Environment, see (Sial, 2018).

In 2016, Pakistan made its first climate action plan called the Nationally Determined Contributions, which were later updated in 2021. In 2020, Pakistan agreed to the moratorium on building coal-based power plants, from which it backed out in 2023 announcing quadrupling of power plants fueled by domestic coal. This is due to severe power shortages in the country, and successful implementation of the process for producing electricity from domestic coal.

Under the Paris agreement (ratified by Pakistan in 2016), Pakistan committed to limiting emissions to 50% of business as usual emissions by 2030. This was based on the pretext that 15% will be met by domestic resources, while 35% will be subject to international financial support.

Pakistan is part of the G77 plus China, Like Minded Developing Countries, and the Coalition of Rainforest nations. (Dunne & Chandrasekhar, 2023)
Updated Nationally Determined Contributions 2021 commits to:

- 60% renewable energy by 2030
- Complete ban on imported coal by 2030
- 500 MT CO2e by 2040 (2018 - 489.87 MT CO2e)

Regarding the industrial sector, with textile sector named as one of the key players, the updated Climate Change Policy (Ministry of Climte Change, Government of Pakistan, 2021) recommends the following policy measures:

a. Incorporate economic incentives to promote emission- reduction by upgrading industrial processes and technologies
b. Prepare voluntary "Corporate Social Responsibility" (CSR) guidelines and encourage the corporate sector to create a CSR fund to cover carbon emission reduction efforts in the industrial sector
c. Detailed aerosol emission impact assessment studies must be made a requirement prior to the installation of any new small and large industry that may be considered a potential source of pollution
d. Promote integration of the "Cleaner Production" strategy in the Industrial sector by making more efficient use of inputs such as energy, water and raw materials
e. Promote the use of energy efficient motors in the industrial sector
f. Encourage the industrial sector to have periodic "Energy Efficiency Audits"

g. Develop capacity to monitor and estimate emissions locally for each industry
h. Ensure that technology transfer is accelerated for industries like cement manufacturing, to control emissions without hampering the production process
i. Explore and introduce incentives for industries to adopt low- emission technologies e.g. dual- functional materials for Carbon capture, utilization, and storage (CCUS)
j. Legislate opportunities for industry to facilitate transition to circular economy model and boost the market demand for recycled products.

Pakistan is committed to net zero targets, measure and disclose sources of GHG emissions, decarbonize value chains, and advocate for climate action. 22 out of 23 signatories of Net Zero Pakistan Initiative are firms from Textile Industry. Following is a summary of Pakistan's strategies and platforms to achieve net zero.

GHG Emissions	Policy Initiatives	Plans and Targets
Energy		
Biggest source of GHG emissions in Pakistan with 218.9 MT CO eq. in 2018	Alternative and Renewable Energy Policy, 2019	At least 20% Renewable energy by 2025 and at least 30% by 2030
	National Energy Efficiency and Conservation Authority Strategic Plan (2020-2023)	6.4 MT CO_2 emissions reduction by 2023
Transportation		
Major energy demand sector contributing to GHG emissions of 51.3 MT CO eq. in 2018	National Electric Vehicle Policy 2019	The policy sets the specific target of at least 20% RE generation by 2025 and at least 30% by 2030
	Switch to Euro 5 (in process) Improve Air quality	Goal is to lower vehicular emissions from combustion and improve urban air quality standards as well as monitoring in provincial capitals and other major cities
Agriculture		
Second highest emitting sector with 198.59 MT CO eq. in 2018	Punjab Smog Policy (2017)	Complete ban on open burning of rice stubble, solid waste and other hazardous materials Disposal of crop residue in an environmentally friendly manner
Industrial Processes		
Third largest emitting sector which releases 25.76 MT CO eq. in 2018	Pakistan's National Action Plan on Sustainable Development Goal-12 (SDG-12) (2017)	Mitigation measures to encourage adoption of clean production technologies, implementation of eco-standard, incentivize carbon trading between industries to limit the production of GHGs Promote bottom-up actions by the private sector, and develop plans for emissions reductions from major sectors particularly cement and textile
Waste		
Ranked lowest-emitting sector in Pakistan that contributes 21.72 MT CO eq. to total GHG emissions in 2018 Methane is the major component with a	Clean Green Pakistan Index (CGPI–2019) Banning of single-use plastics	Strengthening municipal service delivery by the local governments. Includes a composite index of five pillars i.e. water, sanitation, hygiene, solid waste management and plantation Strengthening municipal service delivery by the local governments. Includes a composite index of five pillars i.e. water,

share of 19.2 MT CO equivalent		sanitation, hygiene, solid waste management and plantation. Promote reuse and source reduction of waste
Source: (Khalid, 2023)		

