National Strategy to Boost Vietnam's Textile and Garment Productivity through Innovation and Technology

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NATIONAL STRATEGY TO BOOST VIETNAM'S TEXTILE AND GARMENT PRODUCTIVITY THROUGH INNOVATION AND TECHNOLOGY

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National Strategy to Boost Vietnam’s Textile and Garment Productivity through Innovation and Technology
A strategic foresight project examining plausible future impacts and implications of technology and innovation for Vietnam’s textile and garment industry

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CONTENTS

FOREWORD

The Asian Productivity Organization (APO) was founded with a clear mission: to promote productivity as the cornerstone of inclusive and sustainable growth across Asia and the Pacific. For more than six decades, we have supported our member economies in building capabilities, strengthening institutions, and developing forward-looking strategies to meet the demands of an ever-changing global economy. At its heart, productivity is not merely about producing more with less. It is about enabling societies to flourish, enterprises to remain competitive, and people to live with dignity.

Vietnam's textile and garment industry, a sector that provides livelihoods to millions and sustains a vital share of national exports, exemplifies both the promise and the pressures of globalization. This sector has been an engine of growth, yet it now stands at a crossroads. Rising labor costs, skill mismatches, and heavy reliance on imported materials are challenging its competitiveness. At the same time, sustainability imperatives and shifting buyer expectations are reshaping the industry, demanding innovation, resilience, and transformation. Addressing these issues is essential if Vietnam is to maintain its global position and unlock higher value from its textile economy.

This publication offers timely and practical insights into future pathways. It highlights the strategic choices facing Vietnam as it navigates the twin imperatives of technological adoption and green transition. The scenarios and recommendations presented herein underscore a truth that resonates far beyond Vietnam's borders: productivity growth in the 21st century will be defined not just by efficiency, but by sustainability, adaptability, and the capacity to innovate. For the textile industry, this means embracing Industry 4.0, investing in human capital, and embedding circular practices into every stage of the value chain.

I invite policymakers, business leaders, researchers, and workers alike to reflect deeply on the analyses in these pages. The journey ahead is complex, but it is also filled with opportunity. By harnessing productivity as a driver of innovation and sustainability, Vietnam's textile and garment industry can move beyond being a supplier of low-cost labor toward becoming a global leader in sustainable and high-value production. In doing so, it will contribute not only to Vietnam's economic aspirations but also to the broader vision of the APO: a more productive, sustainable, and inclusive Asia and Pacific.

Dr. Indra Pradana Singawinata
Secretary-General
Asian Productivity Organization

EXECUTIVE SUMMARY

The textile and garment industry is a cornerstone of Vietnam's economy, playing a critical role in driving economic growth, employment, and export revenue. However, the industry is currently at a crossroads, facing significant challenges and opportunities as it navigates an increasingly complex global market. This report provides a comprehensive analysis of the industry's current state, the megatrends shaping its future, potential scenarios for its development, and strategic recommendations for ensuring its long-term competitiveness and sustainability.

Industry Overview

Vietnam's textile and garment sector, employing over 3 million workers, is a leading contributor to GDP and export revenue. The industry comprises two main sectors: textile production (fiber production, spinning, weaving, dyeing, and finishing) and garment manufacturing. Despite notable growth in exports over the last decade, challenges persist, including labor shortages, reliance on imported raw materials, and mounting sustainability demands. Rising labor costs, an aging workforce, and limited domestic value-creation capacity further stress the need for upskilling and technological adaptation, especially as Industry 4.0 gains traction globally.

The industry's heavy reliance on imported materials exposes it to supply chain vulnerabilities, underscoring the need to strengthen domestic supply chains. Additionally, the sector is highly energy-intensive, particularly in dyeing and weaving processes, increasing pressure to adopt sustainable practices as global buyers impose stringent Environmental, Social, and Governance (ESG) criteria. Although green technologies are emerging, widespread adoption remains limited due to outdated machinery and high energy costs.

Megatrends Shaping the Industry

Several global megatrends are reshaping the industry, including:

1. **Sustainability and circular fashion**: Increasing focus on ESG compliance and carbon-neutral manufacturing in major export markets such as the EU, the USA, and Japan.
2. **Geopolitical shifts and trade dynamics**: Opportunities are emerging in the expanding Chinese market amidst an increasingly competitive Asian manufacturing landscape.
3. **Textile innovation and advanced materials**: Growing demand for sustainable, durable materials to counter the fast fashion model.
4. **Digitalization and Industry 4.0**: Automation and digitalization are essential for enhancing productivity, efficiency, and supply chain resilience.
5. **Proactive buyers**: Buyers are increasingly active in the value chain, prioritizing sustainable and customized solutions, which drives deeper collaboration and co-creation with producers.
6. **Skilled labor**: The industry must compete with other sectors for skilled labor while adapting the workforce to meet the demands of digitalization and sustainability.

Future Scenarios

The report presents four potential scenarios based on varying levels of green growth and technology adoption. Total factor productivity is identified as the key driver for sustained growth, especially for the textile sector. Overall, the scenarios provide a forward-looking perspective on the industry's potential trajectories, offering insights into the strategic decisions that will shape its future.

- **Scenario 1 - Slow and Steady (Low Green - Low Tech)**: Focuses on incremental, low-cost improvements. Recommendations include small grants, low-interest loans, and pooled funding to encourage small and medium-sized enterprises (SMEs) in adopting energy-efficient practices and basic Lean methods for waste reduction. Workforce training emphasizes foundational skills, preparing the industry for gradual improvements in green and technological practices.
- **Scenario 2 - Tech Driven (Low Green - High Tech)**: Prioritizes productivity through technology, with limited green initiatives. Recommendations support tax incentives and loans for automation and AI tools, focusing on efficiency and global competitiveness. Training programs on advanced tech skills ensure the workforce can operate new technologies, while basic eco-friendly practices, such as energy monitoring, help firms prepare for future green requirements.
- **Scenario 3 - Green Driven (High Green - Low Tech)**: Emphasizes sustainability with limited technological investment. Grants and tax breaks are recommended for eco-focused initiatives, such as water recycling systems and sustainable materials. Industry associations are advised to foster shared sustainable infrastructure projects, with training in resource management and sustainability standards to build a workforce capable of eco-conscious production.
- **Scenario 4 - Sustainable Innovation (High Green – High Tech)**: Combines high-tech and high-sustainability practices. Recommendations include comprehensive financial programs (grants, tax credits, and low-interest loans) to support advanced green technologies like digital twins and renewable energy. Cross-functional training merges digital literacy with eco-friendly practices, positioning firms to meet global sustainability standards and establish Vietnam as a leader in sustainable textile production.

Core recommendations across scenarios:

- **Financial incentives:** Provide structured support tailored to each scenario, from low-interest loans for incremental changes to substantial grants for high-tech, green integration.
- **Workforce development:** Equip the workforce through training programs that range from foundational skills to advanced digital and green capabilities.
- **Sustainability and green transition:** Promote gradual or comprehensive green practices, aligned with scenario-specific priorities, to meet international standards and market expectations.

These recommendations offer a pathway for Vietnam's textile and garment sector to navigate global challenges, ensuring sustainable and competitive growth that aligns with evolving market demands.

1. INTRODUCTION

The textile and garment industry holds a pivotal position in Vietnam's economy, contributing significantly to the nation's GDP, employment, and export revenue. As one of the country's largest industries, it has become a cornerstone of Vietnam's economic development, driving growth and providing livelihoods for millions of workers. Vietnam's strategic location, coupled with its competitive labor costs and an extensive network of trade agreements, has positioned the country as a key player in the global textile and garment supply chain. However, the industry is not without its challenges. As the global market evolves and technology advances, the industry faces increasing pressure to innovate and adapt. One of the most pressing challenges is the shortage of skilled labor, exacerbated by the rapid pace of technological change. The transition to Industry 4.0, characterized by automation, digitalization, and the integration of advanced manufacturing technologies, necessitates a workforce that is not only larger but also more skilled. Additionally, the industry must contend with the increasing demands for sustainable and eco-friendly production processes, which require substantial investment in new technologies and practices.

Furthermore, the competitive landscape is shifting, with Vietnam's traditional advantage of low labor costs being gradually eroded by the rise of automation and the increasing attractiveness of other sectors, such as electronics and high-tech industries. This shift demands that Vietnam's textile and garment industry reevaluate its strategies to maintain its competitive edge in the global market. The industry must also address the high turnover rates and the challenges of maintaining stable labor relations, which are critical to ensuring consistent production and meeting international standards.

The purpose of this report is to provide a comprehensive analysis of the current state of Vietnam's textile and garment industry, identifying the key opportunities and challenges it faces in the context of global megatrends and technological advancements. The report aims to offer insights into how the industry can navigate these challenges, capitalize on emerging opportunities, and strategically position itself for sustainable growth in the future. By examining the impact of Industry 4.0 technologies, shifts in global demand, and the increasing importance of sustainability, the report seeks to guide stakeholders in making informed decisions that will shape the future of the industry. This report is organized into four main sections:

- Overview of the Industry: This section provides a detailed overview of Vietnam's textile and garment industry, including its economic significance, current state, and key challenges. It sets the stage for understanding the industry's role within the broader context of Vietnam's economic landscape.
- Megatrends in the Textile and Garment Industry in Vietnam: This section explores the major trends that are influencing the textile and garment industry in Vietnam. These include sustainability and circular fashion, geopolitical trade shifts, digitalization and Industry 4.0, textile innovation and advanced materials, proactive buyers, and skilled labor.
- Scenarios: Building on the insights from the previous sections, this part of the report presents possible future scenarios for the industry. These scenarios consider two critical factors: green growth and technology adoption, offering a forward-looking perspective on the industry's potential trajectories.

- Recommendations: The final section of the report provides strategic recommendations for industry stakeholders, including policymakers, business leaders, and investors. These recommendations are designed to address the challenges identified earlier and to leverage the opportunities presented by emerging trends and technologies.

2. CURRENT STATE OF THE TEXTILE AND GARMENT INDUSTRY IN VIETNAM

2.1 Overview

The textile and garment industry in Vietnam can be broadly decomposed into two main sectors: the textile sector and the garment (or apparel) sector. The textile sector involves activities such as fiber production (both natural and synthetic), spinning, weaving, knitting, and finishing fabrics, as well as key subsectors like dyeing and printing, which add significant value through aesthetic and functional enhancements. Meanwhile, the garment sector focuses on the design, cutting, and stitching of fabrics to produce a wide range of apparel products. Subsector specialization, such as in sportswear, fashion, or technical textiles, is essential for meeting the diverse and evolving needs of both domestic and international markets.

Each subsector plays a critical role in the overall supply chain: the textile subsectors provide the necessary raw materials, while the garment subsectors add creativity and functionality, transforming fabrics into finished products. The future success of Vietnam's textile and garment industry will depend on the efficiency, innovation, and sustainability of these subsectors, with enhanced integration between them being crucial for capturing greater value and competitiveness in the global market.

The industry's growth over the past decade has been remarkable. Between 2012 and 2022, textile exports surged by 115%, while garment exports grew by 89%. The number of garment firms increased by 217%, accompanied by a 169% rise in capital investment in the textile sector (GSO, 2023). Vietnam's strategic location, competitive labor costs, and commitment to technology and innovation have made it an attractive destination for global manufacturers and fashion brands. By 2022, Vietnam's textile and garment exports reached USD44 billion, making the country one of the world's top exporters. Knitwear emerged as a key product category, accounting for 42.5% of total garment and textile exports in Vietnam (GSO, 2023). Despite fluctuations in demand, particularly a 9.6% dip in early 2023 (Statista, 2024), the sector remains a powerhouse, contributing more than 16% of Vietnam's GDP and employing over 3 million people.

However, the industry's export-heavy focus presents vulnerabilities. Dependence on markets such as the USA and the EU exposes Vietnam to global demand fluctuations and shifting trade policies. The industry's dualistic structure, characterized by large export-oriented firms and smaller, locally focused enterprises, presents additional challenges. Structural limitations like high upfront costs, an uncertain return on investment (ROI), and workforce shortages further complicate growth. Additionally, environmental sustainability remains a pressing concern. Vietnam has taken proactive steps to address these issues, including Vietnam's initiatives, such as the Sustainable Textile and Apparel Program by the Vietnam Textile and Apparel Association (VITAS) and strategic guidelines by the World Wildlife Fund (WWF) and the Development Strategy for the Textile, Garment, and Leather Footwear Industry of Vietnam until 2030, Vision to 2035, which include ambitious goals and measures to promote resource efficiency and reduce environmental impacts.

TABLE 1

SOME STATISTICS FOR VIETNAM GARMENT AND TEXTILE OVER TIME (SOURCE: WB, 2024 AND GSO) (*: ALL VALUES ARE IN REAL TERMS WITH 2010 AS THE BASE YEAR)

	2012		2022		Change	
	Textile	Garment	Textile	Garment	Textile	Garment
Export (USD'000)*	2452712	11565733	5284409	21856270.4	115%	89%
Number of firms (firm)	2238	4350	4693	13801	110%	217%
Capital ('000 bil VND)*	109092.3	85358.0	293690.2	173159.3	169%	103%
Gross Revenue ('000 bil VND)*	118.17	119.71	287.99	259.48	144%	117%
Labor ('000 employee)	277.15	1516.26	334.32	2918.94	21%	93%
Unskilled labor (%)	84.9	80.5	-5%			
Industry index (%)	104.2	107.5	102.6	115.2	-2%	7%

Understanding these dynamics is critical to ensuring the future success of Vietnam's textile and garment industry. Subsequent sections will explore productivity trends, labor dynamics, capital intensity, energy efficiency, and supply chain optimization. By examining each subsector, policymakers and industry leaders can make informed decisions that drive sustainable development and future growth.

2.2 Labor Trends

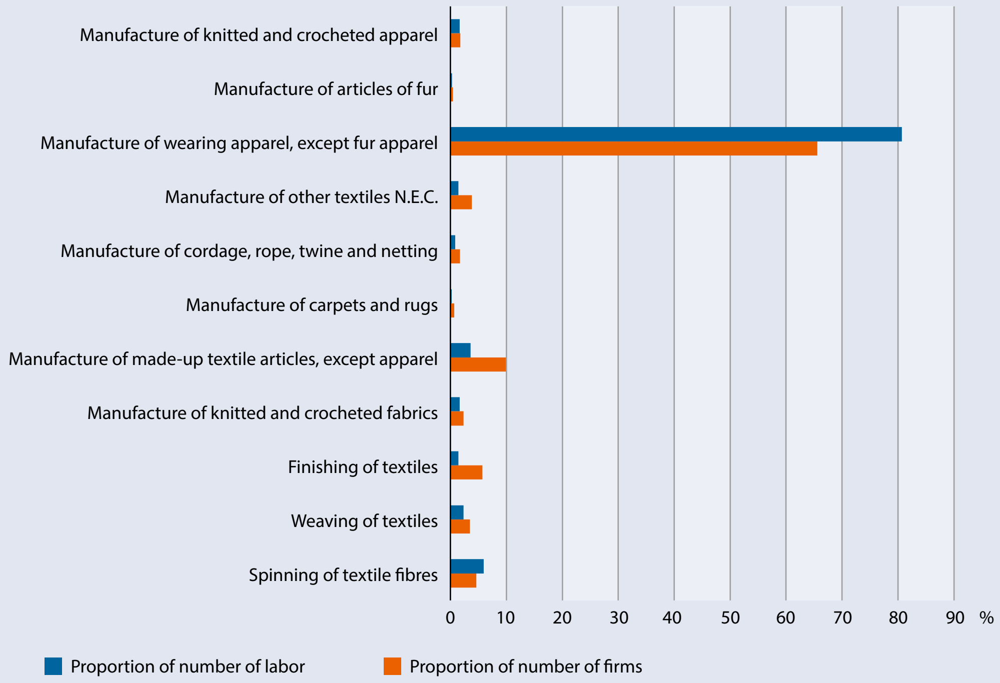
Labor is a crucial driver of Vietnam's textile and garment industry, which employs millions of workers, many of whom are women. In recent years, there has been a clear shift away from basic cut-make-trim (CMT) toward higher value-added, technology-enabled products and processes—such as more complex knitwear, functional/technical textiles, eco-materials, and shorter, personalized orders aligned with buyers' sustainability and traceability requirements. However, the industry still relies heavily on low-cost labor, particularly in rural areas. The availability of a large workforce has traditionally been an advantage, but as labor costs gradually increase, there is a growing need for improved labor productivity to maintain competitiveness.

2.2.1 Workforce Composition and Growth

Figure 1 provides a breakdown of the proportion of firms and labor within various subsectors of Vietnam's textile and garment industry. Notably, the manufacture of wearing apparel, except fur apparel, dominates both categories significantly, comprising 65.6% of firms and employing 80.7% of the labor force in the industry. This underscores the sector's central role in Vietnam's textile economy, highlighting its extensive employment generation despite representing a relatively high proportion of smaller firms. Conversely, subsectors such as spinning of textile fibers, finishing of textiles, and the manufacture of made-up textile articles exhibit higher proportions of firms relative to their labor contributions, suggesting potentially higher capital intensity or smaller scale of operations compared to apparel manufacturing. This distribution underscores the diverse composition of Vietnam's textile and garment industry, where different subsectors play distinct roles in terms of employment and economic contribution.

FIGURE 1

DISTRIBUTION OF NUMBER OF FIRMS AND LABOR ACROSS VIETNAM TEXTILE AND GARMENT SUBSECTORS IN 2022



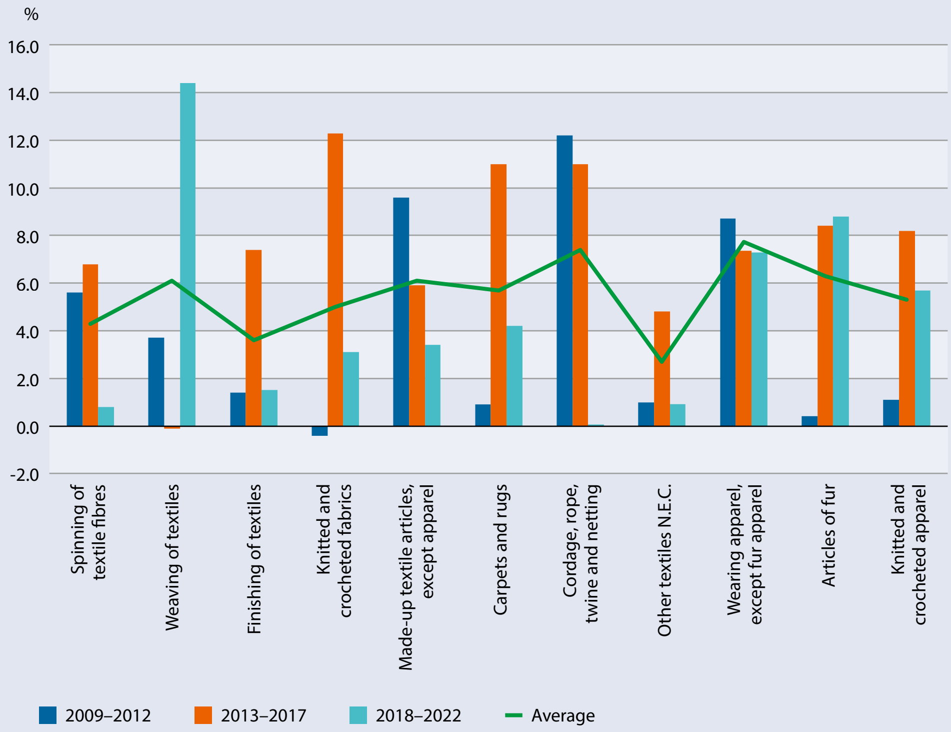
Source: Author calculation based on GSO survey data

Relating to growth, the textile industry in Vietnam has witnessed diverse growth trajectories within its key subsectors in the last 15 years. In the textile subsector, weaving of textiles stands out with an impressive average growth rate of 6.1% during the reviewed period. This growth has been fueled by the rising domestic and global demand for woven fabrics, which continues to drive job creation in the industry. Weaving has been a critical component of Vietnam's textile value chain, benefiting from the country's cost-effective labor force and its integration into regional and global supply networks.

Other key areas within the textile subsector, such as the spinning of textile fibers and finishing of textiles, have demonstrated more moderate growth rates of 4.3% and 3.6%, respectively. These subsectors contribute steadily to workforce expansion, ensuring a balanced distribution of employment across the industry's value chain. In addition, the production of knitted and crocheted fabrics has maintained a solid growth pace of 5.0%, reflecting sustained market demand and production efficiency, which continue to shape the labor dynamics within these subsectors.

FIGURE 2

LABOR GROWTH ACROSS GARMENT AND TEXTILE SUBSECTORS



Source: Author calculation based on GSO business survey data

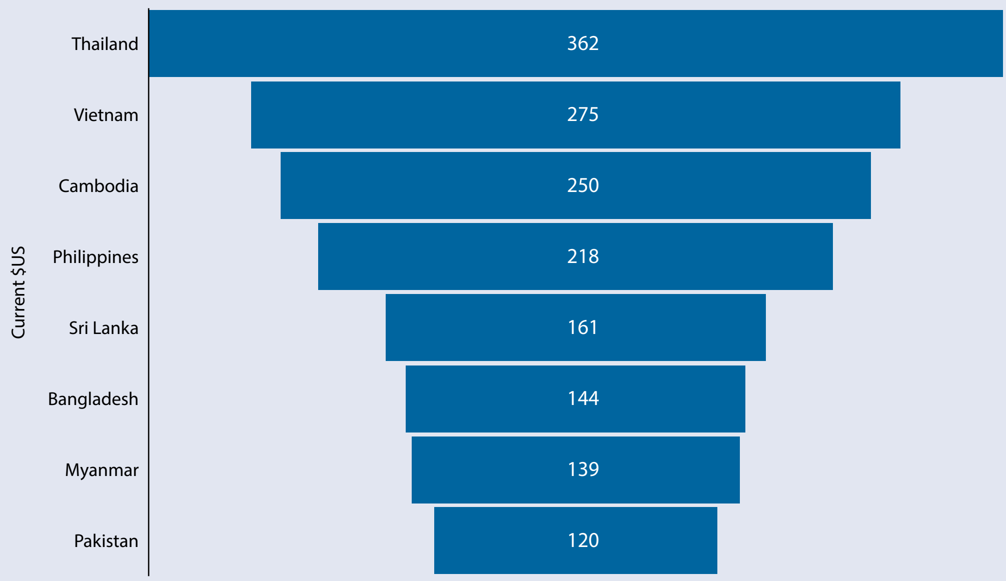
The garment subsector, particularly the manufacturing of wearing apparel (except fur apparel), has been a major driver of Vietnam's industrial growth. The subsector's labor force has grown at an impressive 7.7% annually, highlighting Vietnam's competitive advantage in garment manufacturing. This growth is supported by favorable labor costs, a relatively skilled workforce, and efficient production processes, positioning Vietnam as a leading exporter in global garment markets. Other segments, such as articles of fur and knitted and crocheted apparel, have also shown significant growth rates of 6.3% and 5.3%, respectively, reflecting the industry's diversified capabilities.

2.2.2 Wages and Employment Conditions

The competitive advantage of Vietnam's textile and garment industry is partly driven by its relatively low labor costs. Average nominal monthly wages range from approximately USD215-280 in Vietnam, placing it in the middle range compared to countries like Indonesia, Pakistan, and Sri Lanka, where wages are lower, and Thailand, where wages are higher at around USD362 (ILO, 2021). When adjusted for purchasing power parity (PPP), the wage gap between countries narrows, though Vietnam remains an attractive option for cost-sensitive manufacturing.

FIGURE 3

AVERAGE MONTHLY WAGE ACROSS COUNTRIES



Source: ILO labor survey

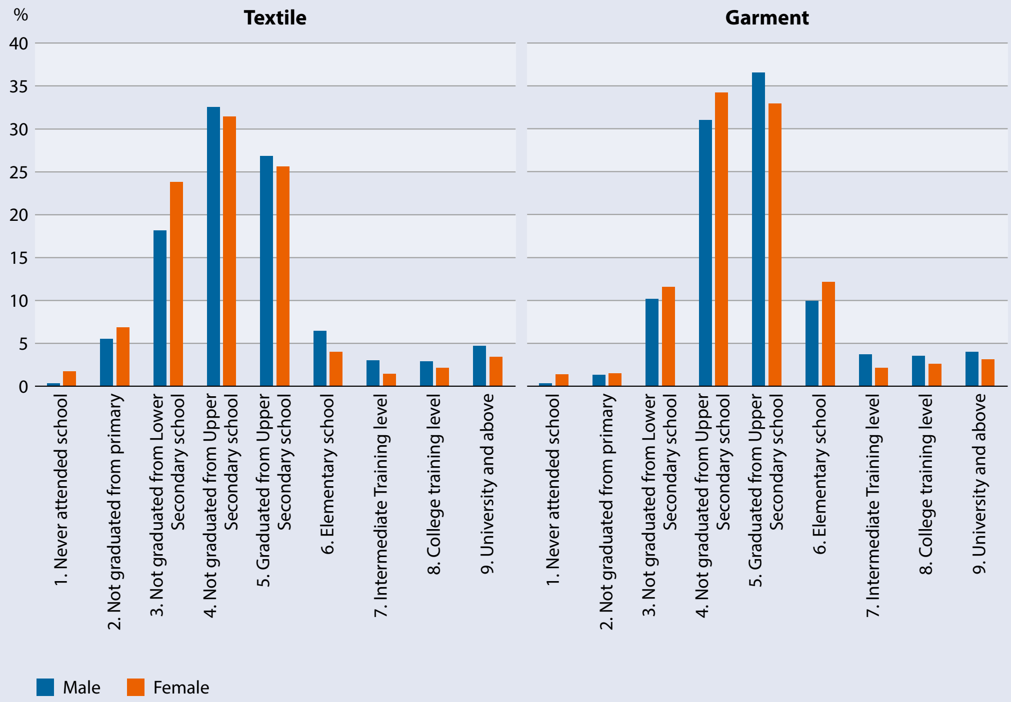
Despite these competitive wages, employment in the sector is characterized by a high proportion of temporary contractual arrangements. While Vietnam has the lowest share of informal employment among its peers, with only 25% of workers in the informal sector compared to 96% in Bangladesh and 76% in Cambodia, temporary workers still face significant job insecurity and limited access to social protection (ILO, 2021). Many workers are employed under casual contracts or as daily laborers, making them vulnerable to labor market fluctuations and global demand changes, particularly in the garment subsector.

2.2.3 Skill Development and Workforce Challenges

Figure 4 highlights the gender distribution and educational attainment among workers. It reveals that a significant proportion of the workforce, particularly female workers, occupies lower-skilled positions with limited educational qualifications, while consistently contributing a smaller proportion of workers with higher education levels (university and above) in both the garment and textile sectors.

FIGURE 4

LABOR BY GENDER AND EDUCATION LEVEL ACROSS TEXTILE AND GARMENT INDUSTRY IN VIETNAM



Source: ILO survey 2018

With the new wave of digitalization and new requirements to go green in production, the industry faces a pressing need to upskill its workforce, particularly in the textile subsector, where advanced technical skills are required for operating and maintaining sophisticated machinery. One of the core issues is the persistent mismatch between the skills provided by educational institutions and the practical requirements of the industry. Many training programs are outdated, lacking focus on modern technology, digital tools, and advanced machinery essential for the industry's evolution. As Vietnam climbs the global value chain, employers need workers proficient in handling automation, data-driven production processes, and high-precision manufacturing tasks. However, the current workforce often lacks these competencies, which constrains the industry's ability to innovate and grow, particularly in high-value areas like textile design, fabric engineering, and sustainable production practices. Employers frequently cite difficulties in finding technically skilled workers who can perform non-routine tasks required in more complex, innovation-driven environments, exacerbating the skills gap.

In addition to these skill-based challenges, high employee turnover rates further impede workforce development in the textile and garment sector (around 36% in 2020). Although the industry offers employment to millions, low wages, job insecurity—especially for those on temporary or informal contracts—and poor working conditions drive many workers to seek better opportunities. This frequent turnover makes it costly for companies to train and retrain workers, limiting investment in long-term skills development. Moreover, widespread misconceptions about the industry persist, particularly among younger workers. Many perceive textile manufacturing as outdated, low-tech, and physically demanding, dominated by repetitive tasks like cut, make, and trim (CMT) operations. These outdated perceptions, combined with practical concerns such as poor occupational health and safety standards—ranging from high dust concentration and noise levels to inadequate lighting and heat—discourage potential workers from entering the industry. Beyond these misconceptions, practical challenges also deter labor attraction. The sector continues to struggle with offering competitive wages, particularly in higher value-added roles that go beyond basic manufacturing tasks. Occupational health and safety concerns, including difficult working conditions with excessive heat, humidity, and poor ventilation, also play a significant role in hampering labor retention. These factors not only affect worker morale and productivity but also compound the industry's difficulty in attracting new talent, particularly as Vietnam seeks to shift toward more advanced, sustainable, and technology-driven manufacturing practices.

Demographically, there has been a noticeable shift from younger to middle-aged workers within the industry, indicating an aging workforce. The aging workforce in certain subsectors, particularly in textile production, poses additional challenges. This demographic transition necessitates strategic workforce planning initiatives focused on skills development, career advancement opportunities, and ensuring sustainable labor practices amidst changing labor market dynamics.

2.2.4 Gender and Labor Mobility

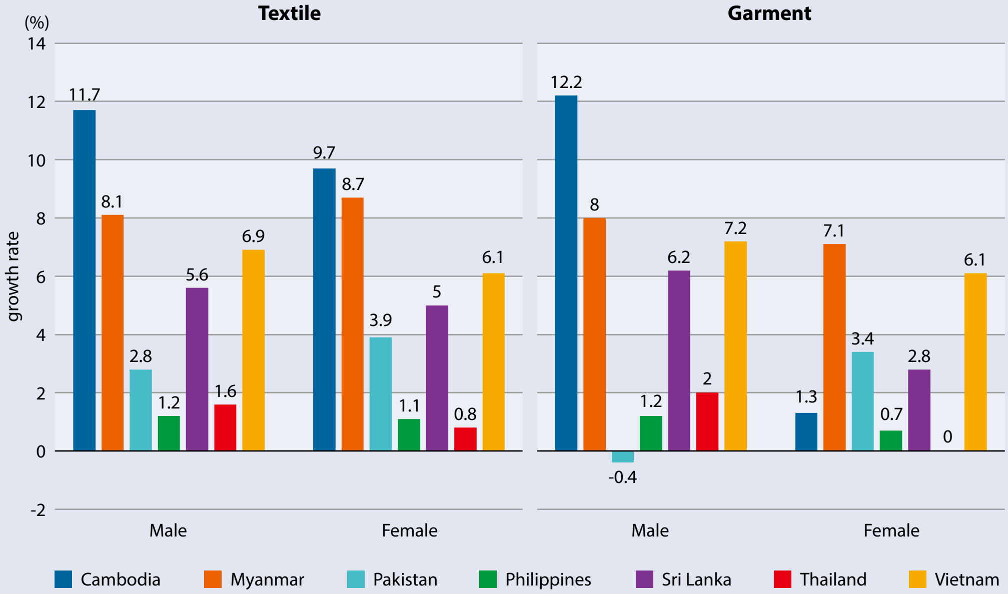
The industry's workforce is predominantly female, particularly in the garment subsector, where women represent more than 70% of the labor force (VITAS, 2021). This gendered labor composition has provided significant employment opportunities for women, but it has also raised issues related to gender wage disparities and career advancement limitations. Addressing these gender inequities will be vital for improving labor conditions and promoting more inclusive growth in the industry.