Various other initiatives are also coming into effect. For instance, the "Decarbonizing Textile Manufacturing" project is a joint effort by the Ministry of Climate Change, Ministry of Commerce, and the WWF-Pakistan. It was approved in 2022, and it estimates to mitigate 345,000 tons of CO2e over five years. This initiative has a two prong approach: providing financial cooperation, and technical cooperation. Through financial cooperation, a fund will be established to provide loans to manufacturers at reduced rates for adopting EE and RE technologies. Furthermore, it aims to catalyze development of domestic financial instruments aimed at small and medium enterprises. The technical cooperation aims at providing advisory support for policy design, enforcement and implementation. (Mitigation Action Forum, 2024).

In 1974, the then Government of Pakistan nationalized almost all of the large-scale businesses, including the banking sector (National Assembly of Pakistan, 1974). While the rest of the industries were gradually denationalized starting from late 1970s, the banking sector remained completely public until the last decade of the twentieth century. During this time, there are widespread news of individuals siphoning off large sums of money borrowed from public sector banks on the pretext of capital investments in the textile sector. During the past four decades, all Public sector banks in Pakistan (with the exception of National Bank of Pakistan) have been privatized or dissolved. New banks have also established themselves in the market. The banking industry is ranked among the top performing sector in Pakistan – in terms of profitability - over the past two decades. However, the market penetration of the banking industry is still low compared to other countries in the region. This is in part due to high discount rate in Pakistan (22% in February, 2024), due to which private borrowing and investment has nosedived. The banks have an easy customer in the form of the Government, which cannot borrow from the Central bank after the 2022 amendment to the State Bank of Pakistan Act. Thus, the commercial banks are the only source of finance for the government. Hence, the banking industry in Pakistan is posting high profits even with the lowest credit to private sector in the region. Consequently, financing for climate friendly capital investments is a serious concern for the textile industry at the moment.

Figure 7. Domestic credit to private sector (% of GDP)
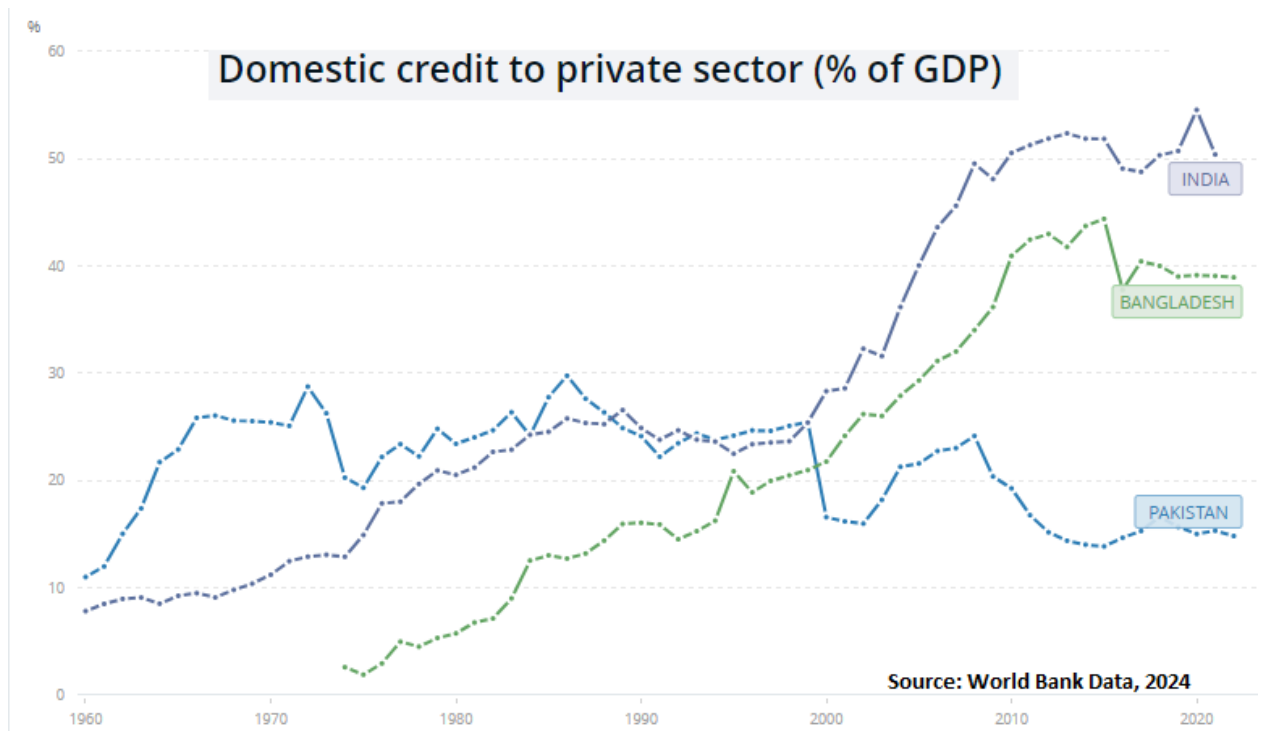
6. International Regulations