Gender disparity remains a persistent challenge within Vietnam's textile and garment industry, especially in terms of income inequality between female and male workers. Over the past decade, wages have grown for both genders, but the growth rate has been consistently lower for women compared to men. From 2010 to 2020, textile wages in Vietnam increased by 6.9% for males and 6.1% for females, while garment wages grew by 7.2% for males and 6.1% for females (ILO, 2021). Although wage growth in Vietnam was higher than in countries like Pakistan and the Philippines, it lagged behind Cambodia and Myanmar, where textile wages for males grew by 13.2% and 8.1%, respectively, and for females by 10.1% and 8.7%. Despite this, Vietnam's wage growth has been relatively balanced between genders, reflecting consistent improvements in both sectors.

Although there has been improvement in the wage gap, with the ratio of female to male income rising from 0.83 in 2012 to 0.90 in 2021, a significant gender disparity persists in the industry. Women constitute a significant majority of the workforce, particularly in garment manufacturing, where labor-intensive processes such as CMT are predominant. These roles tend to offer lower wages and limited career advancement opportunities compared to more skilled positions, which are often occupied by men. Female workers are over-represented among the sector's low-wage earners, with a high percentage earning less than two-thirds of the median income.

FIGURE 5

GROWTH RATE OF REAL MONTHLY WAGE OF EMPLOYEES ACROSS COUNTRIES IN THE PERIOD 2010-2020



Source: ILO

Furthermore, despite their critical role in the industry, many female garment, textile, and footwear (GTF) employees face additional challenges due to the gendered nature of the workplace. The sector is often described as being "female-dominated at the bottom and male-dominated at the top" where women occupy the majority of low-skilled roles, while men hold higher-paying, managerial positions (Vaughn et al., 2019).

In addition to wage disparities, educational attainment also highlights the unequal opportunities faced by women in the textile and garment sectors. A significant proportion of the female workforce occupies lower-skilled positions with limited educational qualifications, and they consistently contribute a smaller proportion of workers with higher education levels (university and above). This educational disparity further limits women's opportunities for advancement into higher-paying, skilled positions within the industry.

Labor mobility is another significant trend, with many workers migrating from rural to urban areas, where the majority of textile and garment factories are located. Provinces such as Ho Chi Minh City, Binh Duong, and Dong Nai are key manufacturing hubs, and internal migration has played a crucial role in shaping the workforce dynamics in these regions. However, these workers often lack access to formal education and training, perpetuating a cycle of low skills and limited mobility, which pose major challenges for the industry.

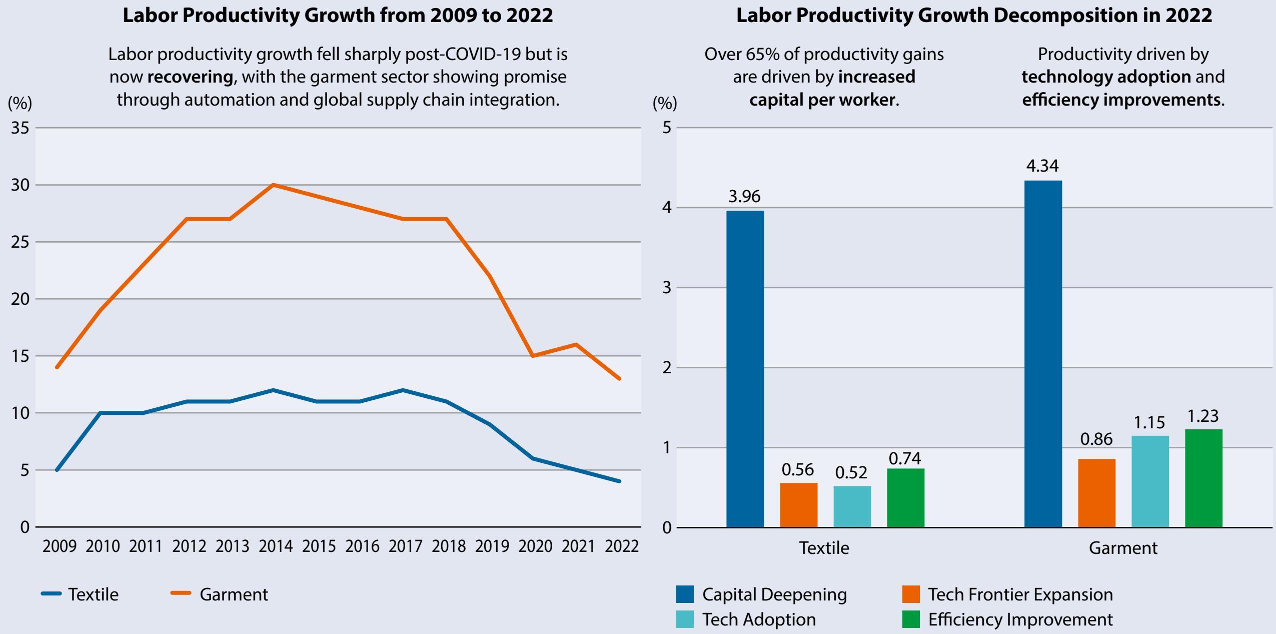
Moreover, migrant female workers, who make up a large portion of the workforce in industrial zones, face acute challenges. These migrant workers often experience difficulties accessing basic social services, with 90% reporting problems in their destination provinces. Specifically, 71% of migrant female workers lack access to public health services (Oxfam & CNCĐ Institute, 2021), exacerbating their vulnerabilities.

2.3 Labor Productivity

Labor productivity in Vietnam's garment and textile industry remains relatively low compared to global benchmarks. While the country benefits from a young and sizable labor force, productivity has been constrained by outdated technology and inefficient production practices. Recent efforts to improve productivity have focused on modernizing equipment, improving worker training, and streamlining production processes (Nguyen et al., 2021). However, despite these initiatives, productivity growth remains uneven across the sector. Figure 6 provides a snapshot of the labor productivity growth in Vietnam's textile and garment industry.

FIGURE 6

VIETNAM'S TEXTILE AND GARMENT PRODUCTIVITY GROWTH

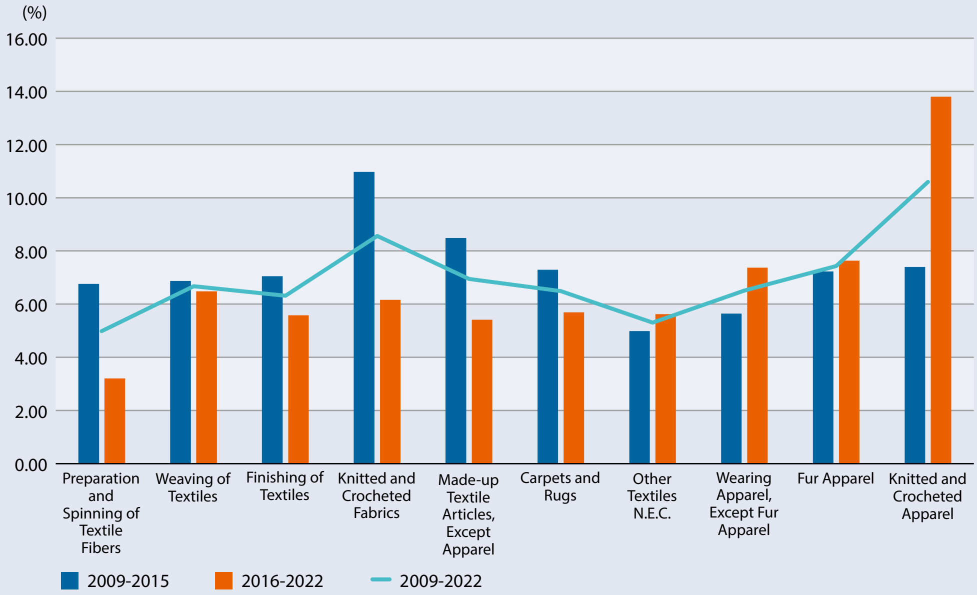


Source: Author calculation from GSO data

Figure 7 highlights notable trends in labor productivity growth within Vietnam's textile and garment subsectors between 2009 and 2022. While there have been efforts to modernize equipment, improve worker training, and streamline production, productivity growth is uneven across the industry. Over this period, there is a clear distinction between the performance of different textile-related industries and the garment sector, revealing divergent productivity trajectories.

FIGURE 7

LABOR PRODUCTIVITY GROWTH ACROSS TEXTILE AND GARMENT SUBSECTORS OVER 2009-2022 PERIOD



Source: Author calculation from GSO data

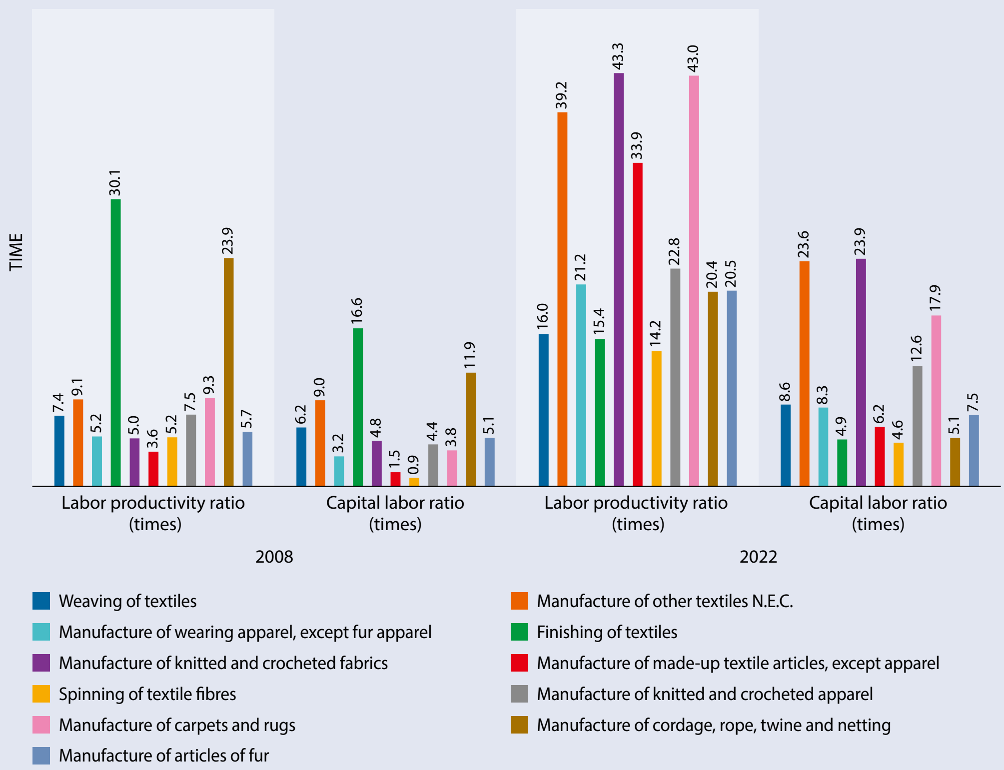
The garment subsector has shown more promising growth in labor productivity. Wearing Apparel, Except Fur Apparel, one of the most critical subsectors in Vietnam's garment industry, experienced an increase in productivity growth from 5.64% (2009–2015) to 7.37% (2016–2022). Notably, the Knitted and Crocheted Apparel subsector witnessed a substantial rise in productivity, surging from 7.39% to 13.80% over the same periods. This encouraging growth can be attributed to the sector's increasing focus on automation, the adoption of modern technologies, and Vietnam's growing integration into global supply chains.

The shift toward more value-added production processes, such as higher-end apparel manufacturing, has also contributed to the overall productivity gains in the garment subsector. However, continued investment in workforce training, particularly in non-routine, technical tasks, will be necessary to sustain this upward trajectory and further drive productivity growth.

In contrast, labor productivity in the textile subsector has generally experienced a decline in growth rate, particularly after 2015. For example, the Preparation and Spinning of Textile Fibers subsector saw a sharp drop in productivity growth from 6.76% (2009–2015) to 3.21% (2016–2022). Similarly, productivity growth in "Weaving of Textiles" decreased slightly from 6.87% to 6.48%, while "Finishing of Textiles" dropped from 7.05% to 5.58%. These declines suggest that, despite technological advances and increased demand, the productivity of the labor force in these subsectors has not kept pace with the sector's expansion.

FIGURE 8

DISTANCE BETWEEN THE 3% MOST PRODUCTIVE FIRMS AND THE REMAINING 97% OF FIRMS ACROSS GARMENT AND TEXTILE SUBSECTORS OVER TIME



Source: Author calculation based on GSO survey data

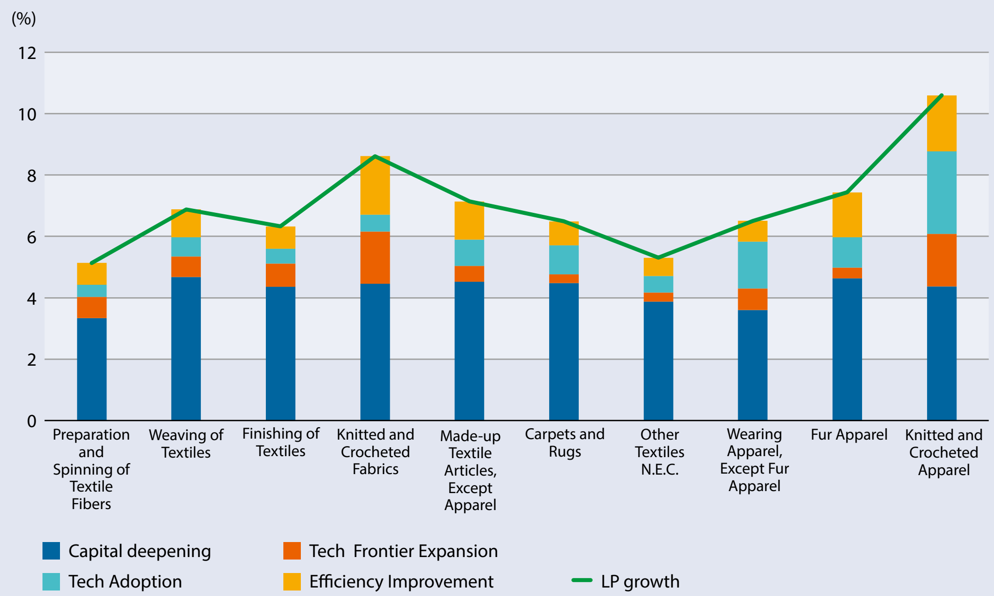
Several factors, such as reliance on outdated machinery, a lack of skilled labor, and slow adaptation to automation, may have contributed to this slowdown. These decreases may also reflect the broader challenge of transitioning from labor-intensive, low-value-added production processes to more capital-intensive, high-value-added activities in the textile subsector. This shift often requires a longer adaptation period, as it involves significant investments in technology, infrastructure, and workforce training before the full benefits can be realized. The slower productivity growth indicates that many firms are still in the process of upgrading their operations to meet the demands of more advanced production techniques.

Figure 8 presents a comparative analysis of labor productivity and capital-labor ratios across Vietnam's textile and garment subsectors from 2009 to 2022, focusing on the top 3% of most productive firms versus the rest. In the weaving of textiles sector, top firms increased their labor productivity ratio from 7.4 times in 2009 to 16.0 times in 2022, with a corresponding rise in their capital-labor ratio from 6.2 to 8.6 times. Similarly, in the manufacture of knitted and crocheted fabrics, leading firms saw their labor productivity ratio soar from 5.0 to 43.3 times over the same period, while their capital-labor ratio jumped from 4.8 to 23.9 times. These figures underscore a widening gap between frontier firms and the industry average, indicating substantial disparities in technological adoption and operational efficiency. While top firms continue to invest significantly in modernization, the broader industry faces challenges in narrowing this gap, necessitating enhanced efforts to improve overall competitiveness and sustainability.

The growth in labor productivity can be decomposed into: (i) capital intensity or capital deepening and (ii) growth in total factor productivity (TFP). To further identify contributors to labor productivity growth, in the report, we utilized the conditional frontier model to investigate the main contributors to TFP growth among garment and textile subsectors. The conditional frontier model examines how an industry in Vietnam is operating in relation to the country's best and most efficient firm while taking into account the challenges in adopting technologies at the firm level. As a result, TFP growth is further decomposed into (i) the increase in technology adoption investment, allowing firms to adopt technologies that are available in the industry; (ii) the efforts of frontier firms to adopt leading technologies to lift up the potential technology frontier (conditional frontier) of the industry; and (iii) the effort of firms at the average level to increase efficiency through learning by doing, organizational innovation or implementing quality management tools. The model utilizes the micro-level data from the business survey conducted by GSO.

FIGURE 9

LABOR PRODUCTIVITY GROWTH DECOMPOSITION ACROSS TEXTILE AND GARMENT SUBSECTOR IN THE 2009-2022 PERIOD



Source: Author calculation based on GSO survey data

Across most subsectors, capital deepening is the major driver of LP growth. The reliance on capital investment suggests that firms are focusing on investing in machinery, expanding production capacity, and intensifying automation. Most subsectors rely heavily on capital deepening to boost labor productivity growth during the 2009-2022 period. The textile subsector—encompassing activities such as Preparation and Spinning of Textile Fibers, Weaving of Textiles, and Manufacture of Other Textiles N.E.C.—demonstrates a particularly strong reliance on capital deepening, with over 65% of productivity improvements coming from increased capital per worker. For instance, Weaving of Textiles and Preparation and Spinning of Textile Fibers report that 70% and 67%, respectively, of their labor productivity gains are due to capital deepening, highlighting the sector's investment in modern machinery, advanced production techniques, and infrastructural upgrades. This trend reflects the capital-intensive nature of traditional textile production, where machinery upgrades and new technologies are vital for boosting efficiency and maintaining competitiveness in global markets.

Conditional Frontier Model

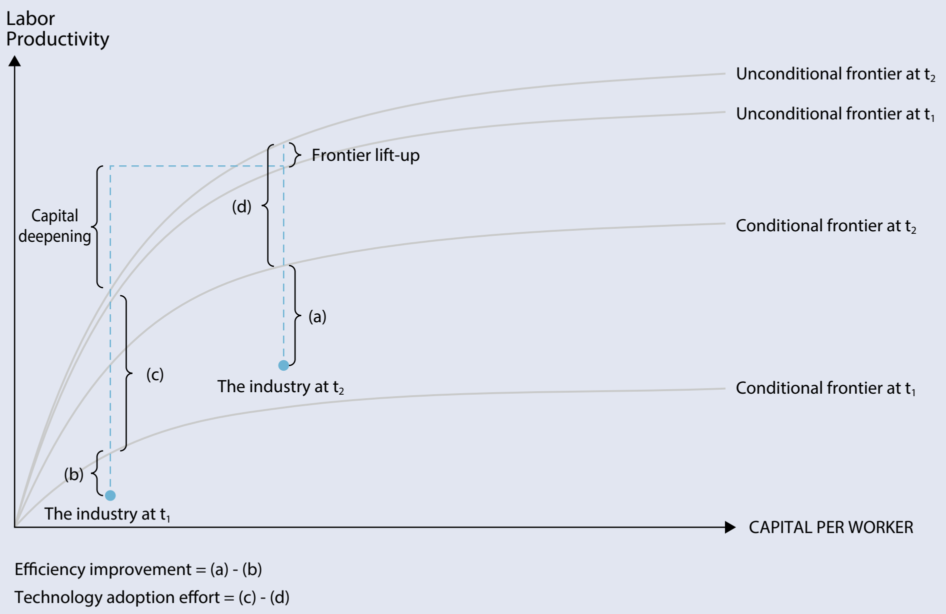
In this report we utilize a conditional frontier model to estimate the impact of technology adoption on economic growth. In particular, the conditional frontier model examines how an industry in Vietnam is operating in relation to the country's best and most efficient firms.

There are two 'frontiers' developed: one that takes into consideration all the barriers to technology adoption (the conditional frontier); and one that looks at how the industry would operate if all barriers to technology adoption were removed (the unconditional frontier).

In this report, a dynamic version of the conditional frontier model is used, which considers changes over time. In this dynamic model, the movement of the two frontiers, together with the movement of the industry average, help to decompose output per worker growth into different components. In particular, the growth in output per worker can be decomposed into: (i) capital intensity; (ii) the increase in technology adoption investment, allowing firms to adopt technologies that are available in the industry; (iii) the efforts of frontier firms to adopt leading technologies to lift up the potential technology frontier (conditional frontier) of the industry; and (iv) the effort of firms at the average level to increase efficiency through learning by doing, organizational innovation, or implementing quality management tools. The various actions firms can take to increase innovation, as well as the impact these efforts have on the components of output per worker growth, are summarized in Figure 10 below.

FIGURE 10

DYNAMIC CONDITIONAL FRONTIER MODEL



Source: Author calculation based on GSO survey data

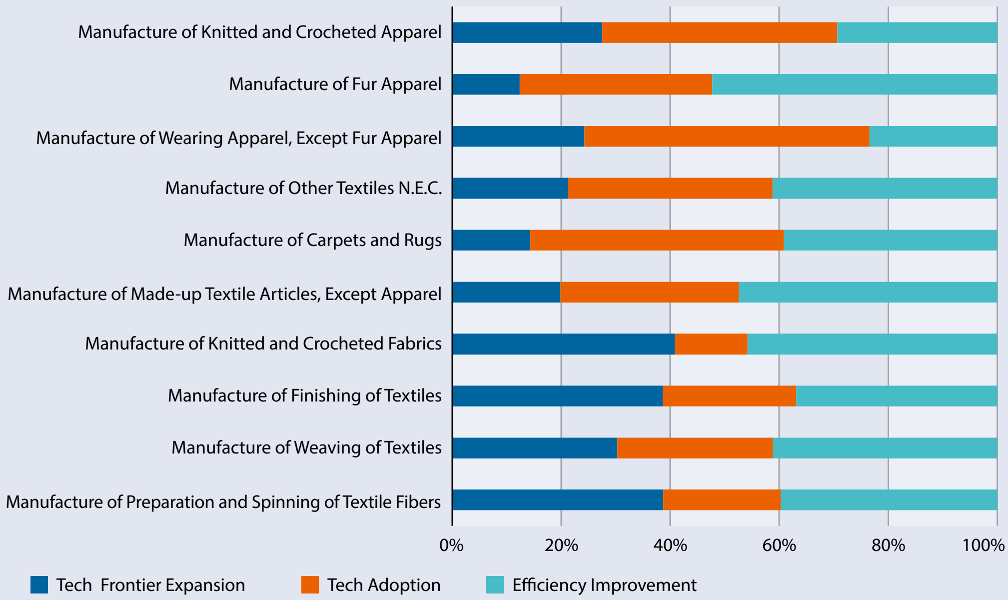
The data of the analysis comes from the Business survey from the General Statistic Office of Vietnam (GSO). GSO and its sub-institutions have conducted the Enterprise Survey to collect information on enterprises operating in Vietnam at the end of each year since 2000. This is a firm-level survey of a representative sample of an economy's private sector across all geographic regions. These include enterprises established and regulated by the Enterprise Law; Cooperatives society/cooperatives union/people's credit funds operating under the Cooperative Law, and established enterprises which are subjected to the regulation of specialized laws such as the Law on Insurance and the Law on Securities.

On the other hand, the garment subsector—including Manufacture of Wearing Apparel, Except Fur Apparel, Manufacture of Fur Apparel, and Manufacture of Knitted and Crocheted Apparel—shows a more balanced approach between capital deepening and TFP growth. Capital deepening accounts for a lower proportion of labor productivity growth in these subsectors compared to textiles, with the Manufacture of Wearing Apparel at 55.3% and Manufacture of Knitted and Crocheted Apparel even lower at 41.2%. This indicates that while capital investments are still important, these garment subsectors rely more heavily on improvements in TFP. This shift can be attributed to factors such as labor-intensive production processes, flexible manufacturing systems, and operational efficiency improvements that allow the garment sector to achieve productivity gains without the same level of capital investment required in textile manufacturing.

Figure 11 presents the components of TFP growth—technology frontier development, technology adoption, and efficiency improvements—while highlighting diverse strategies across subsectors.

FIGURE 11

TFP DECOMPOSITIONS OVER TIME ACROSS GARMENT AND TEXTILE SUBSECTORS IN 2009-2022 IN VIETNAM



Source: Author calculation based on GSO survey

The textile subsector shows a strong reliance on technology investments, with much of its labor productivity (LP) growth coming from either frontier firms pushing the technological boundaries or from an increased rate of technology adoption across average firms. For instance, in subsectors like Preparation and Spinning of Textile Fibers and Weaving of Textiles, we observe that a significant portion of TFP growth is driven by advancements at the technological frontier (42.3% and 33.4%, respectively) as well as increased adoption of existing technologies (43.4% and 45.4%, respectively). This pattern indicates that textile subsectors benefit more directly from investments that raise both the ceiling of technological capabilities and diffuse these innovations throughout the industry. In contrast, efficiency improvements, though present, contribute a relatively smaller share to growth in these subsectors, reflecting a focus on technological rather than operational advances. Since textile manufacturing requires significant machinery, and while Lean and 5S are also implemented to improve process efficiency, the emphasis is more on Total Productive Maintenance (TPM), quality management systems, and energy-saving technologies to optimize machine uptime and reduce waste in material production. In this sector, tools like Six Sigma are also used to control quality and reduce variation in production, which is vital in maintaining consistent fabric quality. However, the full adoption of productivity tools like Lean is somewhat limited in smaller firms, where traditional practices dominate.

The garment subsector, however, exhibits a more balanced approach between technological adoption and improvements in operational efficiency through the application of productivity tools. Sectors such as Manufacture of Wearing Apparel and Manufacture of Fur Apparel highlight the importance of efficiency improvements, where these tools play a crucial role. For instance, the Manufacture of Fur Apparel sees 52.3% of its TFP growth stemming from efficiency gains, largely driven by the adoption of productivity methodologies like 5S, Lean, and other operational optimizations. The manufacture of wearing apparel, though relying more on technology adoption to increase labor productivity, also benefits from applying productivity tools (31%).

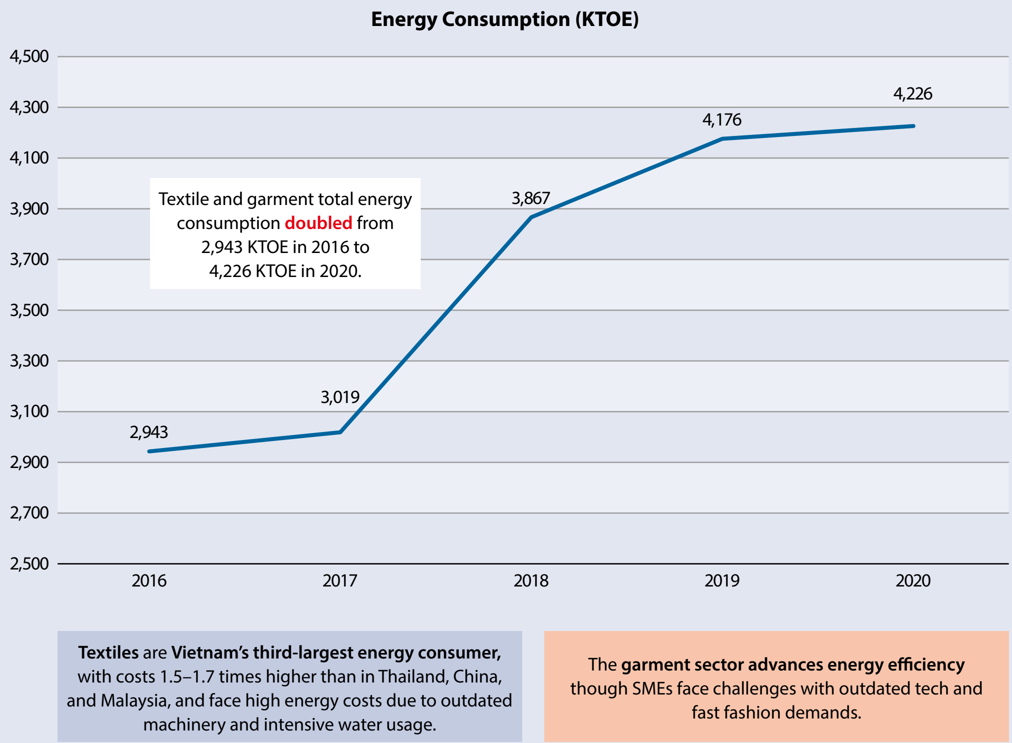
In general, in the garment subsector, which involves labor-intensive processes like cutting, sewing, and assembling garments, the adoption of Lean and 5S practices is widespread. This is largely due to the focus on reducing waste, increasing efficiency, and improving production timelines to meet fast-changing global demand, particularly in the fashion industry. Lean manufacturing helps in managing flow, reducing excess inventory, and streamlining operations, which is vital in the garment sector where production speed and flexibility are critical. This balance between technology adoption and process improvements positions the garment subsector to achieve sustained productivity gains through better utilization of existing resources and refined production processes.

2.4 Energy Efficiency and Green Growth: Pioneering Vietnam's Textile and Garment Future

Energy efficiency and green growth have become critical imperatives for the textile and garment industry in Vietnam, driven by both national policies and international obligations. As one of the world's most energy-intensive industries, this sector faces mounting pressure to reduce its carbon footprint and transition to more sustainable practices. The Vietnam National Green Growth Strategy 2021-2030, for example, mandates reductions in energy consumption and carbon emissions as part of the country's broader commitment to the Paris Agreement. This aligns with Vietnam's pledge to reach net-zero carbon emissions by 2050. Energy consumption is a major concern for Vietnam's textile and garment industry, which is highly energy-intensive. The overall energy consumption in the sector doubled from approximately 2,272 KTOE (thousand tons of oil equivalent) in 2016 to around 4,226 KTOE in 2020. Figure 12 provides an overview of energy consumption in the textile and garment sector in Vietnam.

FIGURE 12

ENERGY USE INTENSITY AND DISTRIBUTION IN VIETNAM'S TEXTILE AND GARMENT SECTORS

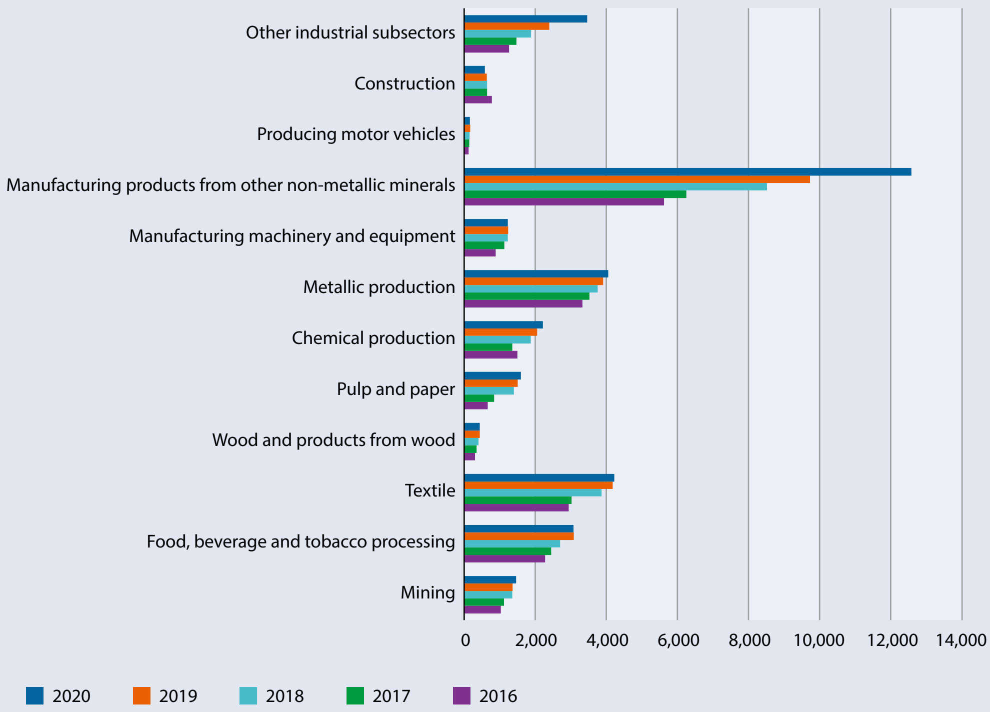


Source: UNESCAP and DEPP, 2023

Textile is the third largest energy consumer in the economy in the 2016-2020 period. Energy costs in Vietnam's garment factories are also higher compared to regional competitors. Vietnamese firms spend 1.5 to 1.7 times more on energy than their counterparts in Thailand, China, and Malaysia. In total, the industry spends approximately USD3 billion annually on energy, with electricity alone accounting for 8% of production costs. In the dyeing subsector, energy costs make up 14% of production expenses (IFC 2018).