European Union and North America are the major markets for Pakistan Textile Exports. As discussed previously, most of the technological advancements are in export-oriented firms. So regulations in these two markets are expected to have the greatest impact on transitioning towards cleaner manufacturing practices. Various regulations are coming in effect:

- EU Green New Deal

The EU Green New Deal aims at transforming the EU economy into a resource-efficient and competitive economy, by making changes to its climate, energy, transportation, and taxation policies. It aims to reduce the net greenhouse gas emissions by at least 50% by 2030 (European Commission, 2024). The green new deal encompasses regulations for exporters to the European Union, promoting climate friendly manufacturing and transportation.

Targets of EU Green New Deal

Source: APTMA Knowledge Brief Series, 2023

- EU Strategy for sustainable and circular textiles

The EU strategy for sustainable and circular textiles focusses specifically on the textile sector, in terms of its consumption and production. It envisions a move away from fast fashion by 2030. This is to be achieve by ensuring that "all textile products placed on the EU market are durable, repairable and recyclable, to a great extent made of recycled fibers, free of hazardous substances, produced in respect of social rights and the environment", wide availability of "profitable re-use and repair services", with "producers taking responsibility for their products along the value chain" (European Commission, 2024). This strategy has a major impact on Pakistan textile industry, since the European Union is traditionally its largest export market. The strategy requires exporters to be responsible for their supply chain as well, implying that the exporters of textiles to the EU are now forced to bring about changes not just to their own processes, but also to their input suppliers along the value chain. During interviews for this report, major export-oriented textile firms in Pakistan were found to be cognizant of this EU strategy, and already working towards implementing changes to their production processes. However, they were generally wary of bringing changes along their input value chains, as their inputs come from sectors which are largely non-corporate. The expectation is that these smaller firms will eventually be forced to bring about the required changes due to fear of losing market share.

- Climate and Resilience Law (environmental labelling)

This French law came into effect in 2021, and covers many aspects of life including food, transportation, and consumption products. France is 10th largest export market of Pakistan's textile industry, with over USD 340 million worth of textile and clothing exports in 2021. More significantly, the Climate and Resilience Law will also become applicable EU wide in 2030. Its direct impact on Pakistan's textile sector is the requirement that products sold in France shall have an environmental label. In the initial phase, a few categories of products are required to carry the environment label by 2030, which includes textiles. The label shall contain information about the environmental impact of the product and compliance along the entire lifecycle (Makersite, 2024). Due to this new law, exporters of textile products to France will need to have complete account of their production process in terms of its impact on the environment. Furthermore, it is expected that the customers will become more aware of the environmental consequences of their purchases of textile products, resulting in preference for products with lower environmental impact. Therefore, textile producers will face a new form of competition in producing merchandise with least environmental damage.

- Anti-Waste for a Circular Economy Law (French law)

This French law envisions elimination of waste and environment damaging substances in the entire manufacturing process. It mandates phasing out of single-use plastics by 2040, "promote a better resource management system from design stage to the recovery of materials", and "provide better and more transparent information to consumers" (Ellen Macarthur Foundation, 2022).

All of these, and other such policies, are already creating changes in export-oriented firms within the textile sector. Large firms, and conglomerates, like US Apparel, Master textiles, Crescent Bahuman, etc. have made tremendous transitions in the past few decades towards adoption of globally acknowledged best practices, and have made significant investments to reduce the carbon footprint of their firms.

7. Barriers to Transitioning towards a Greener Textile Industry

7.1 Resistance

Emission reduction requires structural changes at the firm level, incurring costs as well as labor displacement. Firms are geared towards maximizing costs, generally by socializing the costs. Environmental damage has long been considered an externality, which is why this cost is borne by the society at large. So the transition towards a clean and green textile sector implies a move away from the established practices at the expense of the industry. This is resisted – when enforced – and ignored otherwise.
The matter is worsened by the presence of significant political clout of the textile sector in Pakistan. This political clout is based on a variety of factors:

- the sector is amongst the oldest formal industrial sectors
- has been subsidized since the first five year plan 1955-60
- many in the power circles either hold stakes in textile sector, or are financed by them

-   as the largest exporter with close to 60% of the national exports attributed to the textile sector, the influence on policy is significant in a foreign exchange starved country that is Pakistan
-   largest employer status gives political strength to this sector

Due to these factors, the textile sector is able to resist changes to industrial policies that may harm its profitability. Among a leading concern is regarding formal documentation, as that would make these firms liable to implement existing laws. As will be discussed later, implementation of environment related laws is lax in Pakistan, very few cases are filed against the transgressors, and even fewer are decided.

7.2 Lack of Clear Standards

In the earlier section on the structure of the textile industry, it is shown that all the sectors of the textile industry have presence of large number of small and medium enterprises, often operating in a non-corporate setting. There is lack of understanding of the impact of their business practices on the environment, and the expectations for a move towards a more climate sustainable sector. This is exacerbated by the availability of clearly defined actionable micro-level objective standards. In their absence, the firms are left with vague objectives and goals, which are difficult for small and medium sized firms to understand and establish. This, coupled with lax enforcement, implies that the firms are able to easily stave off this transition with ease.

International standards have largely been established, and countries have generally signed on to national goals, including Pakistan. However, the policy (described in the section on Policy Landscape) is vague for a small or medium sized enterprise, and lacks clear actionable items. For instance, how the greenhouse gas emissions of a small enterprise will be measured when it is a non-corporate entity without formal registration? What alternate model shall an enterprise adopt that reduces the water pollution caused by pumping down of the polluted water into the sub-soil water streams? The governing bodies shall, in consultation with all stakeholders, formulate micro-level standards, mechanisms to gauge various climaterelated contributions of individual firms, and present business models for each category of objectives. With these clearly defined, the stakeholders will be able to compute the impact of each standard on their net profits, allowing informed and objective policy formulation and implementation.

7.3 Enforcement

It is generally known that law enforcement is generally lax in small less developed economies. Environmental laws are ever harder to enforce, due to lack of public will due to lack of understanding of their impact for common good. Moreover, environment is a public good, and an externality for the individual firm, implying that the incentives for the individual firm are to underreport and hide their contributions to climate pollution. The World Wide Fund for Nature (2018) states that there are no environmental audits for medium-sized firms, and no penalties at any level. Sattar and Akhtar (2022) show that the number of convictions for the textile industry is significantly lower than for other industries. This is even more significant when considering that the number of cases brought to the environmental tribunals in Pakistan are significantly lower than those in other parts of the world.

Figure 9. Comparison of Number of Convictions by Environmental Tribunal
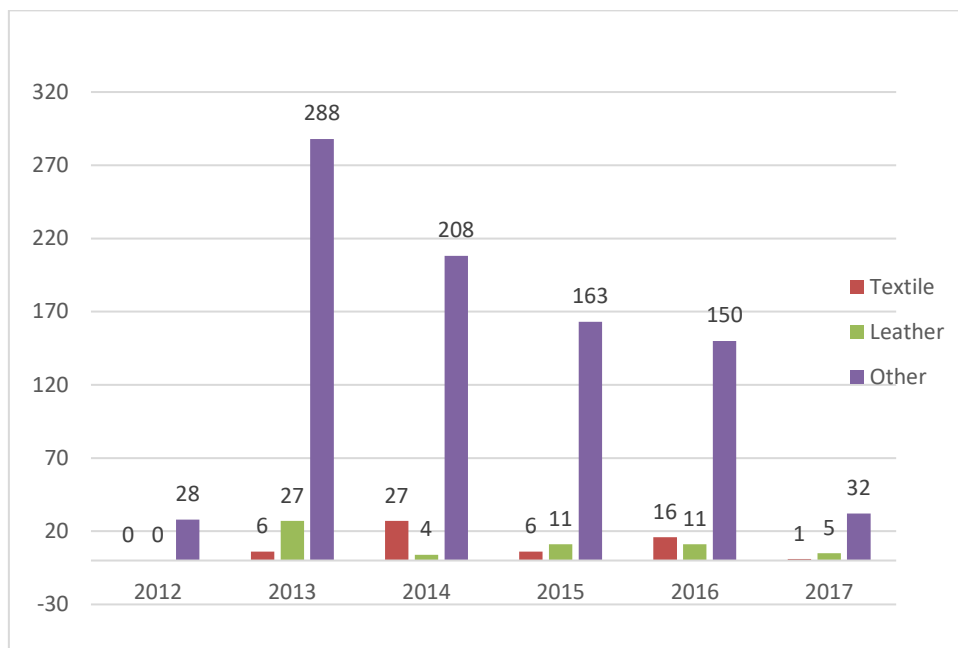
7.4 Institutions