FIGURE 13

VIETNAM INCREASINGLY SHIFTED TOWARD ENERGY-INTENSIFIED PRODUCTION OVER TIME



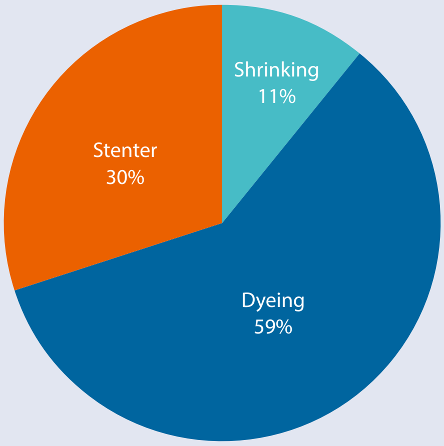
Source: UNESCAP and DEPP, 2023

2.4.1 Green Growth and Energy Efficiency in the Textile Subsector

Vietnam's textile subsector, particularly the spinning, weaving, and dyeing stages, presents enormous potential for resource-efficient upgrades. Dyeing machines and stenter frames are primary energy consumers, ripe for technological improvements. High-efficiency stenter machines, thermal oil heaters, and wastewater heat recovery systems have been identified as promising technologies for reducing both electricity and heat consumption.

FIGURE 14

ENERGY CONSUMPTION DECOMPOSITION IN A TEXTILE FACTORY



Source: IFC, 2018

However, outdated machinery remains a significant barrier. According to a survey conducted by VECEA (2017-2018), nearly 13% of dyeing equipment was over 17 years old, while another 34% was under 10 years old. This reliance on older, less efficient technologies increases not only energy consumption but also water and chemical usage, reducing the overall competitiveness of Vietnam's textile products in global markets.

Furthermore, the industry faces challenges related to intensive water usage in wet processing stages like dyeing, where machines with liquor ratios of 1:10 to 1:15 consume substantial amounts of water and produce large volumes of wastewater (VECEA, 2018). This type of machine consumes large amounts of water, leading to high wastewater treatment costs and associated environmental fees.

In recent years, the textile industry has started implementing green technologies to address these challenges. New systems for optimizing boilers and steam generation, alongside improved air supply controls, have demonstrated significant energy savings. Solar energy is also playing an increasing role, particularly in dyeing operations, where solar thermal technologies are used for hot water generation. This can potentially meet up to 80% of hot water needs, greatly reducing fuel costs. Moreover, rooftop solar photovoltaic (PV) solutions are becoming more common under build-lease-transfer (BLT) models, where factories can purchase clean energy generated on-site without upfront investment. Enterprises are also utilizing automated control systems to manage air supply and optimize blowdown water based on total dissolved solids (TDS) levels, further improving energy performance.

On the water treatment front, dyeing facilities have started recovering and reusing water and thermal energy from high-temperature dyeing machines. Technologies like reverse osmosis (R.O.) are being applied to recycle treated wastewater back into the dyeing process. These efforts not only reduce water consumption but also cut down the pollutants in wastewater, making it easier for factories to comply with environmental regulations.

2.4.2 Sustainability in the Garment Subsector: A Growing Trend

Compared to textiles, the garment subsector has seen more progress in implementing energy efficiency measures. The adoption of LED lighting, energy-efficient sewing machines, and smart energy management systems has helped reduce energy consumption in production facilities. International collaborations with brands such as H&M and Nike have accelerated this trend, as these brands require their suppliers to meet specific sustainability criteria.

The garment subsector, while less energy-intensive than the textile subsector, still has significant opportunities for energy savings. The industry is dominated by small- to medium-sized enterprises (SMEs), which often operate with outdated technologies, leading to inefficiencies in both energy and water consumption. SMEs in the garment sector often lack awareness of energy-saving technologies or face financial barriers to upgrading their machinery and systems. Key systems such as sewing machines, air compressors, irons, and lighting consume significant amounts of energy, offering substantial opportunities for savings through modernization.

Many factories in the garment subsector are turning to solar energy for their energy needs. Solar panel installations on factory rooftops provide renewable energy, reducing reliance on grid electricity. Notable projects, such as the installation of 11 MWp of solar PV rooftop systems by Tan De Company, one of Vietnam's largest garment exporters, demonstrate the sector's shift toward cleaner energy. These systems are expected to generate 12,603 MWh annually and reduce 8,527 tons of CO_2 emissions per year, aligning Vietnamese manufacturers with international green standards.

Global brands are playing a crucial role in advancing sustainability efforts among Vietnamese garment factories, with companies like H&M Group setting ambitious targets to reduce their environmental impact. H&M, for example, aims to significantly reduce its greenhouse gas emissions and transition entirely to renewable electricity in its operations by 2030, based on 2019 levels, with an overarching objective of achieving net-zero emissions by 2040 (HM Group 2022).

The company's sustainability strategy includes reducing reliance on virgin materials by incorporating more recycled content into its products. Additionally, H&M is actively working to phase out coal-based energy in its supply chain, especially in Vietnam. To this end, the brand has halted partnerships with new suppliers using on-site coal boilers and provides financial support to existing factories, enabling them to adopt energy-efficient technologies and sustainable alternatives to fossil fuels. This comprehensive approach underscores H&M's commitment to fostering a greener, more sustainable garment manufacturing industry in Vietnam.

Despite these advancements, the garment subsector still faces considerable challenges. Many Vietnamese garment factories, especially SMEs, operate with outdated equipment, impacting both energy and water efficiency. High energy-consuming equipment, such as sewing machines, air compressors, irons, and lighting systems, often remains in use due to the prohibitive costs of modernizing. While advanced automation technologies—like smart sensors and real-time energy management systems—are available, financial and knowledge barriers make their adoption difficult for SMEs.

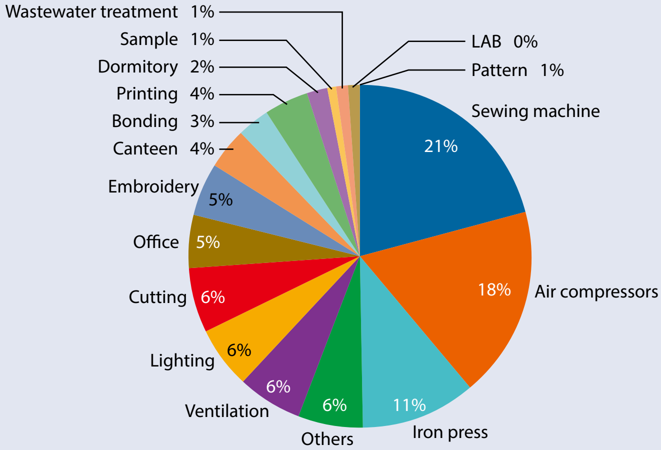
In addition, the traditional structure of the clothing industry often prioritizes low costs and rapid turnaround times, which can conflict with sustainability goals. Transitioning to more eco-friendly production practices involves addressing significant challenges:

- Costs of Sustainable Practices: Using organic materials and adopting eco-friendly technologies increase production costs. This can lead to higher retail prices, posing a challenge in a market largely driven by fast fashion.
- Supply Chain Transparency: The complexity of global supply chains makes it challenging to ensure sustainable practices across all stages, from sourcing materials to production and distribution.
- Consumer Awareness and Market Demand: Although consumer awareness of environmental impact is growing, many buyers still prioritize affordability. Sustainable brands must navigate this price-sensitive market while promoting the value of ethical production.
- Scalability: While smaller-scale sustainable practices are achievable, scaling them up for large volumes presents additional costs and logistical complexities.
- Regulatory Framework: The absence of uniform sustainability standards and enforcement mechanisms across countries hinders broader adoption of sustainable practices.
- Certification and Verification: Obtaining certifications such as Fair Trade or Organic can be time-consuming and expensive, especially for SMEs. Ensuring these standards are upheld across complex supply chains requires dedicated resources.
- Technical Innovation: The industry still requires advancements in developing eco-friendly materials and production processes that reduce waste and energy use.
- Fast Fashion Competition: The continued popularity of fast fashion, with its low costs and rapid product turnover, poses a significant obstacle to the widespread adoption of sustainable practices within the garment sector.

These challenges underscore the need for a concerted effort among manufacturers, brands, regulatory bodies, and consumers to transform Vietnam’s garment subsector into a model of ethical and sustainable production. While progress is being made, comprehensive and sustained efforts will be essential to make lasting change. Automation technologies, such as smart sensors and control systems, are helping optimize energy usage by responding to real-time demand, thus reducing energy waste. In addition, regular maintenance of equipment and process optimization can prevent energy and water losses in garment factories.

FIGURE 15

ENERGY CONSUMPTION DECOMPOSITION IN A GARMENT FACTORY



Source: IFC, 2018

2.5 Supply Chain Participation

Vietnam's integration into the global textile and garment supply chain has intensified in recent years, driven by competitive manufacturing advantages and key trade agreements such as the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) and the EU-Vietnam Free Trade Agreement (EVFTA). These agreements provide preferential market access, boosting foreign direct investment (FDI) and embedding Vietnam even further into global networks.

Vietnam's textile and garment industry is supported by a well-established production network, ranging from raw material processing to the export of finished garments. This network consists of a diverse range of SMEs and larger firms, creating a flexible and adaptable production ecosystem. This allows Vietnam to respond rapidly to shifting global demands and trends, enhancing its competitiveness in the international market.

A diverse production landscape characterizes Vietnam's textile and garment supply chain, which can be divided into design, raw material production, manufacturing, and branding/marketing stages. These stages present distinct challenges and opportunities that influence the industry's efficiency and competitiveness. However, discrepancies between the textile and garment sectors are evident, particularly in terms of raw material dependence and net export performance.

TNG Investment and Trading JSC

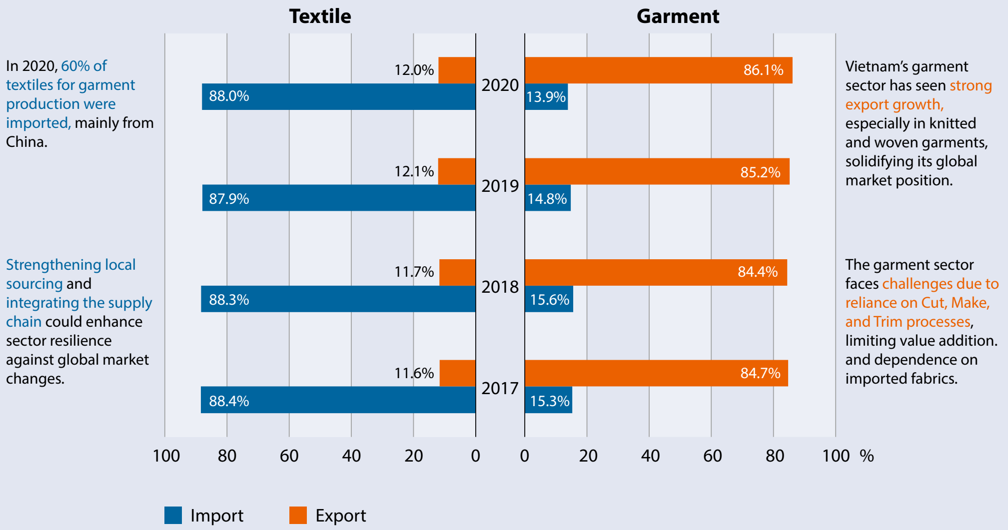
A notable example of effective energy efficiency practices is TNG Investment and Trading JSC, a prominent textile and garment manufacturer in Vietnam. Beginning in 2018, TNG undertook a significant energy efficiency initiative supported by the VNEEIP. The company's approach included a comprehensive set of upgrades to optimize energy use and reduce carbon emissions (VNEEIP, 2022). Key upgrades included the replacement of outdated boilers with high-efficiency models, the transition to LED lighting, and the modernization of production equipment and HVAC systems. These measures improved fuel combustion efficiency from 70% to 85%, resulting in a 15% reduction in fuel consumption (VNEEIP, 2022).

Additionally, the switch to LED lighting achieved a 30% reduction in electricity use for lighting. Upgrades to production machinery and HVAC systems also contributed to a 20% decrease in energy consumption, leading to annual cost savings of approximately VND10.5 billion (about USD450,000) and a reduction in carbon emissions by approximately 18,000 tons per year (TNG Investment and Trading JSC, 2019). TNG's successful energy efficiency program earned the Vietnam Energy Efficiency Award in 2019, recognizing the company's best practices in energy management and serving as a model for the Southeast Asian textile and garment sector (Southeast Asia Energy Efficiency and Conservation Network (SEA-EECN, 2020)).

Figure 16 provides a snapshot of export-import balances in Vietnam's textile and garment industry.

FIGURE 16

VIETNAM'S TEXTILE AND GARMENT EXPORT-IMPORT BALANCES



Source: UN Comtrade

2.5.1 Textile Sector: Reliance on Imported Input

Vietnam's textile sector remains highly dependent on imported raw materials, particularly yarns and fabrics, which are mostly sourced from competitive neighboring countries such as China, the Republic of Korea (ROK), the Republic of China (ROC), and Thailand. In 2020, 60% of the textiles used for garment production were imported, with China being the primary supplier. Key categories like cotton, man-made filaments, and knitted fabrics consistently show a negative trade balance, highlighting the challenges of building a competitive domestic textile supply chain.

In 2020, Vietnam faced a USD10.9 billion trade deficit in cotton and a USD12.3 billion deficit in man-made filaments (Figure 16). The only positive balance was seen in textile fabrics (HS59), which had a surplus of USD365 million. Similarly, man-made filaments (HS54) registered large negative net exports, reaching USD14.02 billion in 2019 before improving to USD12.35 billion in 2020. While the trade deficit in knitted fabrics (HS60) remained significant, the industry recorded a surplus in textile fabrics (HS59), achieving positive net exports ranging from USD309 million in 2017 to USD443 million in 2019. These figures reveal the significant gap between the success of the garment sector and the underdevelopment of the domestic textile industry, which is still reliant on imports for essential materials.

2.5.2 Garment Sector: Strong Export Growth but Limited Value Addition

The textile and garment industry in Vietnam is heavily oriented towards exports, with approximately 85-87% of its production targeted at international markets. In 2022, Vietnam exported textiles worth USD48.8 billion, making it the third-largest textile exporter in the world. That same year, textiles ranked as the second most exported product in Vietnam, reflecting the sector's significance to the national economy. The primary destinations for Vietnam's textile exports include the USA, which accounted for USD19.1 billion, followed by Japan at USD4.72 billion, the ROK at USD4.39 billion, China at USD3.52 billion, and Canada at USD1.57 billion (OEC, 2024).

One of the key drivers behind the 6.3% increase in Vietnam's textile and garment exports in 2022 was the surge in global demand. Rising consumer demand in major markets, including the USA, Europe, and Asia, has led to increased orders for Vietnamese textiles and apparel. Additionally, the post-pandemic recovery has created a surge in orders as countries seek to restock their inventories and satisfy pent-up consumer demand, further propelling export growth.

- Diversification of Export Markets: In recent years, Vietnam has made concerted efforts to diversify its export markets beyond traditional destinations like the USA and the EU. This strategic shift has allowed Vietnam to tap into emerging markets in Asia, Africa, and the Middle East, forging new trade partnerships and creating lucrative opportunities for its textile and garment exports. By expanding its market reach, Vietnam aims to reduce dependency on a limited number of export destinations, ensuring a more stable and resilient export base.

- Strategic Investments in Technology and Innovation: Vietnam's textile and garment sector has also benefited from strategic investments in technology and innovation. Manufacturers are increasingly embracing automation, digitalization, and sustainable practices to enhance efficiency, productivity, and quality in their production processes. This focus on modernization not only improves operational efficiency but also positions Vietnam as a competitive player in the global textile market, capable of meeting evolving consumer demands and sustainability standards.

- Strategic Trade Agreements: The presence of key trade agreements has further bolstered the industry's growth. Agreements such as the CPTPP and the EVFTA have provided Vietnam with tariff reductions and improved market access. These agreements have enhanced the competitiveness of Vietnamese textiles and garments on the international stage, enabling the country to capture a larger market share and attract new customers.

Vietnam's garment sector has demonstrated remarkable export growth, particularly in knitted and woven garments (HS61 and HS62). The efficiency of its production system and competitive pricing have made Vietnam a significant player in global apparel markets. Notably, the country has experienced substantial surpluses in both knitted and woven garments. For instance, net exports of knitted garments rose from USD20.34 billion in 2017 to USD25.66 billion in 2019, before declining slightly to USD23.33 billion in 2020. Similarly, net exports of woven garments increased from USD9.55 billion in 2017 to a peak of USD11.49 billion in 2019, then decreased to USD10.82 billion in 2020.

Despite the impressive export figures, a critical challenge facing the garment sector is the reliance on CMT production processes, which yield lower value addition compared to activities such as design and raw material sourcing. This focus on CMT limits the industry's ability to capture more value within the global supply chain. Moreover, garment manufacturers remain dependent on imported fabrics, underscoring the urgent need for stronger backward linkages within the domestic supply chain. Enhancing local sourcing capabilities and fostering a more integrated supply chain could not only improve value addition but also increase the resilience of the garment sector against global market fluctuations.

2.5.3 The Vibrant Domestic Market

In recent years, Vietnam's domestic fashion market has become increasingly vibrant, driven by rising disposable incomes and evolving consumer preferences. Young consumers, particularly those in Generation Z, are greatly influenced by social media and digital platforms like Shopee, Instagram, YouTube, and TikTok. Their shopping behaviors are shaped by online content related to skin care, makeup, accessories, and footwear, while a significant proportion of older consumers have adapted to remote purchasing, reflecting a growing expectation for a seamless shopping experience.

A survey conducted by Vinatex indicated a promising outlook for the apparel and textile sectors, with consumer spending on clothing ranking just behind food. The average monthly expenditure on clothing among respondents ranged from 150,000 to 500,000 VND, accounting for about 18% of their total spending. Furthermore, nearly 70% of Vietnamese consumers reported shopping for garments at least twice a month during the survey period (WTO Center, 2024).

In response to these market dynamics, Vietnamese garment companies are actively expanding their distribution systems across the country. Despite the current dominance of Chinese-made products in the local market, Vietnamese-made garments are gradually gaining traction. VinatexMart has emerged as the leading retailer of locally made garments and fabrics, with major brands like Viet Tien, Phong Phu, May 10, and Nha Be operating over 1,000 retail stores nationwide (Vinatex, 2024). This success is attributed to diversification in design, brand development, and an expanded distribution network, as noted by Than Duc Viet, Executive Director of May 10.

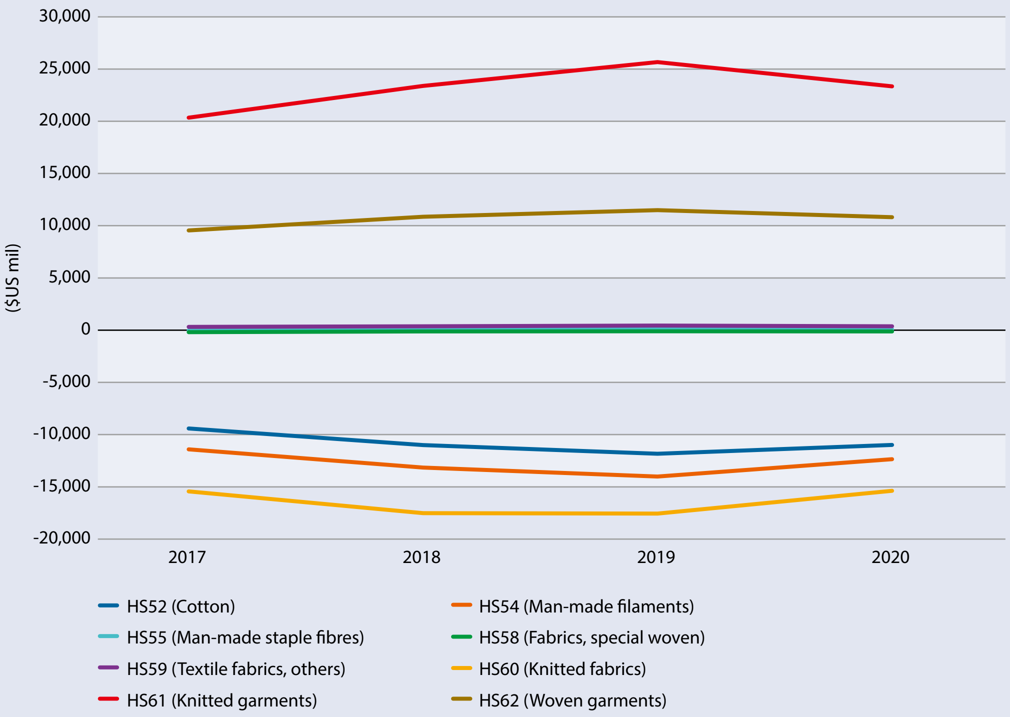
Recognizing the importance of sustainable development in the domestic market, Vietnamese businesses have focused on improving product quality and diversifying their offerings to ensure accessibility for consumers. Vietnam's textile and garment industry is currently concentrated on export markets. However, it is crucial to also consider the potential of the domestic market. The industry's production capacity stands at approximately USD50 billion, indicating that while the domestic market capacity may be smaller, it remains significant.

The domestic garment market in Vietnam has long been served by a diverse array of small local businesses, ranging from large private companies to informal, small-scale workshops. While export-oriented garment firms are larger and more formalized, these local firms have managed to meet international standards in terms of technology. Interestingly, they have also been involved in more complex processes beyond just CMT operations, including design and marketing, which are typically knowledge-intensive activities. Some domestic brands that are considered to have a foothold in the market such as Viet Tien, Nha Be, An Phuoc, and Garment 10 mainly focus on the office product segment.

The domestic fashion industry has become more vibrant, with the rise of young designers and emerging brands. Local products, often sold through traditional markets, street vendors, and e-commerce platforms, remain popular due to their affordability. The government has also supported fashion incubators and initiatives to foster creativity and innovation in local design.

FIGURE 17

NET EXPORT ACROSS TEXTILE AND GARMENT SUBSECTORS IN VIETNAM OVER TIME



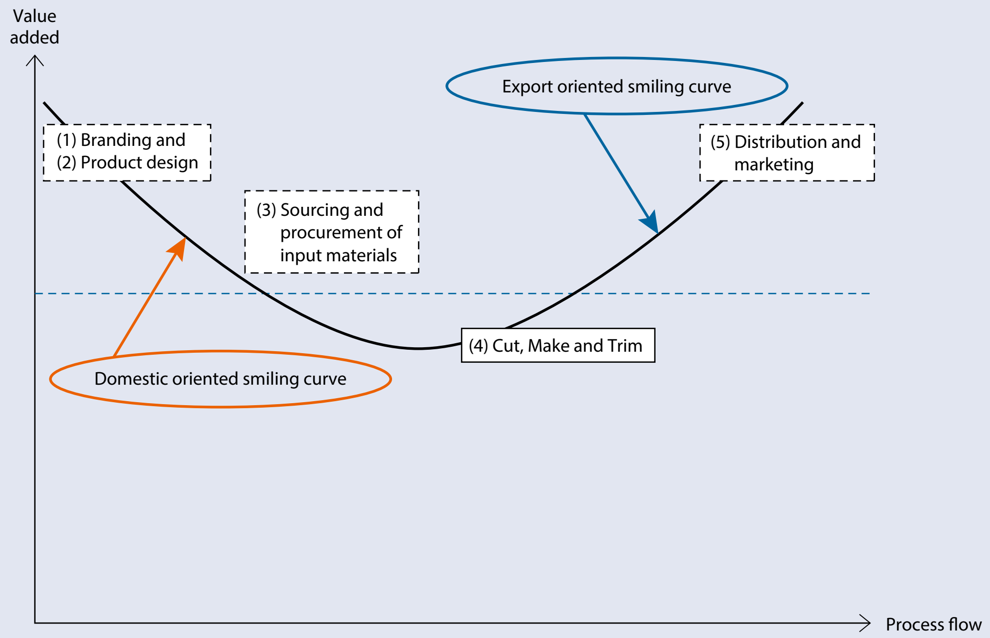
Source: UN Comtrade

Despite these opportunities, the domestic market presents challenges as well. Businesses need to continuously innovate and adapt to new consumer trends to develop effective strategies. Improving product quality and offering unique, valuable products are essential for competitiveness. For instance, companies like Phong Phu and Viet Thang reported revenues exceeding VND1 trillion (approximately USD47.6 million) from domestic sales last year.

However, despite this wider involvement, domestic firms tend to operate at a lower level of technological sophistication and value addition. This gap is largely due to the limited transfer of advanced technology from more developed countries, which has created a notable "export premium" (Goto, 2014). As a result, two distinct value chains—one domestic and the other export-oriented—have evolved side by side with very little interaction between them. The reorientation toward local markets is expected to reshape value chains and shift priorities for many companies. New market players may emerge, driving further change in the organization of supply chains and the broader textile and garment industry landscape in Vietnam.

FIGURE 18

TEXTILE AND GARMENT INDUSTRY SUPPLY CHAIN SMILING CURVE



Source: Author created, adapted from Goto, 2014

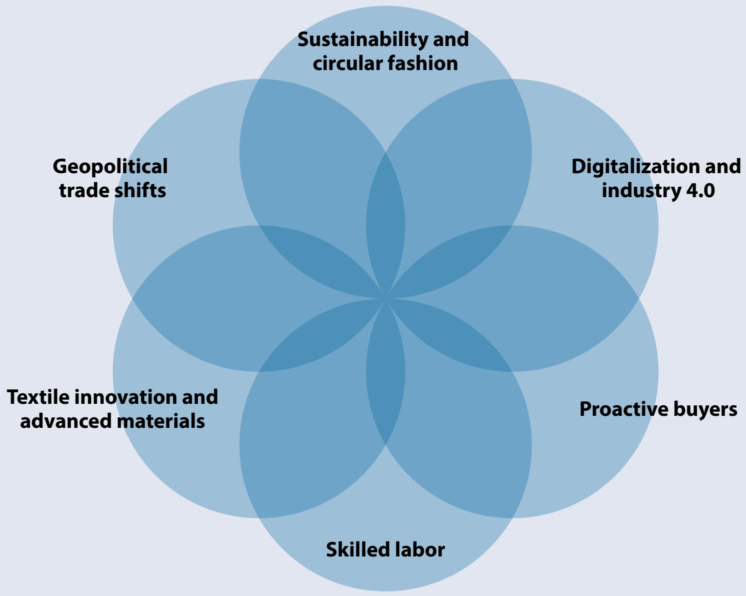
3. MEGATRENDS IN THE TEXTILE AND GARMENT INDUSTRY IN VIETNAM

A megatrend is a long-term, pervasive shift that gradually gains momentum and reshapes the economy. These trends emerge at the intersection of several smaller, time-specific trends. The megatrends analysis for Vietnam's textile and garment industry was conducted using horizon scanning, a process that identified key economic, technological, social, geopolitical, legal, and environmental trends expected to impact the sector. This analysis was further refined through interviews (see Appendix 1 for interview methodology) and workshops with key stakeholders—including businesses and researchers in the industry—held in Hanoi in July and October 2024.

The input from these stakeholders provided valuable insights into the forces shaping the future of the industry. Based on this comprehensive review, the research team identified **seven megatrends** that are expected to drive Vietnam's textile and garment industry up to 2045 (Figure 19). These megatrends will influence everything from market demands to the adoption of advanced technologies, regulatory changes, and sustainability initiatives.

FIGURE 19

KEY MEGATRENDS IMPACTING VIETNAM'S TEXTILE AND GARMENT INDUSTRY



3.1 Sustainability and Circular Fashion

Brands and end-users are increasingly concerned about environmental, social, and governance (ESG), driving regulatory changes to align with these demands. Due to the significant impact of the apparel industry on the environment, contributing to 10% of global greenhouse gas emissions as well as increasing landfill and pollution (McKinsey & Company, 2023), sustainability concerns continue to be the focus of the sector. In 2018, stakeholders in the garment sector committed to climate action through the UNFCCC Fashion Industry Charter for Climate Action. Signatories pledged to reduce greenhouse gas emissions by 30% by 2030 (from a 2015 baseline) and achieve net-zero emissions by 2050. Achieving this reduction requires system-level changes in the production and consumption of textiles and garments regardless of location. As one of the major exporters of textile and garment products, going green is an inevitable trend for Vietnam. Vietnamese textile and garment enterprises are required to develop environmentally friendly products in line with sustainability trends and meet the strict requirements of markets such as the EU, the USA, and Japan. A report by Boston Consulting Group indicates that over the next two to four years, more than 35 new pieces of sustainability-linked regulation are expected to go into effect around the world, targeting import restrictions, product design guidelines, labeling requirements, and more (Jensen et al., 2023). Figure 20 provides a snapshot of some regulatory frameworks related to sustainability.

3.1.1 Stringent Regulatory Framework on Sustainability

Vietnam participates in 16 Free Trade Agreements (FTAs), which require certified origins, sustainable production, and transparent production information for tax relief on exports. To leverage FTAs, Vietnamese businesses must innovate across their operations to remain competitive. Major importing countries are setting requirements for social responsibility, environmentally friendly production, and circular production with the lowest energy and natural resource consumption. For example, the EU's target for full circularity by 2030 intensifies regulatory pressure on the industry, compelling apparel manufacturers to address issues across circularity, traceability, and decarbonization (McKinsey & Company, 2023). Future strategies must focus on complying with stricter origin identification requirements and preparing for potential future taxes like the Extended Producer Responsibility (EPR) and the EU's Carbon Border Adjustment Mechanism (CBAM).

The introduction of the Carbon Border Adjustment Mechanism (CBAM) by the EU marks a significant shift in global climate policy, with notable implications for the fashion and textile industry. Designed to level the playing field between EU producers and their international counterparts, CBAM imposes a carbon price on imports from outside the EU. This approach aims to prevent "carbon leakage," where companies might relocate production to countries with less stringent emissions regulations. By imposing these costs, CBAM encourages cleaner production processes and promotes the adoption of more sustainable practices on a global scale.

FIGURE 20

A SNAPSHOT OF SOME SUSTAINABILITY REGULATIONS IN KEY IMPORTING MARKETS AS OF 05/07/2024

EU	US	Japan	Korea
• Carbon Border Adjustment Mechanism (CBAM) • Waste Framework Directive (WFD) • Corporate Sustainability Reporting Directive (CSRD) • Corporate Sustainability Due Diligence Directive (CSDDD) • Ecodesign for Sustainable Products Regulation (ESPR) • Digital Product Passport (DPP)* • EU Green Claim Directive**	• California's Climate Corporate Data Accountability Act (SB 253) • California's Greenhouse Gases: Climate-Related Financial Risk Bill (SB 261) • Uyghur Forced Labor Prevention Act • New York Fashion Act** • The FABRIC Act**	• Renewable Energy Act • Low Carbon City Promotion Act (Eco-city Law) (Law No. 84 of 2014) • Climate Change Adaptation Act	• Framework Act on Carbon Neutrality and Green Growth for Coping with Climate Crisis • Guidelines for Environmental Labelling and Advertising

Source: https://climate-laws.org/
Note: * provisional agreement; ** proposed

For the fashion and textile industry, renowned for its substantial carbon emissions and environmental impact, the introduction of the Carbon Border Adjustment Mechanism (CBAM) represents both a challenge and an opportunity. Non-EU manufacturers may face higher costs due to the carbon price, which could lead to increased consumer prices or reduced profit margins. This financial pressure is likely to encourage the industry to adopt more carbon-efficient production methods. CBAM also acts as a catalyst for the integration of sustainable technologies and practices, prompting brands to invest in energy-efficient production methods and circular economy models to alleviate the financial impact. Additionally, CBAM will require greater transparency and accountability within supply chains. Companies must gain a clearer understanding of their supply chain emissions, fostering more responsible and sustainable practices.

In response to similar regulatory frameworks, such as the ROK's "Framework Act on Carbon Neutrality and Green Growth for Coping with Climate Crisis," manufacturers are expected to obtain certifications like ISO 14067 for Product Carbon Footprint Verification, ISO 14001 for Environmental Management Systems, Global Reporting Initiative (GRI), and ISO 26000. In Vietnam, about 50% of textile enterprises have adopted green production methods, and approximately 80% have invested in rooftop solar power (Quynh Trang, 2023).

The Corporate Sustainability Due Diligence Directive (CSDDD) mandates large EU companies (over EUR150 million in global turnover and 500+ employees) and large non-EU companies (with EU-wide revenue over EUR300 million) to conduct environmental and human rights due diligence across their operations, subsidiaries, and value chains starting in 2027. The scope of CSDDD will expand in future years, placing a significant compliance burden on companies with extensive international value chains (Brennan, Gonzalez, Puzniak-Holford, Kilsby, & Subramoni, 2024).

In Vietnam, the Prime Minister issued Decision No. 1643/QD-TTg, approving the "Vietnam Textile and Garment Industry Development Strategy to 2030, Vision to 2035." This strategy envisions the industry evolving sustainably within a circular economy model by 2035. It focuses on resource efficiency, waste reduction, and improved environmental and social performance. The strategy sets ambitious targets for reducing the industry's environmental impact by 2030, including a 15% reduction in energy consumption and a 20% reduction in water use by 2023, contributing to long-term sustainability (Viet Nam News, 2022).

3.1.2 Buyer Expectations and Standards about Sustainability

Stringent regulations and growing consumer awareness of environmental concerns are driving stricter requirements from buyers, particularly those representing major brands and international chains. These buyers are restructuring their global supply chains to meet rigorous sustainability targets, which emphasize improved environmental performance, the use of recycled and organic materials, reduced energy consumption, and the conservation of non-renewable resources like water and fossil fuels (WWF Vietnam, 2022). More than 85% of leading brands have publicly declared decarbonization targets for their supply chains (Jensen, et al., 2023). Figure 21 provides a snapshot of some popular sustainability standards and tools.

Net Zero Carbon Emissions: Achieving net zero carbon emissions is a crucial goal for the industry, necessitating a focus on sustainable manufacturing and supply chain practices. Companies are working towards reducing their carbon footprint by adopting energy-efficient technologies and processes, and transitioning to renewable energy sources. This commitment extends to minimizing greenhouse gas emissions across all stages of production and distribution. A key initiative in this shift is the Science Based Targets initiative (SBTi). The SBTi provides a framework for companies to set and achieve science-based emissions reduction targets. For example, Levi's has had its net-zero emissions target for 2050 approved by the SBTi. The company has updated its near-term goals to a 42% reduction in its Scope 3 emissions by 2030, based on a new baseline year of 2022 (Ecotextile, 2024). Similarly, Nike is advancing its sustainability agenda by promoting renewable energy use among its suppliers. The company's approach includes supporting the installation of solar photovoltaic systems on factory rooftops, advocating for policies that enable direct renewable energy sourcing from local utilities, and expanding its biomass renewable energy program with a focus on material manufacturers. In FY23, renewable energy use by suppliers increased by 50%, with renewables accounting for a fifth of energy sourced (Derrick, 2024). Nike is also organizing supplier working groups to accelerate the adoption of renewable energy across multiple countries.

Manufacturing environment: There are increasing requirements about manufacturing practices including factories' energy and environmental standards. For example, LEED standard is an international benchmark for high-performance green buildings, offering benefits such as reduced energy and water consumption, lower operating costs, and improved market access through enhanced sustainability credentials. Pearl Global Vietnam achieved LEED O&M Gold certification in April 2024, becoming the first garment factory in Vietnam to receive this certification (Bureau Veritas, 2024). Bureau Veritas conducted a feasibility study at the factory to evaluate its energy and water consumption, indoor air quality, waste management practices, and other sustainability criteria. In addition, the Higg Facility Environmental Module (FEM) 4.0 launched in 2023 is a comprehensive assessment tool that requires all subcontractors and factories to self-evaluate and verify their environmental performance (Cascale, 2023). This emphasizes more rigorous reporting and accountability, driving further improvements in environmental practices within the industry.

Sustainable Product Certification: For apparel exports, there is a growing preference for products with certifications for recycled content, organic materials, and adherence to Restricted Substances Lists (RSLs). Compliance with Zero Discharge of Hazardous Chemicals (ZDHC) is also increasingly important. These certifications are becoming essential for gaining market access and meeting consumer expectations for sustainable products (Ministry of Foreign Affairs, 2022).

Energy and Waste Management: There is a strong push to eliminate the use of coal and fossil fuels in factory operations (Leal Filho et al., 2024). Instead, companies are investing in solar energy installations and adopting environmentally friendly practices such as reducing greenhouse gas emissions and using eco-friendly air conditioning systems. Waste management strategies are evolving to prioritize recycling, reuse, and reduction of landfill and incineration (McKinsey & Company, 2022). By adopting these practices, the industry aims to minimize its environmental footprint and enhance sustainability.

Social Responsibility: Social responsibility remains a vital aspect of sustainability, emphasizing gender equality, worker welfare, and improved working conditions (Balchin, 2023). Key components include ensuring safe, healthy work environments, fair wages, and respect for labor rights. Labor issues persist in Vietnam, with Better Work Vietnam (2023) reporting that one in four factories were non-compliant in areas like occupational safety and health. Compliance with social responsibility standards such as Worldwide Responsible Accredited Production (WRAP), Business Social Compliance Initiative (BSCI), Sedex Members Ethical Trade Audit (SMETA), and Social & Labor Convergence Program (SLCP), and Better Work is essential for fostering ethical practices and upholding labor rights throughout the supply chain.

In summary, the fashion industry's increasing emphasis on sustainability encompasses a multi-faceted approach involving material choices, environmental management, product certification, energy and waste practices, and social responsibility. These efforts are driving the industry towards more sustainable practices and contributing to its growth and evolution in a way that aligns with global sustainability goals.

FIGURE 21

A SNAPSHOT OF SOME SUSTAINABILITY STANDARDS AND CERTIFICATIONS

Environmental Management Standards:	Climate and net zero frameworks:	Energy Management Standards:	Social Responsibility:
• ISO 14001: Environmental Management Systems ISO 14064-1: Greenhouse Gas Inventories (Part 1) ISO 14064-2: Greenhouse Gas Projects (Part 2) ISO 14067: Carbon Footprint of Products • ISO 14068: Climate Neutrality • HIGG: Higg Index (Sustainable Apparel Coalition) • ISCC/GRS: International Sustainability & Carbon Certification / Global Recycled Standard	• SBTi: Science Based Targets initiative • Climate Action 100+ (CA100+) Taskforce on Climate related Financial Disclosures (TCFD)	• ISO 50001: Energy Management Systems • LEED/EDGE: Leadership in Energy and Environmental Design / Excellence in Design for Greater Efficiencies • Renewable Energy	• ISO 46000: Guidance on Social Responsibility • WRAP: Worldwide Responsible Accredited Production • BSCI: Business Social Compliance Initiative • SMETA: Sedex Members Ethical Trade Audit • SLCP: Social & Labor Convergence Program • Better Work • SA 8000: Social Accountability • ISO 45001: Occupational Health and Safety • ISO 26000: Guidance on Social Responsibility • FSSC 24000: Food Safety System Certification

Opportunities and challenges

Opportunities	Challenges
Market access and profitability: Suppliers who meet sustainability requirements will not only become more competitive but also attract more orders. By leveraging green standards and certifications such as ISO 14001, eco-labels, and product certifications, suppliers can enhance their market access and appeal to environmentally conscious consumers. These certifications can also serve as powerful marketing tools, potentially allowing suppliers to command higher prices for their green products. **Participation in the carbon market:** Companies can offset their emissions, purchase carbon credits, and meet emission reduction targets, which helps manage costs associated with carbon emissions. There are also opportunities to generate carbon credits through sustainable practices and investment in green projects. **Reducing costs:** Brands and manufacturers that have proactively adopted sustainable and circular production practices are well-positioned to benefit under mechanisms like CBAM. These practices, which focus on reducing carbon footprints and utilizing sustainable materials and technologies, can lead to increased operational efficiency and cost savings. Lower carbon emissions reduce the risk of facing additional legal costs or penalties. Additionally, such practices can strengthen a company's market position, especially in environmentally conscious markets like the EU. The focus on sustainability can also lead to reduced production costs and improved profitability. **Government Support:** Companies engaged in sustainable production may receive various forms of government support, including financial assistance and favorable policies. This support can help offset the costs associated with transitioning to more sustainable practices and enhance a company's ability to compete in the market. By aligning with government policies that promote sustainability, businesses can benefit from incentives and assistance that bolster their operational efficiency and market presence.	**Complexity of the regulatory landscape:** The financial burden of transitioning to low-carbon production methods and the administrative complexities of compliance can be particularly overwhelming for businesses, especially SMEs. Approximately 87% of Vietnam's textile and garment companies are SMEs, each employing fewer than 300 workers and with total assets under USD2 million (GSO, 2022). **Financial strain and investment barriers:** Shifting towards sustainable and circular production requires substantial capital investment, straining companies especially SMEs. More than 80% of SMEs lack the capital necessary for investing in green production and achieving green certifications such as LEED and LOTUS (Thanh Thuy, 2024). Currently, less than 10% of factories meet LEED standards, with most compliant facilities being foreign direct investment (FDI) enterprises. **Supply chain and infrastructure challenges:** The textile industry in Vietnam is further challenged by its heavy reliance on imported raw materials, making it difficult for businesses to ensure quality and sustainability throughout the supply chain. Additionally, there is a shortage of large-scale industrial zones specifically designed for garment and textile production, including those with wastewater treatment systems. The industry also suffers from a lack of skilled human resources necessary for implementing Industry 4.0 technologies. **Lack of strategic planning:** Many SMEs lack strategic planning, often prioritizing short-term objectives over long-term sustainability goals. This is partly influenced by current market dynamics, where consumer awareness of sustainable fashion remains limited, and willingness to pay a premium for sustainable products is still relatively low. In addition, SMEs face intense competition from traditional businesses that can produce goods at lower costs, placing significant pressure on sustainable enterprises to remain competitive while upholding higher environmental and ethical standards.

3.2 Geopolitical Trade Shifts

The textile trade's reliance on smooth global transportation makes it vulnerable to conflicts and unrest in key regions like Russia, the Middle East, and parts of the EU. USA leadership in creating political stability is crucial for stabilizing trade. The Global Supply Chain Pressure Index (GSCPI) (Federal Reserve Bank of New York, 2024) indicates a return to pre-pandemic levels, but companies are not reverting to previous supply chains. The pandemic and geopolitical changes are driving long-term shifts, such as reducing dependence on Asia and increasing automation. Companies are regionalizing production and expanding their supplier networks to enhance resilience.

FIGURE 22

GLOBAL SUPPLY CHAIN PRESSURE INDEX (GSCPI)

Source: Federal Reserve Bank of New York, 2024

3.2.1 Increasing Focus on Asia: Greater Competition and Unstable Political Environment

The fashion industry faces multiple crises, from logistical issues due to the Red Sea crisis, the Israel-Palestine conflict, to increased energy prices from the Russia-Ukraine conflict and inflation affecting consumer spending (Rabe & Wiggins, 2024). The fallout between Russia and the West also has a disruptive impact on the energy sector which will affect other commodities as Western sanctions on Russia take effect and Western Europe weans itself from its dependence on Russian oil and gas. Russian trade will shift from Europe to other regions, particularly China and India. On the other hand, geopolitical tensions between the USA and China have led firms to adopt nearshoring and 'China+1' sourcing strategies, aiming to reduce reliance on China and diversify production (EY, 2023).

3.2.2 Nearshoring

Manufacturing activities are moving closer to major consumer markets in the EU and the USA, a trend known as 'nearshoring' (Monaghan, 2023). This shift aims to shorten supply chains and reduce risks associated with long-distance production. However, a complete decoupling from China is unlikely due to the continued reliance on Chinese fabrics and components, as well as the significant Chinese consumer market.

3.2.3 'China+1' Sourcing Strategy

Since the early 2010s, rising labor costs in China have driven the 'China+1' strategy, reducing China's share of global apparel exports from 43% in 2010 to 31% in 2019. This decline has been exacerbated by the US-China trade war, which imposed tariffs up to 7.5% on Chinese textiles and apparel, and the Uyghur Forced Labor Prevention Act (UFLPA) (Maile & Staritz, 2024). Apparel brands are diversifying their supply chains, with Vietnam and Bangladesh emerging as key beneficiaries. However, China is still a large supplier due to the ongoing reliance of lead firms particularly on fabric supply from China, as well as ancillary components such as trims, buttons, and zippers.

3.2.4 Continued Influence of the Asia-Pacific Region

The Asia-Pacific textile market is projected to grow from USD391.20 billion in 2024 to USD443.72 billion by 2029, at a CAGR of 2.55% (Research and Markets, 2024). The Asia-Pacific region remains a powerhouse in the global textile and apparel trade. As a global leader, the region holds a 60.7% market share, including 60.1% in apparel, 60.5% in home textiles, and 62% of raw textile exports (Fibre2Fashion, 2024). This dominance highlights the region's dynamic industry, emphasizing the importance of intra-regional trade for risk management and market expansion. China, Bangladesh, Vietnam, and India are key players in this market, driven by strong demand and internal consumption (CICC Research, 2024).

3.2.5 Emerging Markets: Opportunities to Service Chinese Market

The reconfiguration of global supply chains due to rising labor costs in China and geopolitical considerations is expected to cause significant changes to China's role as a major supplier. Companies have started diversifying their sourcing to other Asian countries to better manage production risks and costs. This strategic shift helps mitigate the impacts of potential disruptions and leverages the benefits of a more diversified supply chain. China is expected to lose its share of trade partners' imports in textiles, where it has been a concentrated supplier (Song, White, Birsha, & Woetz, 2024). At the same time, this represents a significant export opportunity for Vietnam with China. According to the Observatory of Economic Complexity (2024), China holds the highest import potential for textiles, with a gap of USD1.3 billion. It is predicted that trade between the USA and China will decrease by USD63 billion through 2031 (Gilbert, Lang, Mavropoulos, & McAdoo, 2023).These trends will drive world trade growth with ASEAN countries, India, and Mexico, as nearshoring and friend-shoring gain pace. Trade between ASEAN and China will increase by an additional USD438 billion by 2031 (Gilbert, Lang, Mavropoulos, & McAdoo, 2023). This indicates substantial opportunities for Vietnamese businesses aiming to tap into the Chinese market.

Opportunities and challenges

Opportunities	Challenges
China as a potential export market: China remains the largest import market for textiles, with a gap of USD1.3 billion. This represents a significant export opportunity for Vietnamese businesses aiming to tap into the Chinese market. **Emerging as a key beneficiary of "China +1" strategy:** As companies diversify their supply chains away from China, Vietnam has emerged as a key beneficiary alongside Bangladesh, further solidifying Vietnam's position as an alternative sourcing destination. **Intra-regional trade expansion:** The Asia-Pacific region holds a dominant position in the global textile and apparel segment, with Vietnam playing a crucial role. Expanding intra-regional trade within Asia can mitigate risks and explore new market opportunities, enhancing Vietnam's position in the regional supply chain.	**Geopolitical risks:** The textile trade's reliance on smooth global transportation makes it vulnerable to conflicts and unrest in key regions such as Russia, the Middle East, and parts of the EU. These geopolitical tensions can disrupt supply chains and affect trade stability. **Increased Competition:** The focus on Asia, particularly with the 'China+1' strategy, means that Vietnam faces greater competition from other Asian countries like Bangladesh and India. Companies diversifying their sourcing may spread their orders across multiple countries, intensifying competition. **Dependence on imported raw materials:** Vietnam's textile industry remains heavily dependent on imported raw materials, particularly from China. This reliance makes it vulnerable to disruptions in the supply chain caused by geopolitical tensions.

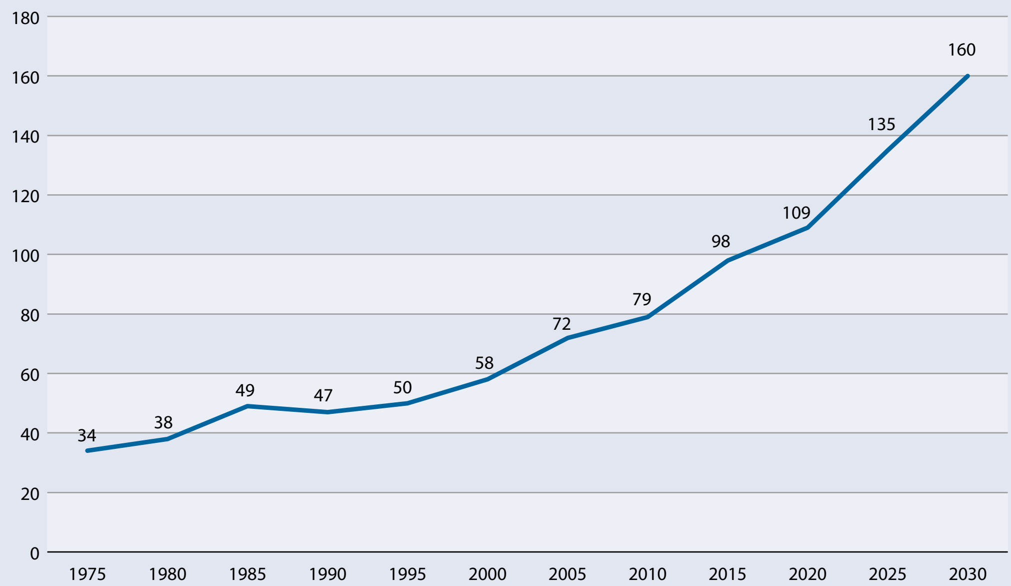
3.3 Textile Innovation and Advanced Materials

3.3.1 Demand for Sustainable Materials

Global fiber production reached a record 124 million tons in 2023, up from 116 million tons in 2022, and is projected to climb to 160 million tons by 2030 if current practices persist (Textile Exchange, 2024) (Figure 23). With this growth, there is a rising demand for sustainable materials. The sustainable fabrics market is anticipated to grow significantly, from USD32.74 billion in 2024 to USD74.8 billion by 2032, reflecting a compound annual growth rate (CAGR) of 12.50% during this period (Market Research Future, 2024). Brands must focus on reducing carbon emissions and prepare for upcoming regulations. A strong strategy for sourcing preferred raw materials is essential, as it ensures access to sustainable supplies. This approach could yield significant financial benefits; for example, a fashion brand with USD1 billion in annual revenue could see a potential gain of around USD100 million over five years (Jensen, et al., 2023). However, prioritizing cost cuts without considering the impact can disrupt the supply of key materials, leading to shortages and regulatory challenges. BCG and Textile Exchange project a 133-million-ton gap in preferred raw materials by 2030, with only 19% meeting preferred standards due to lack of scale (Boston Consulting Group, 2023).

FIGURE 23

GLOBAL FIBER PRODUCTION (MILLION TONS)



Source: Textile Exchange, 2024

The industry is moving towards replacing new virgin fossil-fuel-derived feedstocks with materials that reduce carbon emissions, aiming to slow down the production of new fibers and raw materials. Several initiatives have supported this transition. For example, the 2025 Sustainable Cotton Challenge, with 159 signatories in 2023, encourages brands, retailers, suppliers, and manufacturers to source 100% of their cotton from more sustainable sources by 2025. Similarly, the 2025 Recycled Polyester Challenge, with 124 signatories in 2023, aims to increase the market share of recycled polyester from 14% in 2019 to 45% by 2025 (Textile Exchange, 2024).

3.3.2 Eco-materials

Sourcing green materials helps reduce the textile industry's dependence on harmful chemicals and encourages responsible production practices. Certifications such as the Global Recycled Standard (GRS) or Recycled Claim Standard (RCS) provide transparency and credibility for recycled fabrics, ensuring they meet specific recycled content and production requirements. Several Vietnamese companies are at the forefront of the sustainable textile movement, driving innovation and creativity. For example, in addition to producing recycled clothing for its own market, Thanh Cong Textile Garment - Investment - Trading JSC supplies recycled products for buyers in the USA, the EU, and Japan (Tuoi Tre News, 2024). Greenyarn turns waste into wearable fabric by combining recycled coffee grounds with plastic bottles, reducing landfill waste (Greenyarn, 2024). Faslink promotes eco-friendly fibers like linen, hemp, coffee, mint, and bamboo, which use fewer resources than traditional cotton (Viet Nam News, 2023). W.ELL Fabric follows a closed-loop Lyocell system to produce bamboo fabric, by recycling up to 98% of NMMO chemicals and significantly reducing wastewater (W.ELL Fabric, 2024). These efforts highlight Vietnam's potential to reshape how fashion is created and consumed, positioning the country as a key supplier of eco-friendly textiles.

3.3.3 Innovations in Next-gen Textiles

Next-generation textiles represent a paradigm shift in the textile industry, incorporating the latest advances in materials, technologies, and functionalities. These textiles aim to meet modern demands for sustainability, advanced performance, smart capabilities, and versatility. They go beyond traditional fabrics, integrating smart sensors, responsive materials, sustainable components, and functional coatings. According to the Material Innovation Initiative (MII) (2024), investment in next-gen materials increased by 10% in 2023, reflecting strong interest and potential in this sector. In 2023, there were 144 companies dedicated to researching and developing next-gen materials, up from 95 in 2021. MII projects the industry will reach USD2.2 billion by 2026 (Material Innovation Initiative, 2024).

Opportunities and challenges

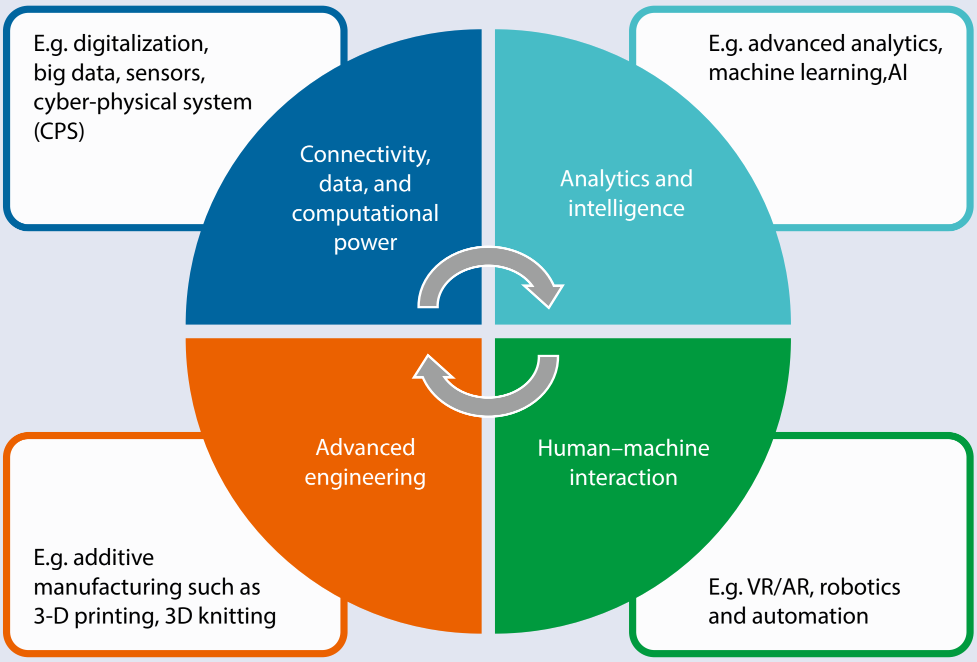
Opportunities	Challenges
Suppliers of eco-friendly textiles: Vietnamese textile firms have the potential to position themselves as leading suppliers of eco-friendly textiles. With brands and retailers globally prioritizing sustainable sourcing, Vietnam's innovative use of durable, recycled, natural, and organic materials can attract significant investment and create numerous job opportunities. Companies like Thanh Cong Textile and Garment, Greenyarn, Faslink, and W.ELL Fabric are already demonstrating how waste can be transformed into wearable fashion, and natural fibers can be used sustainably. This innovative approach not only enhances Vietnam's reputation but also opens new markets and strengthens its competitive edge in the global textile industry. **Collaboration and partnership:** Investing in research and development to produce environmentally friendly fashion products is a significant opportunity for Vietnamese textile firms. Collaborations like that between Hansae Group and Hanosimex to produce recycled textiles (Hai Yen, 2022) highlight the importance of partnerships in advancing sustainability. With the growing demand for certifications like the Global Recycled Standard (GRS) or Recycled Claim Standard (RCS), Vietnamese firms can gain credibility and market access by ensuring their products meet specific recycled content and production requirements. **Next-generation textiles (NGTs):** The development and adoption of next-generation textiles represent a paradigm shift in the industry. Vietnamese firms can capitalize on the latest advances in materials, technologies, and functionalities to meet modern demands for sustainability, advanced performance, smart capabilities, and versatility. The increasing investment in next-gen materials, despite global economic challenges, underscores the potential for growth in this sector (Material Innovation Initiative, 2024). With 144 companies globally dedicated to researching and developing next-gen materials by 2023, Vietnamese firms have the opportunity to collaborate, innovate, and lead in this space, offering high-performance, animal-free, and environmentally friendly materials.	**Securing a sustainable supply chain:** A significant challenge for Vietnamese textile firms is the need to secure a robust supply of sustainable raw materials. According to the Ministry of Industry and Trade, Vietnam is currently only able to actively produce about 30-40% of its domestic raw material needs. Specifically, Vietnam can meet just 0.2% of its cotton demand and 30% of its fiber demand, with the remainder needing to be imported from countries such as the USA, China, and the ROC (Vietnam Textile and Apparel Association, 2022). As brands drive carbon reduction and prepare for upcoming regulations, they need a reliable supply of preferred materials. Without a well-planned strategy, firms may face a materials gap and an inability to adapt to new regulatory landscapes. **Scalability of Innovations:** While next-generation textiles offer exciting possibilities, the scalability of these innovations remains a challenge. The industry is accustomed to rapid sourcing, but new materials may take years to commercialize. Ensuring that innovations are scalable, have robust supply chain tracking systems, scientifically-backed data, and potential for circularity at the end of life is crucial. Without proper investment and support, the demand-and-supply gap for sustainable materials could widen, significantly impacting the industry's ability to meet climate targets and sustainable goals. **Lack of resources:** The majority of enterprises in the industry are SMEs with limited capital and human resources, resulting in insufficient investment in research and technology. Vietnam's strong reliance on other markets such as China for textile materials represents a significant weakness as the global textile industry evolves and requires continuous innovation and adaptation in next-gen materials.

3.4 Textile 4.0 – Adoption of Industry 4.0 Principles

Vietnam's textile industry is at a critical juncture, struggling with outdated technology compared to regional and global competitors. Only 30% of businesses, including foreign-invested enterprises and large domestic companies, have adopted automation at various stages of production, with less than 5% planning to implement connected automation technology (Phuong Thao, 2021). The implementation of Industry 4.0 is set to revolutionize Vietnam's textile and garment industry by enhancing productivity and profitability significantly. Industry 4.0 is characterized by increasing automation and the employment of smart machines and smart factories; informed data helps to make better decisions and produce goods more efficiently and productively across the value chain (IBM, 2024) (Figure 24). According to Majumdar, Garg, and Jain (2021), the adoption of these advanced technologies can increase manufacturing productivity by up to 55% and profit margins by as much as 15%.

FIGURE 24

KEY TECHNOLOGIES IN INDUSTRY 4.0



Source: McKinsey & Company, 2022

3.4.1 Shift from Labor-intensive to Value-added Production

Vietnam's textile and garment industry is at a critical juncture, facing intense competition as cheap labor is no longer an advantage compared to countries such as Bangladesh. Without a strategic transformation and substantial investment in modern technologies, the industry risks stagnation and losing its competitive edge. Therefore, despite its labor-intensive nature, the Vietnamese textile and garment sector is gradually transitioning towards a value-added production model by adopting Industry 4.0 technologies. Innovations such as artificial intelligence (AI), interactive robotics, smart sensors, and 3D printing are increasingly being integrated into manufacturing processes. These technologies are expected to boost productivity by 21% to 46% (ADB, 2021), positioning the industry for future growth. Research by the Vietnam National Textile and Garment Group highlights that a fiber factory utilizing Industry 4.0 models can reduce labor by up to 70% and cut energy usage by up to 25% (WWF, 2022). Similarly, a textile dyeing factory operating under the 4.0 model can achieve a 30% reduction in labor, 50% less water usage, and 50% lower energy consumption. Over the past decade, labor productivity per capita in Vietnam's textile industry has nearly quadrupled, and technological advancements have significantly improved the efficiency of spinning and weaving processes. For instance, the number of employees needed for 10,000 spindles has decreased from over 110 to just 25-30, reflecting a fourfold increase in labor productivity (WWF, 2022). The shift from relying on human skill to leveraging data-driven automation has also enhanced the accuracy and stability of the dyeing process, with first-time accurate dyeing rates improving from 70-80% to 95-98% in many factories (WWF, 2022). In garment production, automation is being increasingly utilized for complex and repetitive tasks, such as fabric spreading, cutting, and adding pockets, reducing labor needs and material waste.