In the absence of effective public institutions to enforce a transition towards environmentally friendly industrial practices, and the political clout of the textile industry to lay ineffective any attempt towards such enforcement, informal institutions are required. An important mechanism in such a situation is change from within – a move towards sustainable environmentally friendly manufacturing practices due to understanding of this issue as a global player. Such a change from within is possible when the industry understands the problem and is motivated to bring about a positive change. However, the textile sector in Pakistan lacks such peer pressure as well as understanding.

An important change agent is the demand, where the customer forces changes by altering buying behavior in favor of green producers. Such understanding is still lacking in the domestic customer base. However, importing nations are fast applying policies and regulations, a sample of which are discussed in the previous section, making it increasingly difficult for exporters to continue with non-sustainable manufacturing practices. At the moment, this is the primary change agent for the textile sector of Pakistan. The EU's Carbon Border Adjustment Mechanism (CBAM) is one such tool that the EU is using to put a fair price on the carbon emitted during the production process. The first reporting period for importers ended on January 31, 2024. While textiles are presently not covered by CBAM, the sector will eventually be covered, so the export-oriented firms are already considering it when planning for the future. Large export-oriented firms are not just required to change their own practices, but are also required to affect change in their supply chain. Furthermore, the technology adoption process is such that the initial changes in technology occur in large firms, which are then adopted by smaller firms, even if they are catering to the domestic market.

Changes in the production practices of a vast majority of firms moving towards environmentally sustainable manufacturing can be traced back to the aforementioned mechanism.

7.5 Carbon Border Adjustment Mechanism (CBAM) and Pakistan

CABM is a proposed duty on imported goods into the EU based on GHG emissions in their production process. The policy is widely considered to be designed to dis-incentivize offshoring of production by EU producers. This will impact textile exports to the EU due to increased cost of transitioning towards green production, increased compliance costs, etc.

No robust estimates of the exact impact on Pakistan's textile exports to the EU exist at the moment, as textiles arenot on the list of industries on which CABM is coming into effect from 2025. The implementation of CABM may change the industry in a variety of ways, affecting Pakistan's textile industry in the process. Some of the possible scenarios are discussed below:

- Consumers become increasing sensitive to the origin of the textile products, resulting in a shift towards buying local. In this scenario, CBAM will act affectively as a protection measure for EU-based textile firms, wiping away competition from imported goods. Pakistan's textile industry will suffer heavily in this scenario; resultantly, climate friendly production technology adoption will be minimal.

- The increase in production costs due to CBAM ispassed on to the consumer and results in price hikes and a global move away from fast fashion. The textile industry, around the world, will then compete using product differentiation and the longevity of their product. Pakistan textile industry will follow suit, resulting in partial adoption of climate friendly production processes, since some may continue to produce using old methods, absorbing CBAM in price hike.

- The price hike is mitigated by improvements in production efficiencies. Firms not adopting climate friendly production will be edged out. In this scenario, the global textile industry will move towards the new technology. Initial advantage of EU textile producers will be soon deflected by producers in Pakistan, Bangladesh, etc. due to their reduced cost. This will have a greater impact on climate friendly production, as any firm not adopting the new standards will face the threat of extinction.

- Another possible scenario is that CBAM is not adopted by non-EU countries. The global textile market will be bifurcated. Pakistan textile industry will get specialized in terms of export regions. Firms exporting to the EU will adopt climate friendly technologies, while firms exporting elsewhere will continue with traditional methods. The impact on climate might be minimal, as firms targeting the EU market might import their inputs, resulting in minimal change in input industries' technologies. Alternatively, adoption of climate friendly production technology may be widespread, with the Pakistan textile industry attempting to edge out competition and take the lion's share of the EU market.

Since textiles is not in the list of industries on which CBAM will be applied starting 2025, most of the Pakistan export-oriented textile industry leaders interviewed for this report appear to be observing this new phenomenon closely. Government of Pakistan's Textiles and Apparel Policy (2020) makes no mention of CBAM, depicting the lack of commitment at this stage.

8. Labor Force

Pakistan's textile industry employs approximately 45 percent of the total industrial labor force, out of which approximately 30% workers are female (GIZ, 2024). This is higher than the national level female Labor Force Participation Rate (LFPR) in Pakistan, which at 21.3% is significantly lower than any comparable economy (Pakistan Bureau of Statistics, 2022). According to World Economic Forum Gender Gap Report 2023 (World Economic Forum, 2023), Pakistan is ranked 142 on The Global Gender Gap Index, out of 146 countries evaluated. In this region, India is ranked 127, while Bangladesh is ranked 59.

Within the textile sector, the female employment varies dramatically based on trade, which is high in stitching and quality assurance, low in weaving and spinning. Globally, the textile sector is known to employ female labor in large numbers, and in some countries, the textile sector employs more women than men. In Pakistan, weaving and spinning are still predominantly considered male centric, which is another reason for overall low female employment in this sector. According to findings of Dr. Laurie Reijnders and Ms. Farida Khan, presented at the ILO sponsored consultative session on the Gender wage gap in the textile and garment sector of Pakistan (2016), gender wage gap is found to be higher in the textile industry at 33 percent, as compared to the rest of the country where the gender wage gap is estimated at 26 percent. Reasons for low female LFPR include:

- Social norms

  In a traditional Pakistani household, the wife takes care of chores at home while the husband acts as the bread winner in the market. This doesn't imply that the women are necessarily restricted to the confines of the house, though that is also witnessed. Women do leave the house for shopping, etc. In rural settings, women also work the fields. However, traditionally, women do not exchange labor for compensation in labor market. This traditional household has inertia, acting as a major barrier for women to be embedded in the labor markets.

- Perception of workplace harassment

  Women are perceived to be more prone to harassment than men. Many believe that a woman is likely to face harassment in the place of work, as well as during travel to and from work. Thus, women are restricted from working in any industry in Pakistan.

- Transportation

  Ample transportation facilities are generally not available. Resultantly, travel to and from place of work often requires transferring between multiples modes of transportation, with high degree of uncertainty in their timings and availability. Most of the working class does not have access to a motor car. Men use motorcycles widely in Pakistan, while a woman driving a motorcycle has been considered a taboo in Pakistan. Over the past decade, this trend is changing whereby women have started to ride motorcycles independently. This is expected to help improve mobility. Some large textile firms have instituted their own transportation services, which is why women employment in textile sector is slightly better than other manufacturing sectors.

- Lack of separate facilities (e.g. toilets, etc.)

  Since Pakistani society has been patriarchal for a long time, there is lack of understanding for female workers' requirements. Most offices have little to no facilities for female workers, including but not limited to, toilets, personal hygiene products, child care centers, etc.

- Education and skill development

  Due to patriarchal nature of the society, women are less likely to get education, especially technical education, as compared to men. About a third of Pakistan's school aged children are out of school, with greater proportion of female children. This situation is improving in the urban areas, but will take a while before this change translates to increased female participation in the labor market.

- Linkages to other sectors

  Other sectors also play an important role in improving female labor force participation. If one sector has higher female presence, it is likely that female labor participation will increase in closely linked sectors. This is generally attributed to ease of communication, comfort level of women working with other women, increased hiring referrals of same gender, etc. Textile sector in Pakistan has better gender balance than the economy on average, partly due to linkages especially in the knitting and stitching sector.

- Reservation wage

  Reservation wage is a known key determinant of entry decision for labor. This seems to be high in Pakistan, considering that the national gender wage gap is 26%, still much better than other similar less developed economies. An interesting comparison of Pakistan is with Bangladesh, which is ranked 83 places better than Pakistan on the Global Gender Gap Index 2023 rankings, published by World Economic Forum. Dr. Hafeez Pasha, a leading economist in Pakistan and former UN Assistant Secretary General, ascribes this to the much lower reservation wage of the Bangladesh female labor.

- Role of state and lack of public investments

  The role of the state in promoting gender neutrality is well documented (Thévenon, 2013). Some of the determinants of labor force participation, as discussed above, can be improved through policies and public investments. However, Pakistan has long been mired with polarization in politics and religion, leading to issues related to household dynamics being considered taboo. The inertia has built up overtime, and the governments have done little to improve this key variable. In more recent years, discussions have started especially due to the growth pattern displayed by Bangladesh, largely attributed to women in the formal labor market. Government has recently launched women specific buses, pink motorcycles for women on subsidized rates, women focused educational initiatives, etc.