3.4.2 Automation Technology Adoption

One of the primary drivers of technological advancement in Vietnam's textile and garment industry is the upgrade of industrial facilities to improve energy efficiency and operational functions. Globally, textile manufacturing facilities are investing in automation solutions that reduce costs and maintain consistent quality throughout the year. These upgrades are crucial for staying competitive, as they help reduce the workforce required for various tasks, thereby lowering operational costs (Technavio, 2023). The global market for automation in the textile industry is experiencing substantial growth, with projections estimating an increase of USD775.92 million by 2028, at a compound annual growth rate (CAGR) of 3.75% (Technavio, 2023). This growth is driven by the widespread recognition of automation's benefits, including enhanced process efficiency, reduced labor costs, and improved product quality. Robotics and sensors play a pivotal role in automating processes such as knitting, yarn tension management, and other critical production stages. The use of autolevellers and draw frames has been particularly effective in maintaining consistent yarn tension, improving overall productivity, and ensuring high-quality output (Technavio, 2023). AI, robotics, and smart sensors have seen high levels of adoption within the industry, particularly in regions with advanced manufacturing capabilities. However, other technologies like Cyber-Physical Systems (CPS) and human-robot interaction are still in the early stages of adoption among apparel firms in Vietnam (Van Ta, Jin, & Cho, 2024).

3.4.3 Data Analytics for Optimal Decision-making

Embedded sensors and interconnected machinery produce vast amounts of big data for manufacturing companies. The smart factory's network architecture relies on interconnectivity. Real-time data collected from sensors, devices, and machines on the factory floor can be immediately consumed and utilized by other factory assets and shared across the enterprise software stack, including enterprise resource planning (ERP) and other business management software (IBM, 2024). Data analytics enable manufacturers to investigate historical trends, identify patterns, and make better decisions. Smart factories can also leverage data from other parts of the organization and their extended ecosystem of suppliers and distributors to create deeper insights. By analyzing data from human resources, sales, or warehousing, manufacturers can make informed production decisions based on sales margins and personnel needs. This comprehensive digital representation of operations is known as a "digital twin." A study by McKinsey & Company (Fox, Goldrick, & Whittington, 2018) reveals that apparel companies leveraging advanced analytics can realize significant benefits, including a 15-20% reduction in inventory costs, a 10-15% increase in revenue, and a 5-10% improvement in gross margin.

3.4.4 Custom Manufacturing

Smart factories are capable of producing customized goods that meet individual customer needs more cost-effectively. In many industry segments, manufacturers aim to achieve a “lot size of one” in an economical way. By using advanced simulation software, new materials, and technologies like 3D printing, manufacturers can easily create small batches of specialized items for specific customers (IBM, 2024). While the first industrial revolution focused on mass production, Industry 4.0 is about mass customization, an important driver of competitive advantages (Shi et al., 2023)

3.4.5 Supply Chain Integration

Industrial operations depend on a transparent, lean, and efficient supply chain, which must be integrated with production operations as part of a robust Industry 4.0 strategy (Saha et al., 2023). This integration transforms how manufacturers source raw materials and deliver finished products. Sharing production data with suppliers enables better delivery scheduling, and predictive shipping allows companies to meet consumer demand efficiently. This also enables firms to engage in global value chains via collaborative efforts with supply chain partners (Deepthi, & Bansal, 2024).

Opportunities	Challenges
Enhanced productivity and efficiency: The adoption of Industry 4.0 technologies offers a significant opportunity to enhance productivity and operational efficiency within Vietnam's textile and garment industry. Automation, AI, robotics, and smart sensors can streamline production processes, reduce manual labor, and increase output quality. This shift from labor-intensive methods to value-added production systems can lead to productivity gains of 21% to 46% (ADB, 2021).	**Infrastructure limitations in SMEs:** A significant challenge is the lack of automation-compatible infrastructure, particularly among SMEs. Implementing Industry 4.0 technologies often requires substantial investments in new machinery, facility upgrades, and the establishment of centralized control systems. For many SMEs, these costs are prohibitive, and the downtime associated with transitioning to automated systems can disrupt production and affect profitability.
Global competitiveness: By adopting Industry 4.0 technologies, Vietnam can position itself as a more competitive player in the global textile and apparel market. By integrating advanced manufacturing technologies, Vietnamese firms can meet the increasing demands for high-quality products and quicker turnaround times, making the country an even more attractive destination for foreign direct investment.	**High initial investment costs:** The integration of advanced technologies such as AI, robotics, and smart sensors requires considerable upfront investment. For many companies, especially smaller ones, these costs can be a significant barrier. Additionally, the return on investment might not be immediate, making it challenging for businesses with limited financial resources to justify the expenditure.
Sustainability and energy efficiency: The push towards automation and digitalization also aligns with global trends in sustainability. Upgrading industrial facilities to be more energy-efficient and adopting eco-friendly technologies can help Vietnamese firms reduce their environmental footprint. This focus on sustainability can enhance the industry's appeal to environmentally conscious consumers and global brands.	**Workforce displacement and skill gaps:** The shift towards automation and digitalization may lead to workforce displacement, as jobs traditionally performed by manual labor are increasingly automated. This creates a challenge in terms of retraining and upskilling the existing workforce to operate and manage new technologies. The skill gap in managing sophisticated machinery and digital systems could hinder the industry's ability to fully capitalize on Industry 4.0 advancements.
Expansion of digital platforms: The growth of e-commerce and the use of digital platforms present significant opportunities for Vietnamese textile and garment companies. By leveraging online sales channels, businesses can reach a broader global audience, reduce dependency on traditional retail channels, and respond more swiftly to market changes. The ability to engage directly with consumers through digital platforms also opens up new revenue streams and marketing opportunities.	**Reliance on low-cost labor:** Vietnam's textile and garment industry has traditionally relied on low-cost labor as a competitive advantage. The transition to automated processes could disrupt this model, particularly for SMEs that continue to find manual labor more economical. The challenge lies in balancing the benefits of automation with the economic realities of low-cost labor in developing regions.
Skilled workforce development: Vietnam's young and increasingly skilled workforce is well-positioned to take advantage of Industry 4.0 technologies. As more workers are trained in advanced manufacturing techniques and digital tools, the industry can expect a rise in innovation, improved production processes, and a more resilient labor force.	

3.5 Proactive Buyers

3.5.1 Personalization

The textile industry is rapidly embracing personalization, with the market for customized apparel projected to reach USD38.3 billion by 2026, growing at a CAGR of 8.7% (Market Research Future). Social media platforms like Instagram and Pinterest have become key drivers of this trend, flooded with consumer-generated content showcasing personalized clothing and accessories.

Powered by 4IR technologies and innovative business models, the industry is focusing on personalized production. Unlike the past eras—marked by mechanization, mass production, and digitalization—the current revolution prioritizes hyper-personalization, catering to individual preferences rather than the mass-produced items made for the average consumer (Jin & Shin, 2021). This shift addresses the significant issue of unmatched demand and oversupply that plagued previous industrial eras, leading to excess inventory and environmental harm.

Now, consumers seek fashion products that reflect their unique style and fit, and companies like Stitch Fix are meeting this demand by utilizing AI and big data to offer personalized styling services (Marr, 2024). With 4IR technologies, personalization can significantly reduce unsold inventory, contributing to environmental sustainability while enhancing consumer satisfaction. Hyper-personalization, which encompasses both customization and personalization, offers tailored solutions that satisfy individual customer needs (Deloitte, 2024). This approach not only improves the consumer experience but also enhances operational efficiency for manufacturers and retailers.

3.5.2 Value Co-Creation with Buyers

The integration of 3D design technology into the textile industry is revolutionizing how businesses interact with buyers and create value. This advanced technology allows companies to nearly eliminate traditional sample-making processes, enabling fully digital fashion shows—from initial design to final product—using virtual models. What once took 30 to 50 weeks, from sketching a design to obtaining final customer approval, can now be completed in just 5 to 9 weeks (Vietnam Textile & Apparel Association, 2024). Digital tools allow for immediate adjustments, significantly reducing turnaround times and fostering closer collaboration between manufacturers and buyers.

This transformation not only streamlines production but also deepens the relationships between businesses and their buyers. By taking a more active role in the value chain, companies can co-create value, ensuring that final products closely match buyer expectations and market demands. This collaborative approach, underpinned by cutting-edge technology, is essential for maintaining competitiveness in the rapidly evolving global textile market.

Moreover, this shift accelerates supply chain processes and helps reposition the industry towards greater value-added participation, such as Free On Board (FOB), Original Design Manufacturing (ODM), or Owning Brand Manufacturing (OBM) methods. Many factories are currently transitioning from Original Equipment Manufacturing (OEM)/Contract Manufacturing (CM) production to ODM/FOB, and several businesses in Vietnam have already successfully made this transition (Hoang Anh, 2024). This evolution necessitates increased cooperation and collaboration between enterprises, across different stages of the supply chain, and among related sectors such as textiles, dyeing, footwear, and accessories.

Opportunities and challenges

Opportunities	Challenges
Growing Market Demand: The market for customized apparel is projected to reach USD2.17 billion at a CAGR of 8.04% between 2023 and 2028 (Technavio, 2024), reflecting a strong consumer preference for personalized fashion. This trend offers significant growth potential for companies that can effectively tap into this market. **Increased efficiency and effectiveness:** By eliminating traditional sample-making processes and using digital models, companies can minimize unsold inventory and waste, supporting more sustainable production practices. This reduces excess inventory and minimizes environmental impact while enhancing consumer satisfaction. The adoption of 3D design technology enables faster turnaround times, reducing the design-to-approval process. This speed enhances responsiveness to market trends and buyer needs. **Improved relationships with buyers:** The integration of 4IR technologies, such as AI and big data, facilitates hyper-personalization, allowing companies to offer products that cater to individual preferences. Personalization improves the consumer experience by providing tailored solutions that reflect individual styles and preferences. Digital tools foster closer collaboration between manufacturers and buyers, allowing for real-time feedback and adjustments. This leads to products that better match buyer expectations and strengthens business relationships. This can lead to higher customer loyalty and satisfaction. **Engagement with global value chain:** Improved collaboration and integration across the supply chain enhance overall efficiency and performance, benefiting from closer cooperation between different stages of production and related sectors. There is a potential to transition towards value-added activities such as FOB, ODM, and OBM, allowing companies to capture more value and improve their market position, leading to higher profitability and better alignment with market demands.	**Complexity of implementation:** Integrating advanced technologies for personalization and digital tools requires substantial investment and expertise. Personalized production and advanced technologies can lead to higher costs compared to traditional mass production. Balancing these costs with competitive pricing poses a challenge. Companies may face challenges in effectively developing and implementing these systems. **Scalability issues:** Scaling personalized production to handle large volumes while maintaining quality can be difficult. Companies need to manage production scale without compromising on customization. **Data management:** Managing, analyzing, and sharing data among various parties using digital tools can be complex. Companies need robust data management and security practices to ensure accurate decision-making and protect sensitive information. **Market dynamics:** The fast-paced nature of the fashion industry means companies must remain agile and responsive to changing trends and buyer preferences, which can be challenging in a dynamic market environment. As personalization becomes more common, consumer expectations rise, requiring continuous innovation and adaptation to meet evolving demands, which can be resource-intensive.

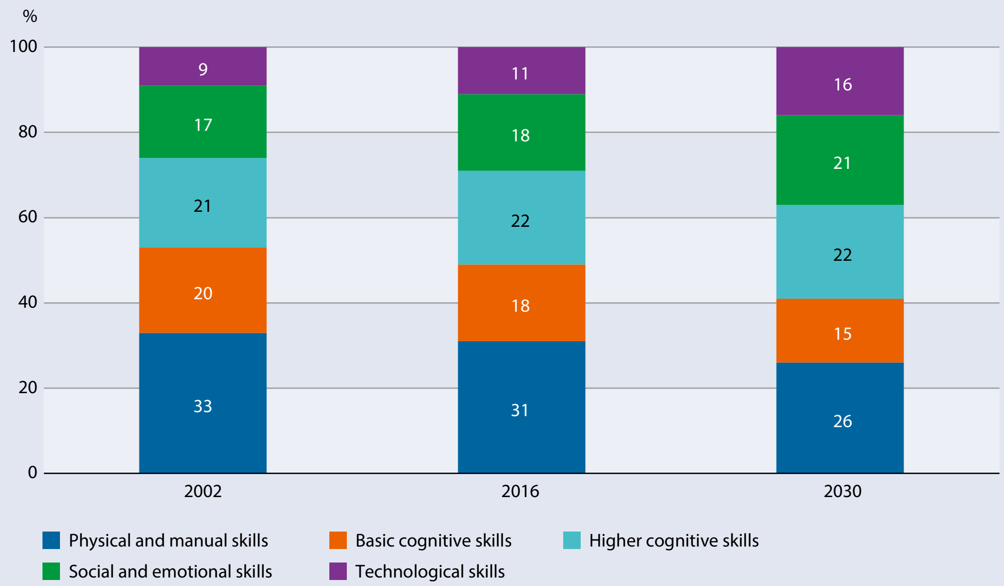
3.6 Skilled Labor

3.6.1 Skill Requirements

Despite Vietnam's large labor force, the textile and garment industry faces a critical shortage of skilled workers. As advanced technology reshapes the industry and market demands evolve, substantial investment in training and human resource development has become essential. Industry experts suggest that while the overall number of workers required may remain stable or even decrease due to technological advancements, the demand for highly skilled labor is expected to rise significantly. The future will see a growing need for technical skills—such as digital literacy, IT, programming, technology design, engineering, and equipment maintenance. Additionally, there will be increasing demand for advanced cognitive skills like project management and creativity, alongside social and emotional skills such as entrepreneurship and initiative-taking. In contrast, physical and manual labor skills (e.g., material handling) and basic cognitive skills (e.g., basic literacy, numeracy, and communication) are anticipated to decline by 2030 (Figure 25). This trend reflects the broader global shift towards Industry 4.0, which emphasizes automation and advanced technologies, highlighting the necessity for upskilling and re-skilling to maintain competitiveness.

FIGURE 25

ACCELERATION OF SKILL SHIFTS (% OF TIME)



Source: McKinsey Global Institute, 2018

3.6.1.1 Upskilling

As Industry 4.0 continues to shape the manufacturing landscape, companies will face more than just a shortage of skilled employees. The shift towards automation and digitalization will bring additional challenges related to the skill development of the existing workforce (McKinsey Global Institute, 2018). One challenge is the need for upskilling, where workers accustomed to manual tasks will be required to learn how to operate advanced machinery, such as robots. In the textile and garment industry, digital, information and communication technology (ICT) skills, along with creative thinking and design capabilities, will become increasingly critical (Asia Development Bank, 2023). This transition demands significant training efforts to ensure that workers can effectively handle new tools and technologies.

3.6.1.2 Re-skilling

Another major challenge is re-skilling. Industry 4.0 is expected to lead to some degree of job displacement, with certain roles becoming obsolete while new ones emerge. Companies will need to invest in re-skilling programs to prepare their labor force for these changes, ensuring that employees can transition smoothly into new roles created by technological advancements (Asia Development Bank, 2021). Additionally, the rapid pace of technological change will require continuous learning strategies, as technologies may become obsolete at an accelerated rate. Companies will need to implement ongoing professional development to help their workforce adapt to these frequent changes.

3.6.1.3 Employee Mindset

There is a need for a fundamental shift in the mindset of the labor force. Given the magnitude of the changes that Industry 4.0 will bring, employees may resist or oppose the implementation of new technologies. Many organizations encounter significant resistance when implementing new technologies due to employees' fears of job displacement and a greater level of surveillance over their work, discomfort with digital tools, and a preference for established processes (Cugno, Castagnoli, & Büchi, 2021). This resistance is often described as organizational inertia, which hinders the adoption of innovative practices necessary for advanced manufacturing processes (Sharma et al., 2023). Companies must therefore plan for and encourage a change in mindset, fostering an environment that embraces innovation and facilitates a smooth transition to advanced manufacturing processes.

3.6.2 Competing Industries for Talent Recruitment and Retention

In the next five to 10 years, Vietnam's advantage of low labor costs in the garment sector is expected to diminish as automation becomes more widespread. As a result, the industry will increasingly rely on smart, well-educated local talent capable of adapting production lines to integrate the latest technological solutions.

3.6.2.1 Relationships with Employees

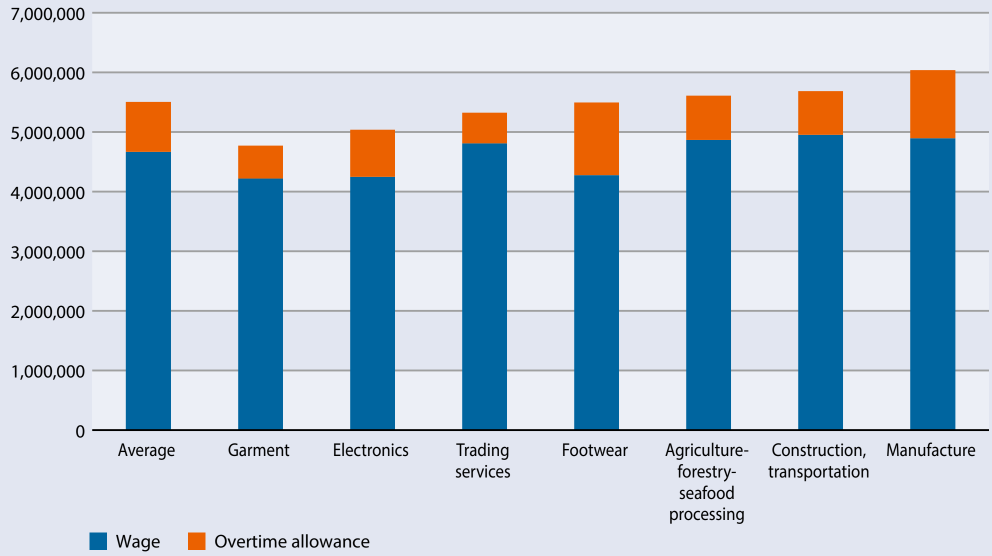
The labor market in Vietnam, particularly in the garment industry, is highly competitive. Before the COVID-19 pandemic, the number of garment enterprises was rapidly increasing, leading to consistently high demand for labor. Despite efforts to offer competitive wages, the industry has struggled with an unstable workforce. High turnover rates have been a persistent issue, with workers frequently changing jobs in pursuit of better pay or leaving for personal reasons without claiming employer-provided social benefits. In 2018, turnover rates were reported to be 15-20% for large companies, 20-30% for small companies, and 30-40% for FDI enterprises (Vietnam Investment Review, 2018). This high turnover, coupled with labor shortages, has created challenges for factory owners, who must maintain good relations with their workers or risk financial losses due to unfilled or under-filled orders. In addition, the vast majority of workers in garment enterprises are migrant workers from rural areas of Vietnam, where factory jobs offer significantly higher wages compared to agricultural work. This wage differential often compels workers to endure challenging working conditions and overlook labor law violations. To address these issues, the garment industry must focus on maintaining strong relationships with its workforce and invest in training and retention strategies to remain competitive in an increasingly dynamic labor market.

3.6.2.2 Increasing Competition from Other Industries

In addition to the competitive nature of the labor market, the garment industry faces competition from other rapidly growing sectors such as construction, furniture, and electronics (Figure 26) (Institute of Workers and Trade Unions, 2021). The textile industry is often viewed as less attractive because it is perceived as demanding and labor-intensive. Many workers see it as requiring repetitive tasks with limited career advancement opportunities. This perception is compounded by concerns over working conditions, which can include exposure to chemicals and a physically demanding environment. The nature of the work in textile manufacturing, which often involves long hours and manual labor, contrasts sharply with the more advanced and cleaner environments associated with high-tech industries (International Labour Organization, 2022).

FIGURE 26

GARMENT WORKERS' AVERAGE WAGE COMPARED TO OTHER INDUSTRIES' WORKERS' WAGES (VND)



Source: Institute of Workers and Trade Unions, 2021

High-tech sectors, such as electronics, offer more appealing work environments and career prospects. These industries are associated with higher wages, cleaner and safer workplaces, and opportunities for professional growth and development. The advanced nature of technology in these fields, combined with the higher skill requirements, makes them more attractive to potential employees. Electronics and other tech industries also typically offer more appealing benefits and a greater emphasis on innovation, which can be more motivating for prospective workers. Furthermore, the textile industry's reliance on chemicals and the labor-intensive nature of its processes contribute to its less favorable image. The potential health risks associated with chemical exposure and the physically demanding tasks involved can deter individuals from pursuing careers in this sector. In contrast, industries like electronics are often perceived as offering safer working conditions and a more modern, technologically advanced work environment.

3.6.3 The Importance of Education and Training

Establishing comprehensive vocational training programs and fostering collaboration with universities and research institutes are critical measures to ensure the supply of skilled labor that meets the industry's increasingly sophisticated requirements (Asia Development Bank, 2023). To succeed in this new era, workers will need a broad range of qualifications and skills. Knowledge in ICT, basic information technology, and the ability to use and interact with smart machines will be essential. Understanding machine-to-machine communication, IT security, and data protection will also be critical. Additionally, workers will need to be skilled in data literacy, including the ability to process and analyze data, interpret visual data outputs, and make informed decisions based on this information. A strong foundation in technical know-how, particularly in manufacturing processes and machine maintenance, will be crucial, along with personal skills such as adaptability, decision-making, teamwork, and communication. Importantly, a mindset geared towards lifelong learning will be essential for success in the rapidly evolving landscape of Industry 4.0 (Cugno, Castagnoli, & Büchi, 2021).

Overall, to remain competitive in this challenging labor market, the textile industry needs to address these perceptions by improving working conditions, investing in cleaner technologies, and enhancing career development opportunities. By making the sector more attractive to potential employees and emphasizing advancements such as automation and technology integration, the industry can better compete with high-tech sectors for skilled talent.

Opportunities and challenges

Opportunities	Challenges
Improvement of labor productivity: The integration of Industry 4.0 technologies such as automation and digital tools presents opportunities to enhance labor productivity and improve the overall quality of output. **Enhanced skill development:** The evolving demands of the market present a chance to upskill and re-skill the workforce. Training programs focused on advanced manufacturing techniques can help workers transition from manual tasks to operating sophisticated machinery, ensuring that the labor force remains relevant and competitive. This can set Vietnam apart from other labor-intensive countries and create a strong competitive advantage. **Improved labor relations:** By investing in training, retention strategies, and better working conditions, the industry has the potential to reduce high turnover rates and foster more stable and productive relationships with workers, which is crucial in maintaining competitiveness. **Strategic collaborations:** Forming alliances with universities, research institutes, and international brands can drive innovation, enhance research and development capabilities, and ensure a steady supply of skilled labor.	**Skilled labor shortage:** The textile industry faces a significant shortage of skilled workers, exacerbated by the need for upskilling and re-skilling to keep pace with technological advancements. This requires substantial investment in training and development programs. **High turnover rates:** The industry struggles with high employee turnover, which disrupts production and increases recruitment and training costs. This issue is compounded by the competitive nature of the labor market and the need to maintain good relations with workers. **Competition:** The textile industry is often perceived as labor-intensive and less appealing compared to high-tech sectors. The repetitive nature of the work, exposure to chemicals, and demanding conditions make it less attractive to potential employees. Rapidly growing industries such as electronics, footwear, and furniture offer higher wages and better working conditions, drawing talent away from the textile sector. This intensifies the challenge of recruiting and retaining skilled workers. **Resistance to change:** Employees may resist the implementation of new technologies due to fear of job displacement or unfamiliarity with advanced systems. Companies need to manage this resistance and foster a culture that embraces technological change.

4. SCENARIOS FOR VIETNAM'S TEXTILE AND GARMENT INDUSTRY: A GENERAL EQUILIBRIUM ANALYSIS OF GREEN GROWTH AND GLOBAL TECHNOLOGIES TO ENHANCE COMPETITIVENESS

4.1 Scenario Design

This study employs the Global Trade and Environment Model (GTEM) – a recursive dynamic, multi-country, and multi-region computable general equilibrium (CGE) framework developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) – to analyze economic activities (Nong et al., 2023, Lu et al., 2024). We employ the Global Trade Analysis Project database version 10a (which represents the world economy in 2014), with 141 countries and regions[1] and 65 sectors[2] (Aguiar et al., 2019). For this study, the data is aggregated into 22 countries/regions—including Vietnam and its key textile and garment trading partners—and 46 industrial sectors, focusing on the textile and garment supply chains (see Appendix 2 for more details on the model and database).

1 https://www.gtap.agecon.purdue.edu/databases/regions.aspx?version=10
2 https://www.gtap.agecon.purdue.edu/databases/contribute/detailedsector.asp

BOX 1

DESCRIPTION OF A CGE MODEL

A **recursive dynamic multi-region, multi-sector computable general equilibrium (CGE) model** is a powerful economic modeling tool used by researchers and policymakers to simulate and analyze the impacts of policy changes, economic shocks, technological development, and structural transformations over time across multiple regions and sectors. It helps decision-makers understand how economies might evolve under different scenarios, taking into account the complex interactions between industries, regions, and households.

Key Features of a Recursive Dynamic CGE Model

1. Multi-Region Framework:

- **What It Means:** The model covers multiple geographic regions (e.g., countries or groups of countries). Each region is treated as an individual economy with its own resources, industries, and consumer behavior. However, the regions are interconnected through trade, investment, and financial flows.
- **Why It Matters:** This allows for the analysis of how changes in one region (such as a new trade policy or economic growth) can affect other regions, making it essential for understanding global and regional economic integration, trade agreements, or international cooperation.

2. Multi-Sector Structure:

- **What It Means:** The model divides each regional economy into multiple sectors or industries, such as agriculture, manufacturing, services, and energy. Each sector interacts with others, both as suppliers of inputs (e.g., fibers) and as consumers of outputs (e.g., households buying wearing apparel).
- **Why It Matters:** This enables the evaluation of sector-specific policies or shocks (like carbon taxes or technological innovations) and their cascading effects on the broader economy. It also helps in understanding sectoral impacts on employment, production, and consumption.

3. Recursive Dynamic Approach:

- **What It Means:** The model is dynamic, meaning it captures changes over time, but it follows a **recursive** structure. This means it solves the model year by year, where the outcomes of one year (like capital accumulation or labor market conditions) influence the next. However, agents in the economy (e.g., firms and households) typically make decisions based on current conditions rather than perfect foresight of the future.
- **Why It Matters:** This approach allows for analyzing the evolution of economies over the medium to long term, such as the impact of gradual reforms or infrastructure investments. It also captures cumulative effects, such as how policy or technological changes in one year can lead to larger changes over decades.

4. General Equilibrium Nature:

- **What It Means:** A CGE model captures the equilibrium across all markets (goods, services, labor, and capital) simultaneously. It accounts for how supply and demand interact across different markets to determine prices, production levels, and consumption patterns.
- **Why It Matters:** This provides a comprehensive view of how changes in one part of the economy (such as a tax on carbon emissions or a change in labor policy or technological innovations) will ripple through all markets, affecting prices, production, trade, and income distribution. It highlights trade-offs and synergies between policies.

5. Key Agents in the Economy:

- **Households:** Consumers make decisions on spending and saving based on income, preferences, and prices.
- **Firms:** Producers decide how much to produce based on costs, prices, and available technologies.
- **Government:** The model captures government activities, including taxation, spending, and subsidies.
- **Rest of the World:** It simulates international trade, investment, and capital flows, showing how domestic economies interact with global markets.
- Why It Matters: This enables policymakers to assess distributional impacts, such as how changes in taxes, subsidies, or trade policies will affect different households, industries, and regions. It is especially useful for equity and inclusion analysis.

6. Key Data Inputs:

- The model uses large datasets, such as input-output tables (which show the flow of goods and services between sectors), trade data, labor market statistics, and national accounts.
- **Why It Matters:** High-quality data ensures that the model's results reflect real-world economic conditions and provide realistic forecasts, making it a reliable tool for evidence-based policy design.

Applications for Policymakers

1. **Policy Impact Analysis:**
   - Policymakers can simulate the economic impacts of policy proposals, such as tax reforms, energy policies, trade agreements, or labor market regulations. The model shows how these policies affect GDP, employment, inflation, income distribution, and sectoral output.
2. **Trade and Globalization:**
   - A multi-region CGE model helps evaluate the effects of trade policies, tariffs, and trade agreements (e.g., free trade zones, tariffs) on both domestic and international economies. It provides insights into how different countries or regions will be impacted by changes in trade flows and global supply chains.
3. **Environmental and Climate Policies:**
   - By incorporating environmental data, the model can assess the effects of carbon pricing, emissions reductions, or renewable energy transitions. It helps estimate the economic cost of environmental policies and identifies opportunities for sustainable growth while mitigating adverse impacts on industries and workers.
4. **Technological Change and Innovation:**
   - Policymakers can use the model to analyze how technological advancements (e.g., automation, digitalization) will affect labor markets, productivity, and industrial competitiveness. It highlights the sectors likely to benefit or suffer and suggests policy responses to support vulnerable industries or regions.
5. **Investment and Infrastructure Planning:**
   - The recursive dynamic feature allows for long-term analysis of infrastructure investments (e.g., transport, energy, digital infrastructure) by showing how they stimulate growth, productivity, and job creation over time.
6. **Income Distribution and Equity:**
   - CGE models can be used to study the distributional effects of policies. For example, policymakers can assess how tax reforms or social policies (like healthcare or education subsidies) impact different income groups or regions.

4.1.1 Baseline Scenario

We project the global economy from 2014 to 2045 under a baseline scenario (see Box 2) aligned with Shared Socioeconomic Pathway 2 (SSP2), which incorporates forecasts for real GDP and population growth through 2045 (Fricko et al., 2017). Labor supply is assumed to grow in line with population trends. In each region, real GDP projections are achieved by adjusting primary-factor-augmenting technological change to match the anticipated GDP levels.

In addition, we integrate projections for productivity and efficiency improvements in the crop, livestock, fishery, and food processing sectors, based on estimates from Hatfield-Dodds et al. (2017). Global emissions forecasts are derived from the International Energy Agency's World Energy Outlook 2023 (IEA, 2021), which predicts that global emissions could peak at 56.5 billion tons of CO_2-equivalent (CO_2e) annually by 2030, declining to 51.5 billion tons by 2050. Projections for individual greenhouse gases (such as CO_2 and CH4) are accounted for by endogenizing global emission intensity for each gas. We also assume a uniform 1% annual improvement in energy efficiency across all sectors and households worldwide. For Vietnam, GDP and export forecasts to key trading partners—including China, India, the USA, Canada, the UK, Australia, Japan, and the ROK—are based on estimates from the General Statistics Office of Vietnam, covering the period from 2014 to 2023.

BOX 2

UNDERSTANDING TECHNOLOGICAL ADVANCEMENTS VS. BASELINE SCENARIOS

1. **Baseline Scenario (Status Quo):**
   - This reflects a future where technological change occurs at a predicted or historical pace, based on current trends and assumptions.
   - It assumes that no major innovations, breakthroughs, or disruptive technologies occur beyond what is already anticipated.
   - The baseline serves as a reference point for comparing the effects of new technological innovations.
2. **Introduction of Technological Advancements:**
   - When evaluating technological advancements, the model introduces new or improved technologies that exceed the assumptions in the baseline.
   - These advancements can include things like:
     - **Increased productivity** (e.g., automation, artificial intelligence).
     - **Energy efficiency** improvements (e.g., renewable energy sources, energy storage systems).
     - **Cost reductions** in production processes or materials (e.g., 3D printing, nanotechnology).
     - **Environmental benefits** (e.g., carbon capture technologies, circular economy innovations).
3. **Comparative Analysis:**
   - The impact of technological advancements is measured by comparing key outcomes (such as GDP, emissions, productivity, or sector-specific growth) between the baseline scenario and a scenario where new technologies are introduced.
   - **Deviations from the baseline** are analyzed to understand the incremental effects of these advancements. This can highlight how much technology changes the overall trajectory of the economy, industry, or society.