9. Solutions

Transitioning towards an environmentally friendly textile industry is riddled with barriers, which are briefly discussed in the previous sections. Due to a wide array of stake holders, the policy space to overcome these barriers is very limited as most choices adversely

impact at least some players. Hence, a pareto-improvement appears to be an impossibility. However, given the swiftly deteriorating climate conditions, it is imperative that a transition be made towards climate friendly manufacturing processes. Such transition is pivotal for the wellbeing of the people.

Due to competing interests, universally agreed upon solutions are rare. The policy makers need to work towards reducing the GHG emissions and carbon footprint of the industrial sector, of which textiles is the largest in case of Pakistan. The world leaders seem to agree to this objective, as shown by the outcome of the COP27 and COP28 summits.

An important aspect related to reducing the impact of industrial production on climate change - often overlooked - is lack of awareness, especially amongst the small and medium enterprises. This can be overcome by strong and consistent advocacy for better practices. A recent study shows that in case of Vietnam, consumer awareness impacted the transition towards demand for "green product consumption" (Nguyen, 2023). Similar findings have been made for other countries[5], showing that the demand for better environmental practices comes from consumers due to their knowledge of the disastrous effects of business-as-usual practices. Strong advocacy for better practices will make producers as well as consumers more cognizant of the dangers of environment degradation. In Pakistan where law enforcement is lax, and the textile industry has strong clout over policy making (previously discussed), an organic change in the behavior of the producers as well as consumers is likely to bring about a more sustainable change to the production practices. This has been witnessed in other instances in Pakistan. For instance, the dairy industry ran public campaigns about the dangers of using non-packaged milk. This brought about a significant change in consumer behavior, which in turn led to a transition towards packaged dairy products, especially milk.

Technical and technological advancements can also lead to adoption of better practices. There are two ways to bring about such change: either through enforcement in the large firms with downstream adoption to follow, or through direct intervention by policy makers to onshore the latest technology directly at various levels of production value chain.

Recycling innovations are already underway, with significant emphasis being laid on the RRR (reduce, resale, recycle) approach. Some producers interviewed stated that a couple of decades ago, their focus used to be on acquiring international certifications like ISO. Overtime, they have realized that these certification standards keep evolving, causing a continuous change in the production process, which is often costly. More recently, they claim that they have developed in-house expertise to understand global long-term trends, for instance SDGs, which are now included at the strategic planning stage. As a result they find it easier to acquire the required certifications without much change in their existing strategies and plans. For instance, US group (one of the largest manufacturers and exporters of apparel) has provided funding for a project at the Institute of Polymer and Textile Engineering, University of the Punjab, Pakistan, to convert cotton cloth into liquid and back into a fiber to recycle cotton. Master Textile, another major textile exporter, has entered into an MoU with the Government College University, Lahore, to plant two acres of urban forest on the latter's campus. This will help achieve a net zero standard for Master Textiles. Similar initiatives are being taken by many other large-scale textile manufacturers. However, such initiatives are primarily being taken only by large export-oriented firms. The RRR approach is one such example, where firms understood the future of the textile value chain and planned their capital investments

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[5] For detailed review, see (Barbu, Deselnicu, Catană, Cioca, & Ioanid, 2022)

accordingly. The data on such investments in Pakistan is rare and the estimates are generally not reliable, since the transformation towards RRR approach is still in its early days and now widely applied. Similarly, there is discussion around reshoring / nearshoring to shorten the supply chain as well as satisfying the new laws coming into effect, particularly in Europe, regarding Environmental labelling.

The policymakers can institute change by running Customer Awareness campaigns. Various regional studies have shown that increasing volume of customers have been found to be cognizant of the environmental impact of their buying behavior, but are unaware of how to act effectively. Running Awareness campaigns will show customers how to act, which will in turn affect change.

Effective incentives, including but not limited to financial support, supportive taxation policies, stringent law enforcement, etc. can also instil change in the textile sector. As earlier discussed, financial support is critical especially considering that the central bank discount rate in Pakistan is 22%, and is expected to hold steady in the near future. Capital investments at this rate are not financially viable, which is represented by little to no investment in the country. Alternative financial instruments shall be created to finance capital investments required for the transition towards an environmentally friendly textile sector.

The textile industry in Pakistan is beneficiary of many subsidies, with the export subsidy leading the way (Pakistan Economic Survey, 2023). This taxation and subsidy structure needs closer inspection and readjustment to give high priority to environmentally friendly business practices. A carefully calibrated taxation policy can incentivize the cottage industry and small firms towards a step-by-step objective approach towards a sustainable future.