Key Areas of Impact of Technological Advancements vs. Baseline:

1. **Economic Growth and Productivity:**
   - **In the baseline scenario:** Productivity grows at a slow or historical rate, limiting potential economic growth.
   - **With technological advancements:** Improved technologies can significantly boost productivity across sectors, leading to higher GDP growth, more efficient industries, and better use of resources.
   - **Example:** Automation and AI might increase manufacturing output compared to the baseline where traditional production methods are assumed.
2. **Employment and Labor Markets:**
   - **In the baseline scenario:** Employment and wages grow at expected rates, often constrained by slow technological progress.
   - **With technological advancements:** New technologies might shift labor demand by automating tasks, creating new industries, or requiring more skilled labor. The overall impact on employment may be higher or lower depending on the nature of the technological change.
   - **Example:** The introduction of AI-driven services might require new skills and jobs, differing from the baseline where these jobs don't exist yet.

3. **Environmental Impact:**
   - **In the baseline scenario:** Emissions, resource use, and environmental degradation continue at projected rates based on current technologies.
   - **With technological advancements:** Green technologies (e.g., renewable energy, electric vehicles, carbon capture) can reduce emissions and resource use, leading to more sustainable growth paths compared to the baseline.
   - **Example:** A baseline might project rising CO_2 emissions, but with advancements in clean energy, emissions could stabilize or decrease significantly.
4. **Market Structure and Competition:**
   - **In the baseline scenario:** Industries continue to operate with the same competitive dynamics, often with gradual technological changes.
   - **With technological advancements:** Innovations can disrupt market structures, enabling new entrants or transforming existing players into more dominant forces.
   - **Example:** In the baseline, the automotive industry might rely on internal combustion engines. With advancements in electric vehicles and batteries, this industry could shift dramatically, creating new market leaders and disrupting traditional players.
5. **Social and Societal Impacts:**
   - **In the baseline scenario:** Social development follows predictable trends in terms of education, healthcare, and quality of life improvements.
   - **With technological advancements:** Innovations in areas like healthcare (e.g., biotechnology, telemedicine) or education (e.g., digital learning) can lead to faster improvements in human well-being than what is projected in the baseline.
   - **Example:** A baseline might predict steady improvements in health outcomes, but advancements in gene therapy or telemedicine could dramatically accelerate health benefits for the population.
6. **Sector-Specific Developments:**
   - **In the baseline scenario:** Each sector grows or changes based on historical trends and current technology.
   - **With technological advancements:** Key sectors such as energy, manufacturing, and agriculture may undergo transformation. New technologies can lead to changes in production methods, cost structures, and output levels.
   - **Example:** In agriculture, the baseline may assume traditional farming methods, but with advancements in precision farming and biotechnology, crop yields might increase, and resource usage might decrease.

4.1.2 Green Growth and Technological Development Scenarios

We design the green growth and technological development scenarios around four key pathways: low green–low tech, low green–high tech, high green–low tech, and high green–high tech. These scenarios examine how varying rates of green growth and technological advancements in Vietnam's textile and garment industries will impact the sectors and their supply chains.

In all scenarios, only the Vietnam textile and garment industries experience differentiated shocks, while shocks for the global textile and garment industries remain unchanged with the values shown in Table 2. We assume global energy efficiency improves at a rate of 3% per year from 2024 to 2030, as estimated by the International Energy Agency[3], with a slower growth rate of 2.5% per year between 2031 and 2037, and 2% per year from 2037 to 2045 following business cycles. These assumptions align with the Solow growth model, which predicts decreasing annual energy efficiency gains over time. The same growth pattern is assumed for chemical use and the recycling of water and materials. For annual labor productivity growth in the textile and garment industries, we follow estimates from (El Achkar Hilal et al., 2022).

TABLE 2

COMMON SHOCKS FOR WORLD'S TEXTILE AND GARMENT INDUSTRIES

Target	Indicator	Period		
		2024-30	2031-37	2038-45
Green growth	Energy efficient growth (%/year)	3%	2.50%	2%
	Chemical utilization efficiency growth (%/year)	3%	2.50%	2%
	Re-use efficiency growth of water and recycling material (%/year)	3%	2.50%	2%
Technology development	Labor productivity (textile industry)	7%	6%	5%
	Labor productivity (garment industry)	6%	5%	4%

Note: In all green growth and technological development scenarios, the common shocks for world's textile and garment industries are implemented. In other words, there are only differences in shock values for Vietnam's textile and garment industries if not specified, for example, in Scenario S12.

Table 3 outlines four primary scenarios focused on Vietnam's textile and garment industries. In the first scenario (S1: low green–low tech), these industries achieve only 1% annual growth in green growth indicators, which is lower than the growth observed in international markets. In this scenario, we assume that labor productivity growth rates in Vietnam's textile and garment sectors remain on par with those of the international market. In the second scenario (S2: low green–high tech), Vietnam is assumed to achieve labor productivity growth rates two percentage points higher per year than those in the global market. Similarly, in the third (S3: high green–low tech) and fourth scenarios (S4: high green–high tech), we assume improvements in green growth indicators and technological development in Vietnam's textile and garment industries that exceed the respective growth rates in international markets. The major differences in growth rates in Vietnam compared to the rates in the international market over scenarios S1-S4 are to show clear impact differences across scenarios. Over experiments in selections of growth rates, these are the rates giving clear signals in showing the impacts of factors on the growth and competitiveness of the textile and garment industry in Vietnam.

3 https://www.iea.org/reports/energy-efficiency-the-decade-for-action/decade-for-action-highlights

In addition to the four main scenarios, we also conduct supplementary analyses to explore additional scenarios, focusing on the impact of individual indicators on the performance of Vietnam's textile and garment industry.

- S5 = S4 + maintenance of the same labor productivity growth per annum in 2038-2045 as in 2031-2037.
- S6 = S4 + maintenance of the same labor productivity growth per annum in 2031-2045 as in 2024-2030.
- S7 = S6 + capital productivity growth by 3% per annum in 2024-2045.
- S8 = S6 + capital productivity growth by 5% per annum in 2024-2045.
- S9 = S6 + capital productivity growth by 7% per annum in 2024-2045.
- S10 = S4 + total factor productivity increases by 1% per annum in 2024-2045 to substitute for increasing labor and capital productivity.
- S11 = S4 + total factor productivity increases by 2% per annum in 2037-2045 for textile industry.
- S12 = S11 + total factor productivity of all other countries increases by 0.5% per annum to substitute for labor productivity.

TABLE 3

FOUR MAIN SCENARIOS FOCUSING ON VIETNAM'S TEXTILE AND GARMENT INDUSTRIES

Target	Scenarios	S1 (Low Green – Low Tech)			S2 (Low Green - High Tech)			S3 (High Green - Low tech)			S4 (High Green - High Tech)		
	Indicators/periods	2024-30	2031-37	2037-45	2024-30	2031-37	2037-45	2024-30	2031-37	2037-45	2024-30	2031-37	2037-45
Green growth	Energy efficient growth (%/year)	1%	1%	1%	1%	1%	1%	5%	4%	3%	5%	4%	3%
	Chemical utilization efficiency growth (%/year)	1%	1%	1%	1%	1%	1%	5%	4%	3%	5%	4%	3%
	Re-use efficiency growth of water and recycling material (%/year)	1%	1%	1%	1%	1%	1%	5%	4%	3%	5%	4%	3%
	Utilization efficiency growth of vegetable oils substituted for chemicals (%/year)	nil	nil	nil	nil	nil	nil	5%	4%	3%	5%	4%	3%
Technological development	Labor productivity (textile industry)	7%	6%	5%	9%	8%	7%	7%	6%	5%	9%	8%	7%
	Labor productivity (garment industry)	6%	5%	4%	8%	7%	6%	6%	5%	4%	8%	7%	6%

We also decompose the impact of each factor/growth by developing generic scenarios as shown in Table 4. We select a growth rate of 1% as a generic unit to ease the impact assessment of each factor on the output level of the textile and garment industry. In other words, it helps answer the question, for example, if energy efficiency increases by 1% per year, how much percentage of textile and garment output levels will increase.

TABLE 4

SHOCKS PREPARED FOR SCENARIOS FOR IMPACT DECOMPOSITION ANALYSIS

Target	Indicators	Scenarios						
		A0	A1	A2	A3	A4	A5	A6
		2024-45	2024-45	2024-45	2024-45	2024-45	2024-45	2024-45
Green growth	Energy efficient growth (%/year)	0%	1%					1%
	Chemical utilization efficiency growth (%/year)	0%		1%				1%
	Re-use efficiency growth of water and recycling material (%/year)	0%			1%			1%
	Utilization efficiency growth of vegetable oils substituted for chemicals (%/year)	0%				1%		1%
Technological development	Labor productivity (textile industry) (%/year)	0%					1%	1%
	Labor productivity (garment industry) (%/year)	0%					1%	1%

4.2 Result Analysis

In general, productivity improvements in a specific factor make it more efficient and cost-effective to use, enhancing the performance of sectors that rely on that factor, as well as the broader economy. Related supply chains also benefit from cheaper inputs, further boosting sectoral performance. However, whether a sector grows or experiences a decline in output depends on its competitiveness relative to similar sectors in other markets. For instance, if textile and garment industries in markets outside Vietnam perform significantly better and offer lower product prices, Vietnam's textile and garment sector may struggle to expand production and may even need to reduce output. Nonetheless, the negative impact would be less severe than in the absence of productivity improvements. It is also noted that baseline values and changes relative to these baselines for each scenario are provided in Appendix 3.

4.2.1 Primary Scenarios

The future of Vietnam's textile and garment industry can be shaped by various approaches to green growth and technological advancement. To explore this, we have identified four key scenarios that represent different combinations of environmental sustainability and productivity improvements. These scenarios range from minimal advancements in both areas to full integration of cutting-edge technology and green practices. Each scenario presents distinct opportunities and challenges for the industry, outlining potential paths for Vietnam to remain competitive while addressing global market demands for efficiency, sustainability, and innovation.

4.2.1.1 Scenario 1 Slow and Steady (Low Green – Low Tech)

This scenario reflects a gradual, conservative approach with minimal advancements in both green growth and technology. The industry's focus remains on maintaining current practices without significant investment in sustainability or technological improvements. In terms of **green growth**, there are only slight improvements in energy efficiency, chemical usage, water consumption, and the use of recycled materials. These changes are incremental and do not involve any major overhauls in environmental practices. For **technology and productivity**, labor productivity in both the textile and garment sectors remains at baseline levels, meaning there is little to no progress in adopting new technologies or improving efficiency.

Opportunities in this scenario include the benefit of lower initial investments for adopting green technology, as businesses do not need to commit significant resources to drastic changes. Additionally, stable, incremental improvements in both efficiency and labor productivity could still provide small gains over time without the risks associated with rapid transformation.

However, the **challenges** are substantial. The industry risks falling behind international standards on sustainability and innovation, which are becoming increasingly important in global markets. Additionally, this approach limits Vietnam's ability to meet growing global demand for sustainable and efficient production processes, ultimately affecting its competitiveness on the world stage.

Conditions for the scenario to occur	Risks
• Cost-benefit focus: Government and industry prioritize cost-saving over green and technological investments. • Stable market demand: International markets continue to accept Vietnam's production at its current environmental and technological levels. • Incremental industry changes: A slow, conservative approach to improvements, focusing on maintaining current productivity and environmental impact without pushing for radical change.	• Market access: Growing global emphasis on sustainability could result in a lack of access to eco-conscious markets/buyers. • Environmental costs: Over time, the lack of green practices may lead to higher operational costs due to resource inefficiencies (e.g., water, chemicals). • Reputation damage: Limited focus on environmental impact could harm Vietnam's reputation with global brands and consumers.

4.2.1.2 Scenario 2: Tech Driven (Low Green – High Tech)

This scenario centers on leveraging technological advancements to enhance productivity while maintaining minimal improvements in environmental sustainability. The industry prioritizes efficiency and productivity through technology, often at the expense of green initiatives. Regarding **green growth**, this scenario sees minimal improvements in environmental practices and initiatives. The emphasis is primarily on technological solutions rather than adopting sustainable practices. In **terms of technology and productivity**, there are significant enhancements in labor productivity across both the textile and garment sectors. The integration of advanced technologies enables companies to optimize operations and achieve higher output levels, leading to increased competitiveness in global markets.

The **opportunities** presented by this scenario include the potential for higher labor productivity, which can significantly enhance a company's competitiveness on the international stage. Additionally, businesses can increase their production capacity and output without making substantial changes to their environmental practices, allowing for short-term gains in efficiency. However, the **challenges** are noteworthy. The focus on low green growth may lead to regulatory hurdles and reputation issues, especially in sustainability-focused markets where consumers and brands are increasingly demanding eco-friendly practices. Furthermore, the long-term environmental inefficiencies and resource usage associated with minimal green initiatives could hinder future growth and viability in a market that is progressively leaning towards sustainability.

Conditions for the scenario to occur	Risks
• Advanced automation: Strong focus on improving productivity through technology adoption, including automation, AI, and robotics. • Labor productivity initiatives: Workforce training and technology integration lead to improved labor productivity, offsetting the lack of green initiatives. • Global demand for efficiency: Continued demand for efficient, low-cost production rather than purely sustainable practices.	• Market access: Growing global emphasis on sustainability could result in a lack of access to eco-conscious markets. • Environmental costs: Over time, the lack of green practices may lead to higher operational costs due to resource inefficiencies (e.g., water, chemicals). • Reputation damage: Limited focus on environmental impact could harm Vietnam's reputation with global brands and consumers.

4.2.1.3 Scenario 3: Green Driven (High Green – Low Tech)

This scenario emphasizes a strong commitment to environmental sustainability while making only moderate advancements in labor productivity. The textile and garment industries in this context focus on improving ecological outcomes rather than technological innovation. In terms of **green growth**, this scenario showcases significant improvements in areas such as energy efficiency, chemical usage, water conservation, and the utilization of recycled materials. Companies adopt robust sustainability practices, striving to minimize their environmental impact and align with global standards for eco-friendliness. However, when it comes to **technology and productivity**, labor productivity remains at baseline levels. The industry does not prioritize technological upgrades, which may limit overall productivity gains. This reliance on established practices may hinder companies' ability to maximize efficiency fully.

The **opportunities** within this scenario are compelling. Companies that achieve strong environmental credentials can access new market segments increasingly focused on sustainability. By improving resource efficiency, businesses can also reduce long-term operational costs, further enhancing their profitability. Nonetheless, there are **challenges** that accompany this scenario. The slower growth in productivity may result in higher production costs, which can limit the competitiveness of firms in the global market. Additionally, the capacity to scale up production in response to increasing demand may be constrained, as the focus on green practices could restrict rapid expansion and adaptation to market changes.

Conditions for the scenario to occur	Risks
• Strong green-focused regulatory frameworks: Government incentives and global agreements encourage significant investment in green practices (e.g., energy efficiency, recycled materials). • Eco-conscious global demand: Increasing demand from eco-focused customers/brands pushes the industry towards greener practices. • Sustainability partnerships: Collaboration with global NGOs, institutions, and environmental organizations to build and promote greener practices.	• Productivity lag: Limited focus on improving technology and productivity may cause production costs to rise, reducing competitiveness in high-volume markets. • Technological barriers: Low adoption of new production technologies may result in operational inefficiencies. • Market fragmentation: Green growth may not be enough if other countries offer both green production and higher productivity, leading to a loss of competitive edge.

4.2.1.4 Scenario 4: Sustainable Innovation (High Green – High Tech)

This scenario represents a synergistic approach, combining high levels of green growth with cutting-edge technological advancements. The objective is to achieve global competitiveness by prioritizing both sustainability and operational efficiency. In terms of **green growth**, this scenario is characterized by significant improvements in energy efficiency, chemical usage, water conservation, and the utilization of recycled materials. Companies in this scenario are committed to meeting and exceeding environmental standards, establishing themselves as leaders in sustainable practices within the textile and garment industry. On the **technology and productivity** front, there are strong improvements in labor productivity across both textiles and garments. The integration of innovative technologies enhances production capabilities, allowing businesses to operate more efficiently and effectively while maintaining their environmental commitments.

The **opportunities** presented in this scenario are substantial. The combination of high green growth and productivity improvements positions companies for long-term sustainability and competitiveness in the global market. Furthermore, businesses can meet the increasing environmental standards demanded by consumers and brands, making them attractive partners for eco-conscious organizations. This scenario fosters innovation leadership, as companies that invest in sustainable practices can appeal to global brands focused on sustainable production. However, the scenario also poses **challenges**. The high initial and ongoing investments required for both green growth and technological upgrades can strain financial resources, particularly for smaller enterprises. Additionally, managing the transition to a sustainable and high-tech model requires careful planning and execution to keep costs under control while implementing significant changes. Balancing these investments and the management of the transition is crucial for success in this competitive landscape.

Conditions for the scenario to occur	Risks
• Strong government support: Policies that promote both green growth and technology adoption, including subsidies for R&D in eco-friendly technologies. • Private sector investment: Significant private investment in technological advancements and green innovations in production processes and workforce capacity training. • Global market shifts: Growing consumer and brand demand for products that are both sustainably produced and cost-efficient, creating a competitive advantage for Vietnam. • Partnerships and innovation: Collaborations with international firms, NGOs, and institutions focused on developing sustainable and high-tech solutions.	• High capital costs: The significant investment required in both green technology and productivity improvements could strain resources, especially for smaller companies. • Implementation challenges: Difficulty in coordinating and implementing both green and technological upgrades simultaneously and over time, leading to potential delays or inefficiencies. • Labor skill gaps: The adoption of advanced green technologies and high-tech processes may require specialized skills and training. A lack of skilled labor retention or difficulties in upskilling the existing workforce could hinder effective implementation and maintenance of new technologies.

4.2.2. Decomposition of Impacts (Scenarios A0-A6)

This section breaks down the individual impact of various factors affecting Vietnam's textile and garment industries, comparing deviations from the baseline across Scenarios A0-A6.

Table 5 highlights the effects on Vietnam's real GDP in each scenario. In Scenario A0, Vietnam benefits from increased global productivity—excluding Vietnam—within the textile and garment industries, driven by green growth and technological advancements. As a result, Vietnam's real GDP steadily rises from 2025 to 2045, reaching a 7.21% increase in 2045 relative to the baseline. This is primarily due to the improved efficiency and reduced costs in global textile and garment production, which positively impact Vietnam's supply chains. Although Vietnam's textile and garment industries do not experience direct productivity growth, the country still benefits from more cost-effective global supply chains.

In Scenarios A1-A5, where individual indicators improve by 1% annually (see Table 4.4), the impacts on Vietnam's real GDP vary. In Scenario A3, the impact on real GDP mirrors that of A0, suggesting that efficiency gains from reusing water and recycling materials in Vietnam's textile and garment industries are not significant drivers of economic growth. Similarly, Scenario A4 shows that substituting vegetable oil for chemicals in these industries does not notably boost Vietnam's economy.

In Scenario A2, improvements in chemical usage lead to modest gains in economic performance, with real GDP increasing by 0.07 percentage points in 2030 and 0.12 percentage points in 2045 compared to A0. However, the largest GDP growth is observed in Scenarios A1 and A5, where improvements in energy efficiency and labor productivity within Vietnam's textile and garment industries drive the most substantial gains. For instance, by 2045, real GDP is 0.25 percentage points higher compared to A0.

Scenario A6 combines the effects of all improvements from A1-A5, demonstrating that these combined advancements would boost Vietnam's real GDP by 0.61 percentage points in 2045 compared to A0. This highlights that energy efficiency and labor productivity improvements are the most critical factors in driving Vietnam's economic growth in this sector.

TABLE 5

IMPACT ON VIETNAM'S REAL GDP ACROSS SCENARIOS (% DEVIATIONS FROM THE BASELINE)

Scenario	2025	2030	2035	2040	2045
A0	0.33	2.09	4.16	5.89	7.21
A1	0.36	2.19	4.32	6.1	7.46
A2	0.36	2.16	4.26	6.01	7.33
A3	0.33	2.09	4.16	5.89	7.21
A4	0.34	2.1	4.16	5.9	7.22
A5	0.39	2.25	4.38	6.13	7.45
A6	0.44	2.41	4.64	6.46	7.82

Table 6 illustrates that the impact on the performance of Vietnam's textile and garment industries, measured by output levels, follows a different trajectory compared to the effect on Vietnam's real GDP. In Scenario A0, where productivity improvements occur in the textile and garment industries of other countries but not in Vietnam, Vietnam's industries experience a significant loss of competitiveness, leading to substantial output reductions. Specifically, Vietnam's textile output declines by 6% in 2025, worsening to a 57% reduction by 2045 compared to the baseline. Similarly, the output level of Vietnam's garment industry decreases by 5% in 2025, reaching a 52% decline by 2045.

These declines are driven by productivity improvements in textile and garment industries in other markets (see Table 4.2), making their production more efficient and cost-effective. As a result, their products become cheaper, enhancing their competitiveness relative to Vietnam's textile and garment sectors.

TABLE 6

IMPACTS ON VIETNAM'S TEXTILE AND GARMENT OUTPUT LEVELS ACROSS SCENARIOS (% DEVIATIONS FROM THE BASELINE)

Industry	Scenario	2025	2030	2035	2040	2045
Textile	A0	-6.1	-19.2	-31.7	-47.6	-57.2
	A1	-6.1	-19.3	-31.7	-47.7	-57.3
	A2	-5.8	-18.3	-30.3	-46.2	-56.0
	A3	-6.1	-19.2	-31.7	-47.6	-57.2
	A4	-6.1	-19.2	-31.6	-47.6	-57.2
	A5	-5.2	-16.5	-27.7	-43.5	-54.0
	A6	-4.8	-15.5	-26.3	-41.9	-52.6
Wearing	A0	-4.7	-15.4	-23.7	-35.9	-51.7
	A1	-4.7	-15.4	-23.7	-35.9	-51.7
	A2	-4.4	-14.4	-22.2	-34.0	-49.8
	A3	-4.7	-15.4	-23.7	-35.9	-51.7
	A4	-4.7	-15.3	-23.7	-35.8	-51.7
	A5	-3.8	-12.6	-19.4	-30.8	-46.9
	A6	-3.5	-11.6	-17.9	-28.8	-44.8

Table 6 reveals that, unlike the impact on Vietnam's real GDP, energy efficiency improvements in Vietnam's textile and garment industries have minimal effects on their output levels, as shown by the small differences between Scenario A1 and A0. This is because energy efficiency improvements primarily benefit the supply chains linked to these industries rather than directly enhancing the industries themselves. Consequently, while the output levels of these sectors see little change, the positive impacts on Vietnam's overall GDP are more pronounced.

Among all scenarios, improving labor productivity in these industries (Scenario A5) has the most favorable impact on their output levels. As labor-intensive sectors, enhancements in labor productivity lead to better performance, reflected in smaller declines in output levels. For instance, the textile sector shows a reduced negative impact of -54%, while the garment sector experiences a -47% decrease, making this the most effective intervention for boosting sector performance.

4.2.3 Result Analysis of Vietnam's Textile and Garment Industries in Green Growth and Technological Development Scenarios (Scenarios S1-S12)

Figure 27 illustrates the impacts on the output levels of Vietnam's textile and garment industries across Scenarios S1-S12. In Scenario S1 (low green–low tech), where Vietnam's labor productivity grows at the same rate as other countries, but green growth indicators remain significantly below global levels, the output of Vietnam's textile industry sees only modest growth for a few years, peaking by 2028. Afterward, the output begins to decline, reaching a 34% reduction by 2045 compared to the baseline. The garment industry follows a similar trend, with output growth peaking in 2035 at a 3.6% increase relative to the baseline, but gradually falling to a 22% reduction by 2045.

In Scenario S2 (low green – high tech), when labor productivity in Vietnam's textile and garment industries improves at a higher rate than in international markets, the performance of these sectors, as measured by output levels, also improves significantly. Specifically, the output level of Vietnam's textile industry gradually increases, reaching 4.8% above the baseline by 2030, while the garment industry sees a more substantial improvement of 13.2% by 2036. However, these years mark the peak growth rates for both industries. Following this peak, they begin to lose competitiveness and cannot sustain their growth, resulting in output declines of 26% for textiles and 10% for garments by 2045 compared to the baseline.

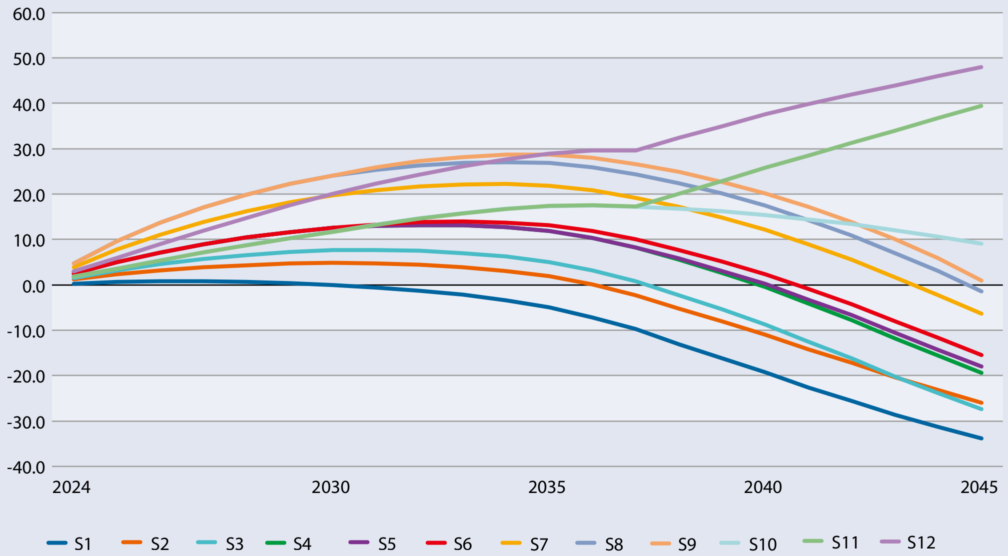
In Scenario S3 (high green – low tech), while green growth indicators in Vietnam surpass international levels, labor productivity remains aligned with global standards. This leads to similar impact patterns on output levels as observed in S2. When both green growth indicators and labor productivity improve at higher rates relative to international levels in Scenario S4 (high green – high tech), the textile and garment industries can only sustain output growth for a limited time—2032 for textiles, reaching a 13.2% increase, and 2037 for garments, approaching a 26.9% increase—before experiencing declines and diminished competitiveness. The results from Scenarios S1-S4 suggest that even when productivity and efficiency in Vietnam's textile and garment industries exceed those in other markets (as in S4), these sectors cannot maintain competitiveness beyond a decade due to the more efficient production and lower costs in other countries.

In Scenarios S5 and S6, although labor productivity in Vietnam's textile and garment industries improves at higher rates, it results in only slight performance enhancements, yielding peak growth rates in the mid-2030s and reduced negative impacts in 2045 compared to the baseline. Notably, while the garment industry still shows positive growth in 2045, the textile industry faces a significant output reduction of 16-18% in S5 and S6 compared to the baseline.

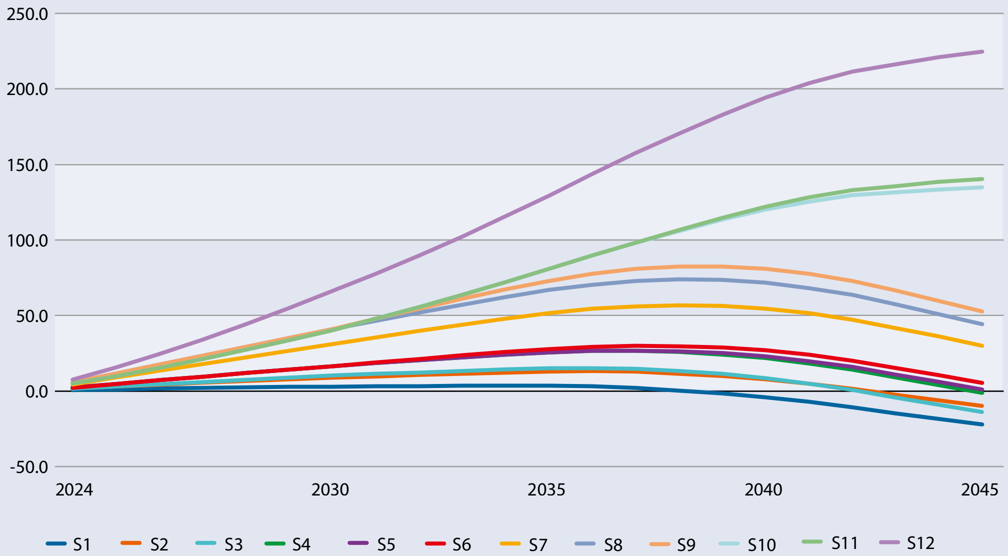
FIGURE 27

IMPACTS ON VIETNAM'S TEXTILE AND GARMENT OUTPUT LEVELS ACROSS SCENARIOS (% DEVIATIONS FROM THE BASELINE)

a) Textile



b) Garment



When capital productivity growth is introduced in Scenarios S7-S9, both industries experience improved performance. For example, the output level of Vietnam's textile industry increases gradually to a peak of 22-29% above the baseline by 2035, declining by only 6.4-1.5% in 2045 compared to the baseline. With a 7% annual increase in capital productivity, the textile industry still manages a positive output growth of 0.9% in 2045 relative to the baseline. However, the results from Scenarios S7-S9 indicate that even significant improvements in capital productivity cannot sustain growth in these industries beyond 2035, resulting in continued long-term competitiveness losses.

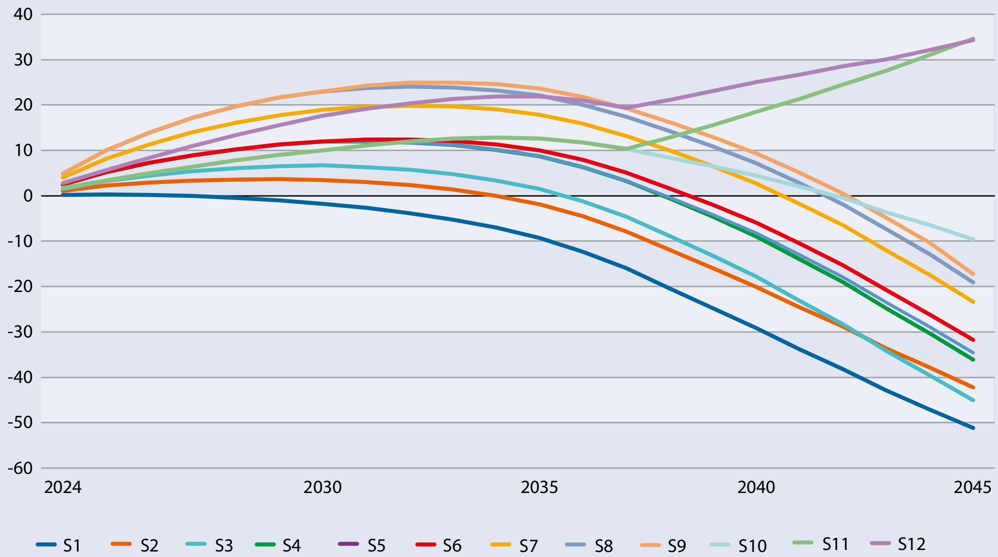
In Scenario S10, where total factor productivity grows at 1% per annum to substitute for labor and capital productivity growth, the performance of Vietnam's textile and garment industries improves significantly. For instance, the output level of the textile industry increases by 17.6% in 2036 and 9.1% in 2045 compared to the baseline, while the garment industry sees gradual output growth from 2024-2045, reaching a remarkable 135% increase by 2045. However, even with a 1% annual increase in total factor productivity, the textile industry still experiences declining output growth trends from 2037-2045.