Industrial change is generally slow due to built-in systemic inertia. In case of a transition towards environmentally friendly manufacturing practices, the inertia is further enhanced since the goal is betterment of a public good at the expense of private costs. Furthermore, the key players argue that Pakistan is responsible for under 1% fo GHG emissions, so the transition to an environmentally friendly, but more expensive production process, will reap no benefit until the entire world doesn't correct its course. This argument, and the resulting resistance to change, is ultimately about firm profitability concerns. This argument supports the potential efficacy of incentives, provided that they are well-designed and well-directed, along with appropriate regulations.

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Appendix

Figure 10. Textile Industry Value Chain
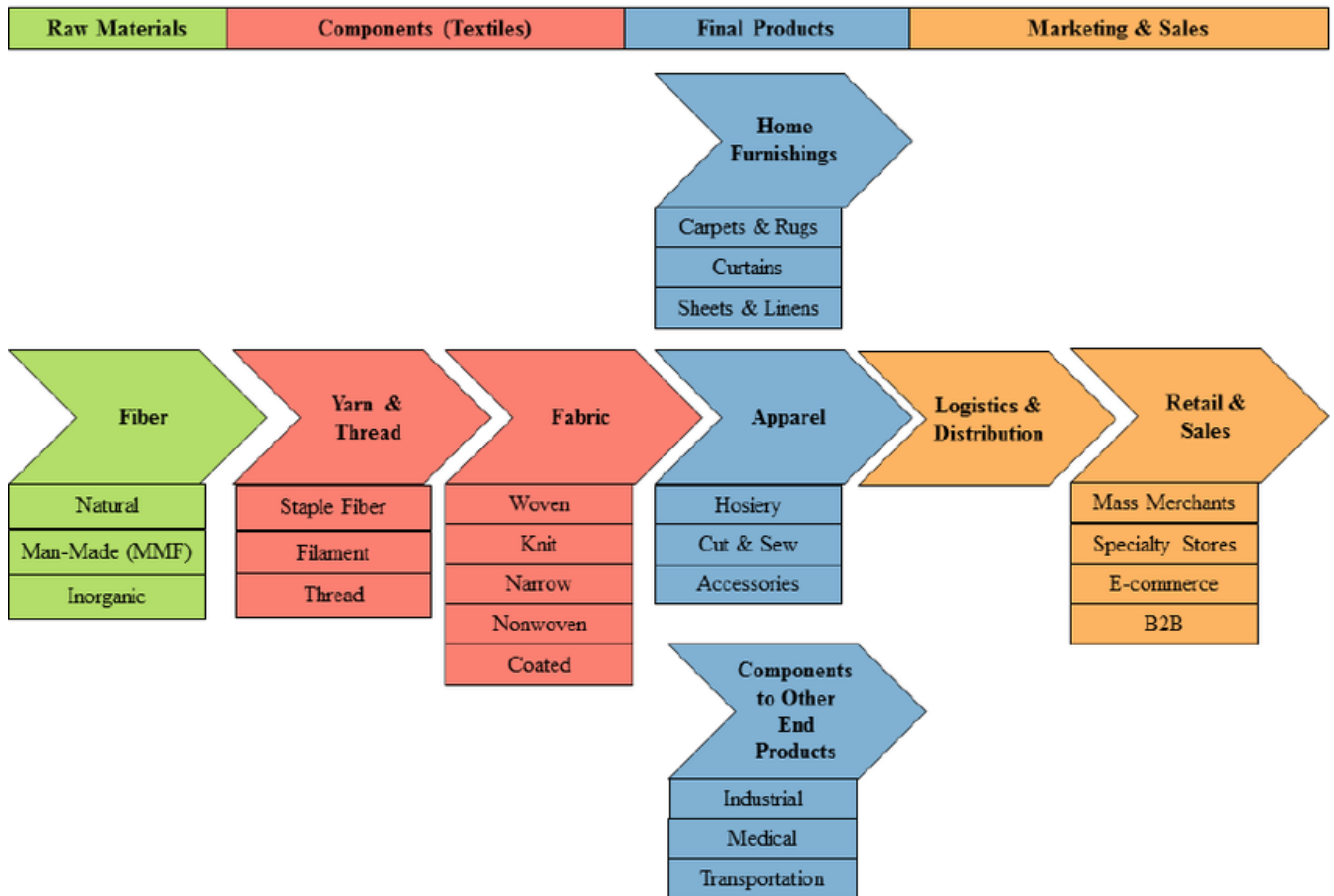
Source: (Bair, Frederick, & Gereffi, 2016)