In Scenario S11, with an increase in total factor productivity to 2% from 2037-2045 instead of 1%, the textile industry no longer shows declining trends, with output levels growing steadily from 2024-2045 and reaching 39.4% above the baseline by 2045. In Scenario S12, when all other markets also experience total factor productivity improvements of 0.5% per annum, Vietnam's textile and garment industries continue to experience gradual output growth from 2024-2045. In fact, these sectors exhibit higher growth rates compared to Scenario S11, with the textile industry increasing its output by 20% in 2030, 29% in 2035, and 48% in 2045 compared to the baseline. The garment industry shows even greater growth rates of 66% in 2030, 130% in 2035, and 225% in 2045. This indicates that a 0.5% improvement in total factor productivity in international markets does not equate to the improvements of other factors shown in Table 2, which ultimately diminishes the competitiveness of international textile and garment industries compared to their Vietnamese counterparts. Figure 28 illustrates the impacts on the export levels of Vietnam's textile and garment industries across Scenarios S1-S12.

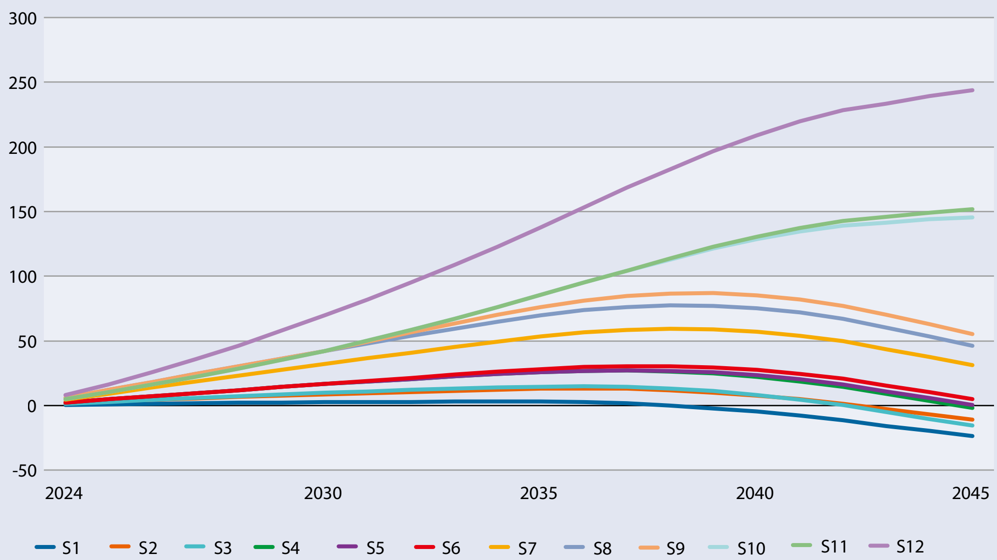
FIGURE 28

IMPACTS ON VIETNAM'S TEXTILE AND WEARING EXPORT LEVELS ACROSS SCENARIOS (% DEVIATIONS FROM THE BASELINE)

a) Textile



b) Wearing



4.2.4 Result Analysis of Vietnam's Textile and Garment Industries' Key Supply Chains in Green Growth and Technological Development Scenarios

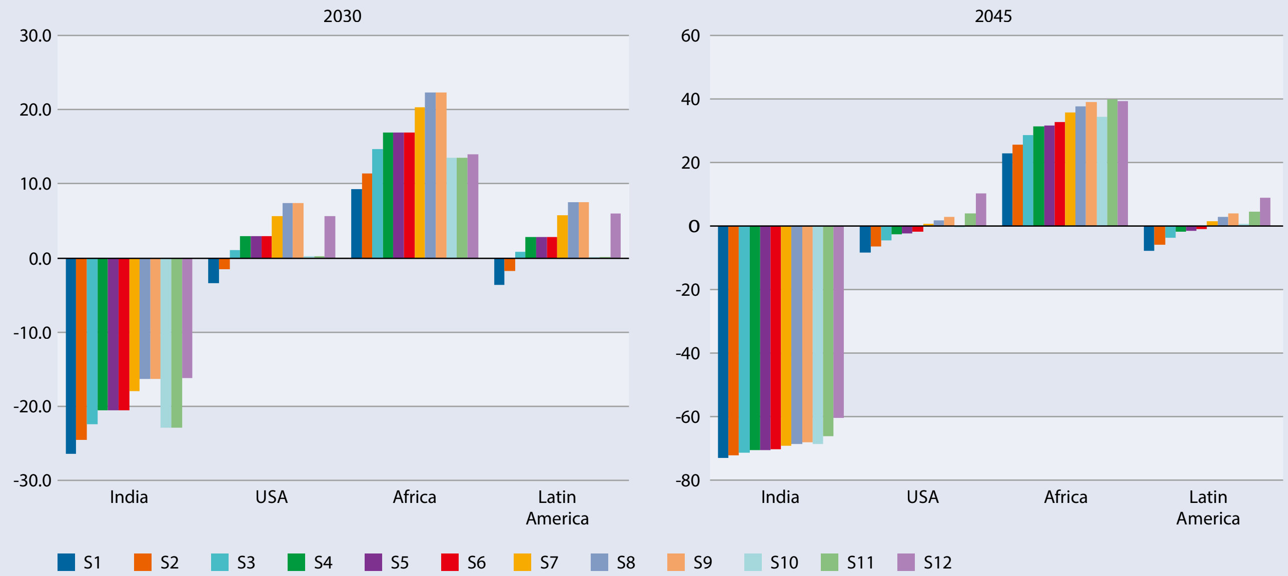
Figure 29 illustrates the impact of fiber imports by Vietnam from its primary trading partners. In the baseline scenario, fiber from Africa, the USA, and Latin America become relatively inexpensive compared to those from other markets, leading most countries, including Vietnam, to significantly increase their import demands for fiber from these regions. Specifically, in the baseline, Vietnam's imports of fibers from Africa, the USA, and Latin America rise from USD1,432 million, USD1,810 million, and USD757 million in 2030 to USD3,436 million, USD3,584 million, and USD1,558 million in 2045 (see Table 3.5 in Appendix 3). In contrast, imports of fiber from India see only a modest increase, rising from USD634 million in 2030 to USD651 million in 2045.

Consequently, in the green growth and technological development scenarios, the relatively cheaper fibers from Africa, the USA, and Latin America continue to dominate exports to Vietnam, effectively substituting for the more expensive fibers from India. This results in substantial increases in imports of fibers from Africa, the USA, and Latin America, while imports from India decrease. Notably, the imports of fibers from Africa to Vietnam experience the highest growth rates across scenarios, driven by strong growth in the textile and garment industries in the USA and Latin America, which create high domestic demand for fibers, with most of Africa's fibers production directed toward exports.

In particular, Vietnam reduces its imports of fibers from India by 16-26% in 2030 and by 60-73% in 2045 across various scenarios compared to the baseline. In contrast, the demand for fibers from Africa increases significantly, with growth rates of 12-22% in 2030 and 26-39% in 2045 across scenarios.

FIGURE 29

IMPACT ON IMPORT OF FIBERS BY VIETNAM FROM MAJOR TRADING PARTNERS IN SELECTED YEARS ACROSS SCENARIOS (% DEVIATIONS FROM THE BASELINE)



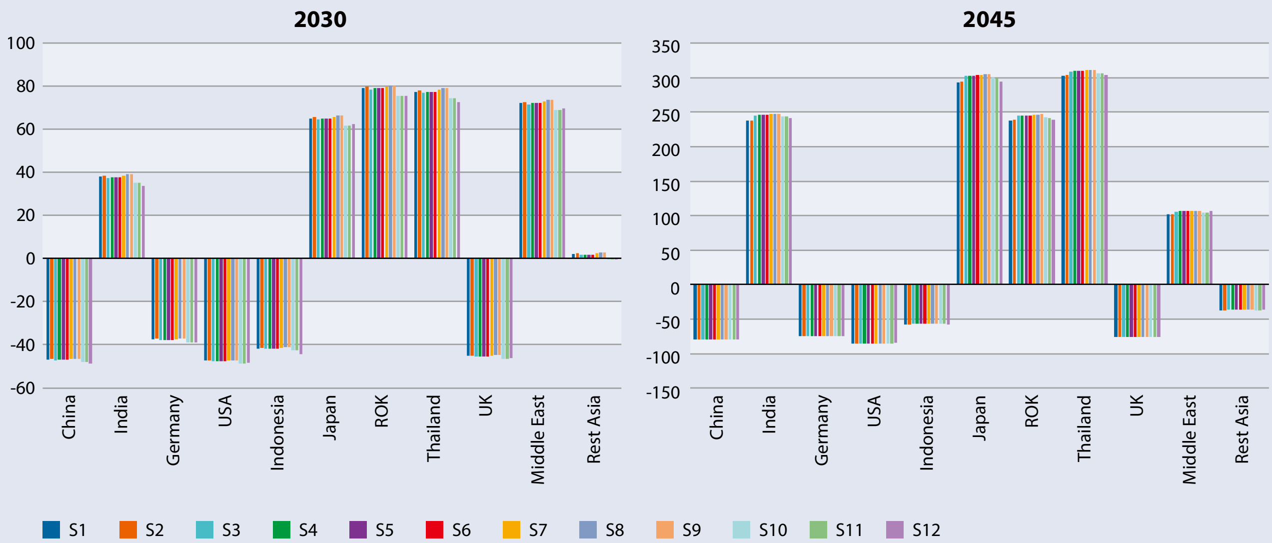
Note: The bars from left to right indicate alternately scenarios S1-S12 in each country/region.

The demand for chemicals is influenced by generic productivity improvements in chemical utilization, resulting in an overall decline in the demand for chemicals per output unit in the textile and garment industries. However, this decline also depends on the relative price changes between trading partners. Specifically, the results indicate that chemical outputs from countries such as China, Germany, the USA, Indonesia, and the UK decrease across scenarios due to their higher prices compared to other markets. This reduction in chemical output shifts the supply curve backward, leading to increased chemical prices in these regions relative to others.

As a consequence, Vietnam's demand for importing chemicals from China, Germany, the USA, Indonesia, and the UK declines significantly, with a reduction of 50% expected in 2030 and 75% in 2045 across scenarios. This decline is partially offset by increased imports of chemicals from other markets, such as India (approximately 40% in 2030 and 250% in 2045), Japan (65% in 2030 and 300% in 2045), the ROK (80% in 2030 and 245% in 2045), Thailand (80% in 2030 and 300% in 2045), and the Middle East (70% in 2030 and 100% in 2045) (see Figure 30).

FIGURE 30

IMPACT ON IMPORT OF CHEMICALS BY VIETNAM FROM MAJOR TRADING PARTNERS IN SELECTED YEARS ACROSS SCENARIOS (% DEVIATIONS FROM THE BASELINE)



Note: The bars from left to right indicate alternately scenarios S1-S12 in each country/region.

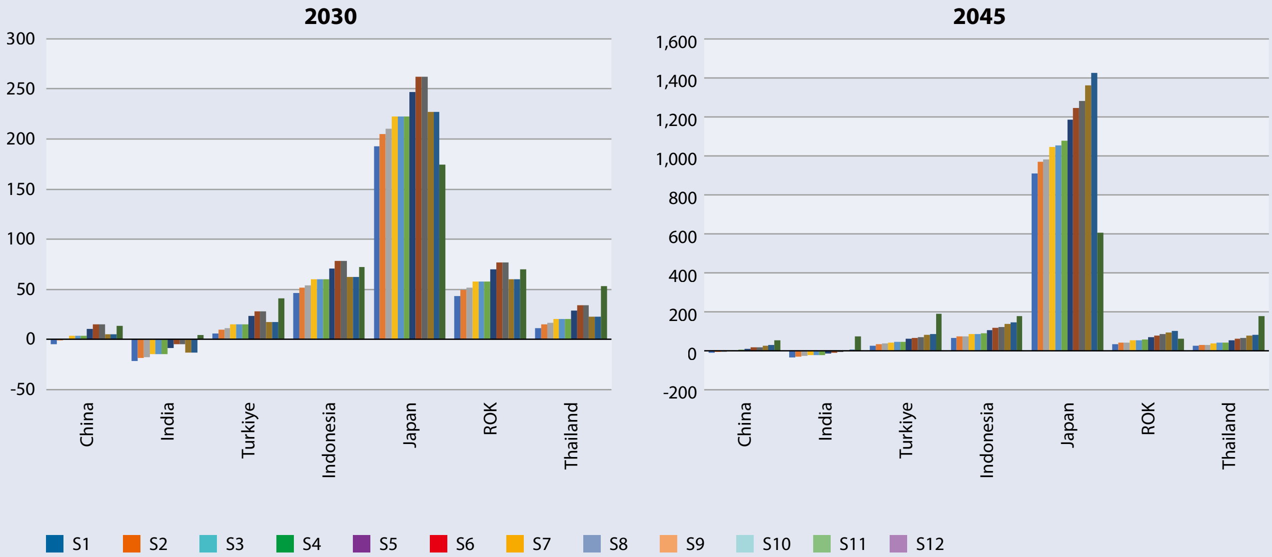
The previous results indicate that textile output levels in Vietnam increase at relatively low rates compared to other countries, with declining trends in output levels after several years and/or a decade across most scenarios. Consequently, textile prices in Vietnam tend to be higher than those in other nations. However, the overall economy of Vietnam benefits from improved productivity, which enhances household well-being. As a result, Vietnam's demand for textiles from foreign markets rises to meet domestic needs.

Figure 31 illustrates that demand for Japanese textiles in Vietnam experiences the highest growth rates compared to textiles from other markets such as China, Turkiye, Indonesia, the ROK, and Thailand. This surge is attributed to significant productivity improvements in Japan's textile industry, which are projected to boost the sector to grow by approximately 70% in 2030 and over 300% by 2045. This boost in productivity reduces the supply price of textiles in Japan, thereby attracting demand from other countries, including Vietnam. For instance, Vietnam's demand for textiles from Japan is expected to increase by 75-260% in 2030 and by six to 14 times in 2045 relative to the baseline.

Imports of textiles from other countries also rise at relatively high rates, although not as dramatically as the demand for Japanese textiles, primarily due to changes in relative prices. Additionally, demand for textiles from India is projected to decline by 14% in 2030 and by 22% in 2045 compared to the baseline, largely due to the lower prices of textiles from other markets, which supply as substitutions for Indian textile.

FIGURE 31

IMPACT ON IMPORT OF TEXTILE BY VIETNAM FROM MAJOR TRADING PARTNERS IN SELECTED YEARS ACROSS SCENARIOS (% DEVIATIONS FROM THE BASELINE)



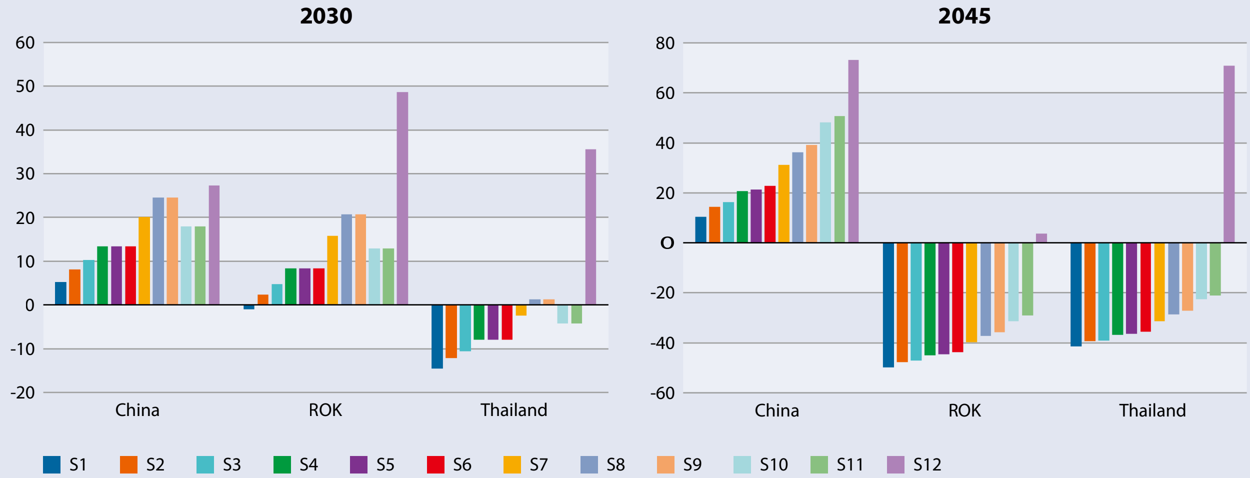
Note: The bars from left to right indicate alternately scenarios S1-S12 in each country/region.

Vietnam's demand for imported apparel also undergoes changes, though it experiences lower growth rates compared to the demand for imported textiles. This is primarily because the apparel sector in Vietnam develops relatively well across various scenarios, as previously indicated. Consequently, the expansion of the apparel sector partially satisfies domestic demand, which is driven by a wealthier economy characterized by increased GDP and income. As a result, the increase in demand from international markets is less pronounced.

Figure 32 illustrates that Vietnam boosts its demand for apparel from China (by 5-27% in 2030) and the ROK (by 2-49% in 2030) to compensate for the relatively high prices of textiles from Thailand. By 2045, Vietnam significantly increases its apparel imports from China (by 10-73%), while substantially reducing demand for apparel from the ROK (by 29-50%) and Thailand (by 21-41%) due to relative price changes.

FIGURE 32

IMPACT ON IMPORT OF APPAREL BY VIETNAM FROM MAJOR TRADING PARTNERS IN SELECTED YEARS ACROSS SCENARIOS (% DEVIATIONS FROM THE BASELINE)



Note: The bars from left to right indicate alternately scenarios S1-S12 in each country/region.

4.2.5 Analysis of Macro Impacts on the Economy of Vietnam

Vietnam is poised for higher economic growth due to more efficient and cost-effective production resulting from productivity improvements. These enhancements benefit the entire supply chain of the textile and apparel industries by reducing input costs, which in turn fosters growth in related sectors, propelling the Vietnamese economy to develop at an accelerated pace.

Table 7 illustrates that Vietnam could achieve a real GDP growth of USD24-65 billion by 2030 and USD113-277 billion by 2045 compared to the baseline. These figures represent significant gains contributing to the overall development of the Vietnamese economy. Scenario S12 indicates the highest increases in real GDP, driven by substantial productivity improvements, while Scenario S1 shows the lowest growth increases due to relatively minimal advancements in green growth and technological development indicators. The results in other scenarios also align with this trend, where real GDP increases correspond with the magnitude of productivity improvements in each scenario.

TABLE 7

BASELINE VALUES OF VIETNAM'S GDP AND CHANGES IN EACH SCENARIO RELATIVE TO THE BASELINE VALUES (USD MILLION)

		2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Value (USD billion)	Base	510	569	597	625	656	687	721	750	781	814	847
Changes (USD billion)	S1	1.73	4.10	7.10	10.50	14.37	18.69	23.50	28.35	33.50	39.07	44.81
Changes (USD billion)	S2	1.99	4.67	7.94	11.63	15.81	20.47	25.60	30.68	36.16	42.00	48.02
Changes (USD billion)	S3	5.10	11.44	18.69	26.69	35.56	45.14	55.59	65.33	75.52	86.37	97.49
Changes (USD billion)	S4	5.36	12.01	19.58	27.94	37.13	47.06	57.82	67.88	78.49	89.62	101.05
Changes (USD billion)	S5	5.36	12.01	19.58	27.94	37.13	47.06	57.82	67.88	78.49	89.62	101.05
Changes (USD billion)	S6	5.36	12.01	19.58	27.94	37.13	47.06	57.82	68.03	78.72	90.03	101.64
Changes (USD billion)	S7	5.81	13.09	21.25	30.25	40.08	50.70	62.15	73.05	84.35	96.30	108.42
Changes (USD billion)	S8	6.12	13.77	22.33	31.75	42.05	53.04	64.96	76.20	87.94	100.20	112.65
Changes (USD billion)	S9	6.12	13.77	22.33	31.75	42.05	53.04	64.96	76.50	88.57	101.10	113.84
Changes (USD billion)	S10	5.61	12.52	20.60	29.63	39.75	50.70	62.73	74.40	86.77	99.96	113.58
Changes (USD billion)	S11	5.61	12.52	20.60	29.63	39.75	50.70	62.73	74.40	86.77	99.96	113.58
Changes (USD billion)	S12	5.71	12.80	21.19	30.56	41.07	52.49	65.11	77.40	90.44	104.35	118.75

		2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Value (USD billion)	Base	882	916	951	987	1,025	1,064	1,101	1,139	1,178	1219.000	1262.000
Changes (USD billion)	S1	50.89	56.88	63.15	69.09	75.34	81.50	87.75	93.85	100.01	106.42	112.95
Changes (USD billion)	S2	54.42	60.73	67.14	73.43	79.75	86.18	92.59	98.75	105.08	111.54	118.25
Changes (USD billion)	S3	109.10	120.64	132.28	142.92	153.75	164.49	174.84	184.86	194.72	204.79	214.79
Changes (USD billion)	S4	112.98	124.76	136.56	147.46	158.47	169.28	179.68	189.76	199.67	209.67	219.59
Changes (USD billion)	S5	112.98	124.76	136.56	147.56	158.57	169.50	180.01	190.10	200.02	210.03	220.09
Changes (USD billion)	S6	113.60	125.49	137.42	148.54	159.59	170.67	181.11	191.24	201.08	211.13	221.10
Changes (USD billion)	S7	120.92	133.28	145.60	156.93	168.31	179.39	189.92	200.01	209.80	219.79	229.68
Changes (USD billion)	S8	125.42	138.04	150.54	161.97	173.33	184.50	194.99	205.02	214.75	224.66	234.48
Changes (USD billion)	S9	126.92	139.69	152.35	163.94	175.38	186.52	196.97	206.96	216.75	226.49	236.25
Changes (USD billion)	S10	127.80	142.16	156.63	170.36	184.09	197.69	210.62	223.02	235.01	246.85	258.46
Changes (USD billion)	S11	127.80	142.16	156.63	171.15	185.73	200.14	213.81	226.89	239.61	252.09	264.14
Changes (USD billion)	S12	133.89	149.03	164.52	180.03	195.47	210.78	225.04	238.73	251.86	264.52	276.76

4.3 Discussions and Summary

The global economy, including Vietnam, is expected to benefit from strong real GDP growth due to productivity improvements in the textile and garment industries. These sectors not only become more cost-effective and efficient but also help reduce production costs across their entire supply chains, enhancing the productivity of other industries. This leads to substantial economic growth, especially in countries like Vietnam, where the textile and garment industries significantly contribute to the GDP and employ a large portion of the workforce.

This report analyzes the impact of various green growth and technological development scenarios on Vietnam's economy, with a focus on the textile and garment industries. We utilize a recursive dynamic computable general equilibrium model (GTEM), widely used for policy and technological development analysis, including in studies like the Australian National Outlook and Global Resources Outlook, which assess the effects of sustainability pathways on global and national economies as well as major manufacturing and service sectors (Hatfield-Dodds et al., 2017; Lu et al., 2024; Nong et al., 2023).

The scenarios are designed to identify key factors influencing Vietnam's textile and garment industries and explore strategies to maintain their global competitiveness. Analysis of scenarios (A0-A6) reveals that while some factors, such as improving chemical utilization efficiency, water recycling, and substituting chemicals with vegetable oils, yield relatively small economic gains, they offer significant environmental benefits. These inputs make up a smaller portion of the textile and garment production process, leading to positive environmental impacts rather than strong economic ones. Energy efficiency improvements also benefit Vietnam's broader economy but have a limited direct impact on textile and garment production unless energy efficiency improvements are substantial, as these industries are not energy-intensive.

Labor productivity improvements, however, are key to boosting the performance of Vietnam's textile and garment sectors, which are labor-intensive and currently have low productivity. Enhancing labor productivity would significantly benefit these sectors in Vietnam. However, this growth can only be sustained for up to a decade, after which the industries face declining competitiveness. Even though productivity in Vietnam's textile and garment industries may grow faster than in other countries, they struggle to compete globally after the mid-2030s. Similarly, improvements in capital efficiency do not significantly alter the trend, as output levels begin to decline after a decade.

The only factor that sustains growth in Vietnam's textile and garment industries through 2045 is an increase in TFP. However, to maintain output growth, particularly in the textile industry, TFP growth must accelerate after a decade. Without at least a 1% annual increase in TFP, the textile industry's output will decline, whereas the garment industry can remain competitive and achieve strong growth with just a 1% improvement per annum.

Overall, the findings indicate that Vietnam's textile industry, in general, shows lower competitiveness compared to its garment industry, which demonstrates greater resilience and faster output growth. The garment industry experiences less severe declines and higher output increases, even under the same productivity improvement rates. Furthermore, labor productivity is a crucial factor for the short- and medium-term development of these sectors, but improvements alone are insufficient to ensure global competitiveness, particularly after the mid-2030s. Similarly, capital productivity does not provide long-term competitiveness. TFP, however, proves to be a more effective driver of growth for Vietnam's textile and garment industries. TFP will need to accelerate in the long term, especially for the textile sector, to maintain global competitiveness. Finally, while green growth indicators primarily benefit the environment, they also help these sectors meet the increasing demand for environmentally friendly products in Western markets, but they offer low cost-effectiveness in production processes.

5. RECOMMENDATIONS

The Vietnamese textile and garment industry stands at a critical juncture, shaped by an array of megatrends that are redefining its landscape. Sustainability and circular fashion, geopolitical trade shifts, digitalization and Industry 4.0, textile innovation, and the evolving dynamics of skilled labor are significant forces driving change. As businesses and policymakers respond to these megatrends, they must embrace innovative strategies to ensure long-term success and resilience. Within this dynamic landscape, **Sustainable Innovation (High Green – High Tech) emerges as a critical pathway for businesses and policymakers**. This scenario envisions a future marked by substantial green growth and technological advancements, aimed at enhancing global competitiveness through sustainability and efficiency. By leveraging these megatrends and aligning with this direction, stakeholders can navigate the complexities of the industry while capitalizing on emerging opportunities.

We propose specific recommendations tailored to address the challenges and opportunities within the industry, focusing on actionable steps for both businesses and policymakers in each scenario.

5.1 Scenario 1: Slow and Steady (Low Green – Low Tech)

Under this scenario, the Vietnamese textile and garment industry focuses on incremental changes with minimal advancements in sustainability and technology. Recommendations focus on supporting the Vietnamese textile and garment industry in making incremental, low-risk improvements in sustainability and operational efficiency, with minimal technological advancement. By providing accessible **financial incentives**, targeted **training and workforce development**, and foundational **sustainability practices**, these recommendations enable gradual adoption of eco-friendly and productivity-enhancing measures. This approach helps policymakers, industry associations, and firms build a foundation for future growth without imposing significant financial burdens, thereby fostering a resilient, cohesive industry prepared for eventual shifts toward greener and more efficient practices.

Financial incentives

- Policymakers:
  - Develop low-interest loans and small grants aimed at incremental improvements in energy efficiency, such as LED lighting and basic HVAC upgrades. These financial supports ensure that SMEs, which may lack substantial capital, can make small-scale improvements without significant financial strain. This approach allows for gradual adaptation to eco-friendly practices without the financial risks associated with larger overhauls.
  - Metrics: Number of SMEs adopting energy-efficient upgrades, initial energy savings, and reported reductions in utility costs.
- Industry associations:
  - Advocate for pooled funding and micro-grants that encourage small firms to share resources for minor technological enhancements and green practices. Collective funding initiatives can help SMEs lower individual costs and share access to basic sustainable infrastructure. This will build industry-wide cohesion and allow for shared learning and gradual scaling.

  - Metrics: Participation in pooled funding programs, the number of joint projects funded, and improved efficiency metrics.

Training and workforce development

- Policymakers:
  - Partner with local vocational schools and training centers to create courses focused on energy management and basic operational efficiency. Basic training programs provide workers with foundational skills that yield immediate operational improvements without heavy investments. This establishes a baseline for workforce readiness that can support future transitions to more advanced practices.
  - Metrics: Enrollment rates, course completion rates, and productivity improvements post-training.
- Industry associations:
  - Conduct workshops on 5S and Lean basics to help firms streamline operations and reduce waste. Introducing simple productivity-enhancing practices ensures that member firms can make meaningful changes without major technological investments. This helps standardize practices across the industry, improving overall efficiency.
  - Metrics: Workshop attendance and participant feedback, measured adoption of Lean practices.
- Firms:
  - Implement basic Lean training programs for workers to increase process efficiency and reduce waste. Lean practices offer quick wins in productivity with minimal initial investment, allowing firms to see cost reductions. This will build operational discipline that prepares firms for more significant future changes.
  - Metrics: Reduction in waste and energy use, improvements in throughput.

Sustainability and green transition

- Policymakers:
  - Introduce and enforce minimal regulations focusing on energy management and basic waste reduction. These regulations encourage adherence to simple sustainability practices without burdening firms financially and lay the groundwork for future environmental policy advancements.
  - Metrics: Compliance rates, environmental impact assessments.
- Industry associations:
  - Focus on promoting basic awareness and sharing best practices for low-cost, incremental sustainability efforts. This could involve organizing educational campaigns, disseminating simple eco-friendly practices, and advocating for minimal compliance with environmental regulations that do not overwhelm smaller firms. By promoting easy-to-implement practices such as energy-saving tips and basic waste management, they can help firms adopt gradual improvements without significant financial strain. This approach ensures that firms are prepared for eventual regulatory shifts and market demands for greener practices.
  - Metrics: Participation rates in educational initiatives, the number of firms adopting basic green practices, and energy and resource use across the industry.
- Firms:
  - Start with simple, low-cost sustainability measures, such as waste segregation, water-saving initiatives, and efficient chemical management. These practices are low-cost yet impactful, aligning with the minimal risk, incremental approach. This approach reduces resource usage gradually and improves overall environmental stewardship.
  - Metrics: Decrease in resource use and waste production.

	SMEs	Large manufacturers
Green technologies	Implement low-cost, high-impact technologies such as LED lighting and energy-efficient HVAC systems.	Integrate energy management systems to track and optimize resource use at a basic level.
Productivity frameworks	With limited resources and a low-tech focus, foundational Lean and 5S offer SMEs straightforward, low-cost methods to improve workspace organization and reduce waste without requiring significant capital or tech upgrades.	Large manufacturers in the textile industry have complex operations, with multiple stages from raw material handling to finished product inspection. Large manufacturers can leverage Lean principles for waste reduction and TQM for consistent quality control. These frameworks are manageable within a low-tech environment but support the higher complexity and scale of large operations.
Short-term strategy	Focus on incremental operational changes that enhance energy efficiency and productivity without significant investments. This could include basic energy audits and small-scale waste reduction efforts.	Optimize existing production processes through energy-saving measures and Lean principles, focusing on minimizing waste and improving workflow efficiency.
Long-term strategy	Gradually build capacity for more comprehensive Lean practices and set aside resources for future green technology upgrades as market conditions evolve.	Plan for future investments in automation and data analytics tools that can be phased in as resources allow, preparing for a shift towards a more high-tech production model.

5.2 Scenario 2: Tech Driven (Low Green – High Tech)

The Tech Driven scenario prioritizes technological advancement with limited progress in green initiatives. The recommendations focus on advancing the industry's technological capabilities to boost productivity while introducing basic eco-friendly practices. Financial incentives, training initiatives, and basic green practices encourage firms to adopt high-tech solutions, such as automation and AI, while integrating manageable sustainability practices to prepare for future green growth. This approach helps Vietnam's textile industry strengthen its competitive position in technology-driven production.

Financial incentives

- Policymakers:
  - Provide tax incentives and low-interest loans specifically targeting the adoption of high-tech solutions such as automation, AI-driven production tools, and robotics. These financial incentives promote the rapid integration of productivity-enhancing technologies, supporting global competitiveness, strengthening Vietnam's positioning in technology-driven production markets, and enhancing output and cost-efficiency.
  - Metrics: Uptake of technology-focused financial incentives, productivity improvement data, and operational cost savings.
- Industry associations:
  - Facilitate partnerships with tech providers to co-finance the integration of advanced technologies. Collaborative financing lowers barriers to tech adoption, particularly for SMEs. This will enhance industry-wide technological capabilities, fostering a competitive edge.
  - Metrics: Participation in co-financing programs, the number of firms adopting new technologies.

Training and workforce development

- Policymakers:
  - Fund training initiatives (such as those organized by industry associations) that prepare the workforce for the use of advanced technologies such as AI and digital manufacturing tools. Advanced training ensures that workers are ready to operate new tech, minimizing the learning curve and optimizing productivity gains. This will help align the workforce's capabilities with the demands of a tech-focused industry.
  - Metrics: Number of trained workers, improvements in productivity after training.
- Industry associations:
  - Offer capability building workshops and training programs that integrate best practices in technology use and introduce firms to cost-effective tech solutions. Workshops bridge the gap between available technology and its practical application and facilitate smoother transitions for firms integrating new tech.
  - Metrics: Number of workshops and training programs, workshop engagement rates.
- Firms:
  - Large manufacturers can implement their own employee training on the use of AI tools, automation, and digital monitoring systems whereas SMEs can leverage training programs and workshops organized by industry associations. Comprehensive training ensures effective use of high-tech solutions, reducing errors, optimizing efficiency and positioning firms as leaders in technological expertise.
  - Metrics: Number of trained employees, increase in production efficiency, reductions in downtime.

Sustainability and green transition

- Policymakers:
  - Introduce supplementary eco-friendly incentives that can be integrated with technology adoption, such as energy-monitoring tools. This encourages firms to incorporate basic green practices without shifting the primary focus from technological development, thereby laying a foundation for future sustainability efforts while prioritizing tech-driven productivity.
  - Metrics: Adoption rates of supplemental eco-friendly tools, reported energy use data.
- Industry associations:
  - Advocate for the integration of basic green practices alongside technological advancements. This includes facilitating partnerships between technology providers and firms to incorporate energy-efficient solutions and promoting optional eco-friendly add-ons like smart energy monitoring tools. Highlighting the synergy between tech and basic eco-friendly measures can help firms gradually integrate sustainability into their operations without disrupting their main focus on productivity. It positions firms to make incremental eco-friendly changes that align with their tech-driven goals, reducing future risks associated with abrupt regulatory changes or shifts in market demand toward greener practices.
  - Metrics: The number of firms that incorporate eco-friendly tools into their tech upgrades, the energy efficiency improvements, and participation in industry-led workshops that focus on sustainable tech integration.
- Firms:
  - Use smart energy monitoring systems and basic eco-friendly practices alongside high-tech improvements. These small, strategic environmental steps help firms maintain a minimal green footprint while focusing on tech-driven output. This also allows for incremental environmental benefits without major shifts in business operations.
  - Metrics: Reports on energy and resource use, emissions tracking.

	SMEs	Large manufacturers
Green technologies	Deploy basic energy monitoring tools to identify inefficiencies, even if sustainability is not the main focus.	Use smart sensors and AI-based production monitoring to optimize productivity without significant green investments initially.
Productivity frameworks	Six Sigma helps SMEs focus on quality and efficiency by reducing defects and standardizing processes, making it a suitable framework in a tech-driven environment where consistent quality is essential for productivity gains.	Large manufacturers benefit from TPM, especially with a tech focus, as it ensures equipment reliability and uptime, maximizing productivity from investments in automation, AI, and other advanced technologies. TPM also integrates well with high-tech tools like IoT for predictive maintenance, helping large firms reduce downtime and optimize efficiency.
Short-term strategy	Adopt scalable technologies like semi-automated machinery to improve productivity while keeping costs manageable. Focus on training staff to handle new tech and maintain basic sustainability efforts.	Invest heavily in automation and robotics to boost productivity. Train teams on the use of advanced production technologies to maintain an edge in efficiency.
Long-term strategy	Expand automation capabilities over time, integrating more sophisticated AI-driven tools as financial resources and expertise grow. Begin planning for more substantial green initiatives that align with technological upgrades.	Gradually integrate more comprehensive green practices as regulatory and market pressures increase, aiming for a dual focus on efficiency and environmental responsibility.

5.3 Scenario 3: Green Driven (High Green – Low Tech)

In the Green Driven scenario, the industry prioritizes sustainability over technological progress. The recommendations focus on establishing robust sustainability practices with basic accessible, supportive technologies. Through targeted financial support, sustainability training, and flexible regulatory frameworks, the industry is encouraged to prioritize green initiatives and low-tech solutions that enhance environmental stewardship. This approach positions the industry as a leader in sustainable practices, meeting eco-conscious market demands and building a foundation for gradual tech adoption.

Financial incentives

- Policymakers:
  - Create grants and tax breaks exclusively for sustainability-focused initiatives, such as investments in water recycling systems and sustainable raw materials. Additionally, policymakers can include incentives for eco-supportive technologies, such as energy-efficient equipment and systems that can optimize resource use without necessarily being highly advanced. This approach ensures that while the primary focus is on sustainability, firms are still supported in adopting accessible technologies that enhance green practices. This will strengthen the industry’s reputation and market positioning as a green leader.
  - Metrics: Number of applications for green grants, compliance with international green standards and certifications.

- Industry associations:
  - Promote funding for shared sustainable infrastructure projects such as recycling facilities while encouraging the use of some tech tools that support these efforts (e.g., water-efficient recycling technologies and eco-monitoring devices). This can reduce the financial burden on individual firms and facilitate collective resource management, thereby enhancing sustainability efforts industry-wide while supporting smaller firms.
  - Metrics: Number of funded projects and participation in shared infrastructure use.

Training and workforce development

- Policymakers:
  - Sponsor training programs on sustainability practices, eco-certification processes, and the use of simple, eco-friendly technologies, such as energy-efficient systems and resource management software, in order to equip workers with the knowledge needed to implement eco-friendly measures and operate supportive technologies effectively. This will ensure a skilled workforce capable of maintaining environmental standards.
  - Metrics: Certifications in green practices, feedback on training efficacy.
- Industry associations:
  - Collaborate with environmental NGOs to develop and disseminate training modules related to sustainability and the application of basic eco-tech solutions. This will bring credibility and depth to training programs through expert partnerships and as a result, build strong, eco-focused competencies within the industry.
  - Metrics: Number of workshops and training, training completion rates, and implementation of sustainable practices.
- Firms:
  - Implement training focused on waste reduction, resource management and the operation of basic technological systems that support sustainable practices (e.g., water-saving devices and eco-monitoring sensors). In-house training ensures that practices align with company-specific needs. These targeted training programs can reduce long-term operational costs through improved resource use.
  - Metrics: Employee awareness and training completion rates.

Sustainability and green transition

- Policymakers:
  - Mandate sustainability targets with a flexible implementation timeline and incorporate guidelines for the adoption of supportive, low-tech innovations. This ensures that firms gradually align with new standards while integrating accessible technological solutions that aid sustainability. Regulatory pressure combined with tech guidelines helps maintain compliance without straining resources, fostering gradual industry-wide improvements. This will strengthen the country's environmental credentials on the global stage and prepare the industry for potential future integration of higher-level technology.
  - Metrics: Compliance rates with new sustainability regulations, adoption rates of basic tech solutions, and reductions in emissions.
- Firms:
  - Focus on adopting eco-friendly processes, such as bio-based dyes and improved water management systems, while integrating low-tech, supportive solutions like energy-efficient production equipment and real-time eco-monitoring systems. By combining green initiatives with practical tech tools, firms can align production with eco-conscious market trends and consumer expectations. This will position firms competitively in eco-focused markets and

prepare them for gradual technological enhancement.

- Metrics: Usage of sustainable materials, water and energy consumption reports, and integration of low-tech eco-supportive systems.

	SMEs	Large manufacturers
Green technologies	Start with cost-effective eco-friendly measures such as water recycling systems and eco-conscious raw materials.	Adopt more comprehensive green practices, such as using bio-based chemicals and improving wastewater management.
Productivity frameworks	Lean principles focus on reducing waste and improving process efficiency, which aligns with sustainability goals in a low-tech context. For SMEs, Lean helps them use resources efficiently, adopting small but impactful green practices without large-scale technological investments.	Six Sigma's focus on process improvement and waste reduction complements the green objectives in this scenario. Large firms can use Six Sigma to systematically reduce their environmental impact by identifying inefficiencies, minimizing resource use, and enhancing quality control in sustainable practices.
Short-term strategy	Prioritize obtaining certifications like OEKO-TEX or GOTS that highlight sustainable practices. Implement small-scale green technologies that reduce resource consumption.	Shift towards sustainable materials and practices that meet global eco-conscious standards. Begin training staff in green protocols and efficient material use.
Long-term strategy	Invest in partnerships with NGOs or government programs that provide resources and knowledge for expanding sustainable practices while gradually incorporating more sustainable technological solutions.	Plan for investment in larger sustainability initiatives, such as closed-loop production models and collaborations with green technology providers, to maintain competitive advantage in eco-conscious markets.

5.4 Scenario 4: Sustainable Innovation (High Green – High Tech)

The Sustainable Innovation scenario represents the optimal path, integrating high levels of both sustainability and technological advancement. The recommendations focus on achieving a balanced integration of advanced sustainability and high-tech innovation to position the industry as a global leader. Comprehensive financial programs, cross-functional training, and stringent green standards drive firms to adopt both eco-friendly and technologically advanced solutions. This dual-focus strategy enhances Vietnam's global competitiveness.

Financial incentives

- Policymakers:
  - Implement comprehensive financial programs combining grants, tax credits, and low-interest loans to support investments in advanced green technologies, such as digital twins and renewable energy installations. These initiatives encourage firms to adopt an integrated approach to sustainability and technology, balancing both for optimal growth. This will position Vietnam as a global leader in sustainable, tech-driven textile production.
  - Metrics: Adoption rate of green-tech solutions, overall reductions in carbon emissions.
- Industry associations:
  - Advocate for green bonds and investment partnerships that fund large-scale eco-tech projects. This will promote industry-wide access to funding, facilitating substantial advancements in sustainability and technology, thereby supporting collective industry

growth and strengthening competitiveness.
  - Metrics: Levels of secured funding, number of partnerships formed.

Training and workforce development

- Policymakers:
  - Support training programs that incorporate digital literacy, AI use, and sustainable manufacturing techniques. It is vital to ensure the workforce is prepared for advanced, integrated tech and green solutions in order to build a skilled, adaptable labor pool capable of handling complex, modern production environments.
  - Metrics: Certification rates, productivity improvements post-training.
- Industry associations:
  - Partner with universities to offer continuous learning opportunities for high-tech and sustainability skills. This can bridge the gap between academic knowledge and practical industry needs. The purpose is to sustain innovation through a well-trained workforce.
  - Metrics: Number of graduates, placement in advanced roles.
- Firms:
  - Invest in cross-functional training that merges technological proficiency with eco-friendly practices. Firms need to prepare teams to operate and innovate within a dual-focus production model which enhances both operational efficiency and environmental stewardship simultaneously.
  - Metrics: Increased workforce adaptability, number of trained employees.

Sustainability and green transition

- Policymakers:
  - Enforce compliance with stringent international sustainability standards and offer grants for eco-friendly R&D projects in order to strengthen the industry's global reputation and ensure long-term market access. This will position Vietnam as a leader in sustainable innovation.
  - Metrics: Number of certified green firms, compliance rates.
- Industry associations:
  - Establish best practice sharing platforms to encourage the adoption of combined green and tech strategies. Fostering an environment of knowledge-sharing and collaborative growth can drive continuous industry-wide improvement.
  - Metrics: Industry-wide green technology adoption and participation rates in knowledge sharing platforms.
- Firms:
  - To remain competitive in the global market, Vietnamese textile businesses must focus on increasing TFP by embracing innovation and technological advancement. Investment in automation, digital technologies, and advanced production systems can drive operational efficiency. With rising labor costs and supply chain complexities, improving productivity is essential for the Vietnamese textile sector.
  - Large manufacturers should lead the industry by adopting high-tech, sustainable processes such as zero-waste production and renewable energy integration, thereby setting a standard for industry peers and encouraging widespread adoption. SMEs can leverage the support of policymakers and industry associations to participate in larger value chains and enhance their capability in terms of green tech adoption and implementation. This will increase competitiveness by meeting advanced environmental expectations.
  - Metrics: Waste reduction, energy efficiency reports, sustainable material usage/production, and market expansion through eco-conscious branding.

	SMEs	Large manufacturers
Green technologies	Use modular renewable energy solutions, such as solar panels, which can be scaled over time. Implement energy-efficient machinery with IoT capabilities for real-time monitoring.	Integrate digital twins and comprehensive renewable energy sources (e.g., large-scale solar or wind energy).
Productivity frameworks	Combining Lean and Six Sigma allows SMEs to enhance both efficiency and quality in a dual-focus environment. Lean provides a foundation of efficiency, while Six Sigma improves process precision and control. Together, they help SMEs meet both high-tech and high-green goals incrementally.	TPM combined with Industry 4.0 offers large manufacturers predictive maintenance and operational efficiency, which is essential in a high-tech environment focused on sustainability. This combination maximizes uptime and productivity while supporting green objectives by reducing waste and energy use. Large firms can leverage this approach for fully automated, sustainable production systems.
Short-term strategy	Leverage government grants and partnerships for initial investments in both green and tech advancements. Focus on training teams to adapt to new tech and sustainable methods simultaneously.	Implement advanced training programs for workforce development in digital manufacturing and green technology. Adopt AI-driven quality control to maximize efficiency while maintaining sustainability.
Long-term strategy	Invest in building capabilities for adopting more complex systems such as AI-driven production optimization and comprehensive waste management solutions. Actively explore opportunities to integrate into higher-value segments of the textile and garment supply chain.	Develop fully automated, smart production lines that integrate sustainability at every stage. Work on zero-waste production models and collaborate with international partners to stay at the forefront of sustainable innovation.

6. CONCLUSIONS

Vietnam's textile and garment industry is at a pivotal moment, with both significant opportunities and challenges shaping its future. As one of the country's most vital economic sectors, the industry has historically driven growth, provided employment, and bolstered export revenues. However, the landscape is rapidly changing due to advancements in technology, shifting global market demands, and the rising importance of sustainability. The industry faces a critical shortage of skilled labor, a challenge that is further complicated by the demands of Industry 4.0. To remain competitive, Vietnam must invest heavily in training and upskilling its workforce, ensuring that it can meet the needs of a technology-driven future. Additionally, the industry must embrace automation, digitalization, and sustainable practices to align with global trends and consumer preferences.

This report has outlined several possible future scenarios for the industry, ranging from highly favorable outcomes, where Vietnam becomes a leader in advanced manufacturing and sustainability, to more challenging situations where the failure to adapt results in a loss of competitiveness. These scenarios underscore the importance of strategic decision-making and proactive measures to secure the industry's future. The recommendations provided emphasize the need for investment in human capital, technological innovation, and sustainable practices. By focusing on these areas, Vietnam's textile and garment industry can not only overcome current challenges but also seize new opportunities, positioning itself as a global leader in the sector.

In conclusion, the path forward for Vietnam's textile and garment industry requires a balanced approach that combines tradition with innovation. By addressing the immediate challenges and leveraging emerging opportunities, the industry can continue to thrive and contribute significantly to Vietnam's economic development, while also meeting the evolving demands of the global market.

References

Aaguiar, A., Chepeliev, M., Corong, E. L., Mcdougall, R. & Van Der Mensbrugghe, D. (2019). The GTAP data base: version 10. *Journal of global economic analysis*, 4, 1-27.

Asia Development Bank. (2021). *Reaping the benefits of industry 4.0 through skills development in high-growth industries in Southeast Asia.*

Asia Development Bank. (2023). *Harnessing the fourth industrial revolution through skills development in high-growth industries in Central and West Asia.*

Balchin, N. (2023, November 17). *How to make textile and garment production more sustainable.* World Economic Forum. Retrieved from *https://www.weforum.org/agenda/2023/11/textile-garment-industry-sustainability-policy-measures/*

Better Work Vietnam. (2023). *Vietnam Annual Report 2023*. Better Work Vietnam. Retrieved from *https://betterwork.org/wp-content/uploads/BWV_AnnualReport_2023_ENG_v8.pdf*

Boston Consulting Group (2023, October 25). *Demand for Sustainable Raw Materials Could Exceed Supply by as Much as 133 Million Tons by 2030*. Boston Consulting Group. Retrieved from *https://www.bcg.com/press/25october2023-sustainable-raw-materials-133-million-tons-2030*

Brennan, S., Gonzalez, R. B., Puzniak-Holford, M., Kilsby, R., & Subramoni, A. (2024, February 18). *Sustainability regulation outlook 2024*. Deloitte. Retrieved from *https://www2.deloitte.com/xe/en/insights/environmental-social-governance/sustainability-regulation-outlook.html*

Bureau Veritas (2024, April 23). *Bureau Veritas successfully supported Vietnam's first garment factory to achieve LEED O&M Gold*. Bureau Veritas. Retrieved from *https://www.bureauveritas.vn/en/newsroom/bureau-veritas-successfully-supported-vietnams-first-garment-factory-achieve-leed-om-gold*

Cai, Y., Newth, D., Finnigan, J. & Gunasekera, D. (2015). A hybrid energy-economy model for global integrated assessment of climate change, carbon mitigation and energy transformation. *Applied Energy, 148*, 381-395.

Cascale. (2023, November 2). *Sustainable Apparel Coalition Launches Higg FEM 4.0*. Cascale. Retrieved from *https://cascale.org/resources/press-news/press-releases/sustainable-apparel-coalition-launches-higg-fem-4-0/*

CICC Research (2024). Textiles and Apparel—Expanding Production Bases Overseas While Moving Up the Industry Chain. In *The Reshaping of China's Industry Chains* (pp. 331-350). Singapore: Springer Nature Singapore.

Cugno, M., Castagnoli, R., & Büchi, G. (2021). Openness to Industry 4.0 and performance: The impact of barriers and incentives. *Technological Forecasting and Social Change, 168*, 120756.

Danish Energy Agency. (2022). *Vietnamese industrial potential for energy emission reductions*. Danish Energy Agency. Retrieved from *https://ens.dk/sites/ens.dk/files/Globalcooperation/vietnamese_industrial_potential_for_energy_emission_reductions_2022.05.20.pdf*

Deepthi, B., & Bansal, V. (2024). Industry 4.0 in textile and apparel industry: A systematic literature review and bibliometric analysis of global research trends. *Vision, 28*(2), 157-170.

Deloitte. (2024). *Connecting with meaning Hyper-personalizing the customer experience using data, analytics, and AI*. Deloitte. Retrieved from *https://www2.deloitte.com/content/dam/Deloitte/ca/Documents/deloitte-analytics/ca-en-omnia-ai-marketing-pov-fin-jun24-aoda.pdf*

Derrick, M. (2024, March 20). *How Nike is Increasing Reliability on Renewable Energy*. Energy Digital. Retrieved from *https://energydigital.com/articles/how-nike-is-increasing-reliability-on-renewable-energy*

Ecotextile (2024, May 15). *SBTi backs Levi's 2050 net zero target*. Ecotextile. Retrieved from https://www.ecotextile.com/2024051532043/fashion-retail-news/sbti-backs-levi-s-2050-net-zero-target.html

El Achkar Hilal, S., Andersson, S., Hyunh, P., Ritchotte, J. & Williams, D. (2022). Employment, wages and productivity trends in the Asian garment sector: Data and policy insights for the future of work. *International Labour Organization.*

EY (2023). *2024 Geostrategic Outlook How to thrive amid ongoing geopolitical complexity.* EY. Retrieved from *https://www.ey.com/content/dam/ey-unified-site/ey-com/en-gl/insights/geostrategy/documents/ey-2024-geostrategic-outlook-report.pdf*

Federal Reserve Bank of New York (2024). *Global Supply Chain Pressure Index (GSCPI).* Federal Reserve Bank of New York. Retrieved from *https://www.newyorkfed.org/research/policy/gscpi#/interactive*

Fibre2Fashion (2024). *Shifting Paradigms in Textile and Apparel Trade: The Asia-Pacific Dominance and Global Trade Dynamics.* Fibre2Fashion. Retrieved from *https://www.fiber2fashion.com/industry-article/9976/shifting-paradigms-in-textile-and-apparel-trade-the-asia-pacific-dominance-and-global-trade-dynamics*

Fox, R., Goldrick, M., & Whittington, K. (2018). *Geek meets chic: Four actions to jump-start advanced analytics in apparel*. McKinsey & Company. Retrieved from *https://www.mckinsey.com/industries/retail/our-insights/geek-meets-chic-four-actions-to-jump-start-advanced-analytics-in-apparel*

Fricko, O., Havlik, P., Rogelj, J., Klimont, Z., Gusti, M., Johnson, N., Kolp, P., Strubegger, M., Valin, H. & Amann, M. (2017). The marker quantification of the Shared Socioeconomic Pathway 2: A middle-of-the-road scenario for the 21st century. *Global Environmental Change, 42*, 251-267.

General Statistics Office (2012-2022). *Data retrieved from GSO business survey*. General Statistics Office.

Gilbert, M., Lang, N., Mavropoulos, G., & McAdoo, M. (2023). *Protectionism, Pandemic, War, and the Future of Trade*. Retrieved from Boston Consulting Group: *https://www.bcg.com/publications/2023/protectionism-pandemic-war-and-future-of-trade*

Global Fashion Agenda (2024). *Establishing a vision roadmap for circular fashion in Vietnam.* Global Fashion Agenda. Retrieved from *https://globalfashionagenda.org/wp-content/uploads/2024/07/240627-WG4-Establishing-a-Vision-Roadmap-for-Circular-Fashion-in-Vietnam.pdf*

Goto, K. (2014). *Vietnam: Upgrading from the export to the domestic market. In T. Fukunishi & T. Yamagata (Eds.)*, The garment industry in low-income countries: An entry point of industrialization. Palgrave Macmillan.

Government of Ho Chi Minh City (2022). Ngành dệt may có thể giảm 1 tỷ USD chi phí nếu dùng năng lượng tái tạo [The textile industry could save 1 billion USD in costs if using renewable energy]. Government of Ho Chi Minh City. Retrieved from *https://tphcm.chinhphu.vn/nganh-det-may-co-the-giam-1-ty-usd-chi-phi-neu-dung-nang-luong-tai-tao-101220320005104046.htm*

Government of Vietnam (2022). *National green growth strategy for 2021-2030, vision towards 2050*. Government of Vietnam. Retrieved from *https://en.baochinhphu.vn/national-green-growth-strategy-for-2021-2030-vision-towards-2050-11142515.htm*

Government of Vietnam (2022). Quyết định 1643/QĐ-TTg 2022 về Chiến lược phát triển ngành Dệt May và Da Giày Việt Nam đến năm 2030. Thư Viện Pháp Luật. Government of Vietnam. Retrieved from *https://thuvienphapluat.vn/van-ban/Thuong-mai/Quyet-dinh-1643-QD-TTg-2022-Chien-luoc-phat-trien-nganh-Det-May-va-Da-Giay-Viet-Nam-den-2030-548362.aspx*

Greenyarn (2024). *Coffee Yarn*. Greenyarn. Retrieved from *https://greenyarn.vn/en/san-pham/coffee-yarn/*

Hai Linh. (2023, July 18). *Khoảng 50% doanh nghiệp dệt may đã thực hiện xanh hóa sản xuất.* Vietnam Economic News. Retrieved from *https://congthuong.vn/khoang-50-doanh-nghiep-det-may-da-thuc-hien-xanh-hoa-san-xuat-262675.html*

Hai Yen (2022). *Garment and textiles going green in push to hit turnover goals.* Hai Yen. Retrieved from Vietnam Investment Review: Garment and textiles going green in push to hit turnover goals.

Hatfield-Dodds, S., Schandl, H., Newth, D., Obersteiner, M., Cai, Y., Baynes, T., West, J. & Havlik, P. (2017). Assessing global resource use and greenhouse emissions to 2050, with ambitious resource efficiency and climate mitigation policies. *Journal of Cleaner Production, 144*, 403-414.

Hertel, T. W. (1997). *Global trade analysis: modeling and applications*, Cambridge university press.

HM Group (2022) *Sustainability Disclosure 2022*. HM Group. Retrieved from *chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://hmgroup.com/wp-content/uploads/2023/03/HM-Group-Sustainability-Disclosure-2022.pdf*

Hoang Anh (2024). *Enhancing the value of textiles and garments Positioning the value in the chain.* Nhan Dan. Retrieved from *https://en.nhandan.vn/positioning-the-value-in-the-chain-post132682.html*

Hossain, M. T., Shahid, M. A., Limon, M. G. M., Hossain, I., & Mahmud, N. (2024). Techniques, applications, and challenges in textiles for sustainable future. *Journal of Open Innovation: Technology, Market, and Complexity*, 100230.

IBM (2024). *Industry 4.0*. IBM. Retrieved from https://www.ibm.com/topics/industry-4-0

IEA (2021). Net Zero by (2050): A Roadmap for the Global Energy Sector, 3rd and 4th Editions (May and October 2021). International Energy Agency (IEA), Paris.

Institute of Workers and Trade Unions. (2021). *The consequences of low wages: a study on fashion suppliers in Vietnam.*

International Labour Organization. (2022). Sustainable development through the global garment industry: A framework for action in Vietnam. ILO. Retrieved from *https://www.ilo.org/sites/default/files/wcmsp5/groups/public/@asia/@ro-bangkok/documents/publication/wcms_848624.pdf*

International Labour Organization. (2022). *The future of work in textiles, clothing, leather, and footwear in Vietnam: Sectoral background paper.* ILO. Retrieved from *https://www.ilo.org/sites/default/files/wcmsp5/groups/public/@asia/@ro-bangkok/documents/publication/wcms_848624.pdf*

Jensen, B., Stoneburner, M., Martinez-Pardo, C., Wilkinson, J., Khodabocus, H., Durbiano, L., . . . Vargas-Gonzalez, M. (2023, October 25). *Sustainable Raw Materials Will Drive Profitability for Fashion and Apparel Brands.* Boston Consulting Group. Retrieved from *https://www.bcg.com/publications/2023/driving-profitability-with-raw-materials-in-fashion*

Jin, B. E., & Shin, D. C. (2021). The power of 4th industrial revolution in the fashion industry: what, why, and how has the industry changed?. *Fashion and Textiles, 8*(1), 31.

Kharrati, K. (2024). *Global Sustainable Fashion Market Size Likely to Expand at a CAGR of 22.9% By 2033.* Custom Market Insights. Retrieved from *https://www.custommarketinsights.com/press-releases/sustainable-fashion-market-size/*

Leal Filho, W., Dinis, M. A. P., Liakh, O., Paço, A., Dennis, K., Shollo, F., & Sidsaph, H. (2024). Reducing the carbon footprint of the textile sector: an overview of impacts and solutions. *Textile Research Journal*, 00405175241236971.

LONGi Green Energy Technology Co., Ltd. (2022). LONGi SEV solar PV project for Vietnam: Tan De. LONGi Green Energy Technology Co., Lt.d Retrieved from https://www.longi.com/en/news/longi-sev-solar-pv-project-for-vietnam-tan-de/

Lu, Y., Schandl, H., Wang, H. & Zhu, J. (2024). China's pathway towards a net zero and circular economy: A model-based scenario analysis. *Resources, Conservation and Recycling, 204*, 107514.

Magnus, K.-H., Ibáñez, P., Scalco, A., & Hügl, J. (2024, May 24). *Reimagining the apparel value chain amid volatility.* McKinsey & Company. Retrieved from *https://www.mckinsey.com/industries/retail/our-insights/reimagining-the-apparel-value-chain-amid-volatility*

Maile, F., & Staritz, C. (2024, February 28). *Towards shorter supply chains? Understanding shifts in the global apparel industry.* Centre for Business and Development Studies. Retrieved from *https://cbds.cbs.dk/towards-shorter-supply-chains-understanding-shifts-in-the-global-apparel-industry/*

Majumdar, A., Garg, H., & Jain, R. (2021). Managing the barriers of Industry 4.0 adoption and implementation in textile and clothing industry: Interpretive structural model and triple helix framework. *Computers in Industry, 125*, 103372.

Market Research Future (2024). *Global Sustainable Fabrics Market Overview Source: https://www.marketresearchfuture.com/reports/sustainable-fabrics-market-7435.* Market Research Future. Retrieved from https://www.marketresearchfuture.com/reports/sustainable-fabrics-market-7435

Marr, B. (2024, March 8). *How Stitch Fix Is Using Generative AI To Help Us Dress Better.* Forbes. Retrieved from https://www.forbes.com/sites/bernardmarr/2024/03/08/how-stitch-fix-is-using-generative-ai-to-help-us-dress-better/

Material Innovation Innitiative. (2024). *2023 State Of The Industry Report: Next-Gen Materials.*

McKinsey & Company (2022, August 17). *What are Industry 4.0, the Fourth Industrial Revolution, and 4IR?.* McKinsey & Company. Retrieved from *https://www.mckinsey.com/featured-insights/mckinsey-explainers/what-are-industry-4-0-the-fourth-industrial-revolution-and-4ir*

McKinsey & Company (2022, July 14). *Scaling textile recycling in Europe—turning waste into value.* McKinsey & Company. Retrieved from *https://www.mckinsey.com/industries/retail/our-insights/scaling-textile-recycling-in-europe-turning-waste-into-value*

McKinsey & Company (2023, May 31). *Redesigning apparel manufacturing in Asia: A pattern for resilience.* McKinsey & Company. Retrieved from *https://www.mckinsey.com/industries/retail/our-insights/redesigning-apparel-manufacturing-in-asia-a-pattern-for-resilience*

McKinsey Global Institute (2018). *Skill shift - Automation and the future of workforce.* McKinsey Global Institute.

Ministry of Foreign Affairs (2022, December 12). *What are the requirements for apparel to enter the European market?* Ministry of Foreign Affairs. Retrieved from *https://www.cbi.eu/market-information/apparel/buyer-requirements*

Monaghan, J. (2023, September 1). *The Global Journey To Nearshoring: A New Dawn In Supply Chains.* Forbes. Retrieved from *https://www.forbes.com/councils/forbesbusinesscouncil/2023/09/01/the-global-journey-to-nearshoring-a-new-dawn-in-supply-chains/*

Nguyen, T. T., & Tran, T. H. (2023). Job satisfaction and organizational commitment on employee turnover intention: A case study of the textile and garment industry in Vietnam. *Journal of Textile Science & Engineering, 13*(1). https://doi.org/10.4172/2165-8064.10004745

Nong, D., Schandl, H., Lu, Y. & Verikios, G. (2023). Resource efficiency and climate change policies to support West Asia's move towards sustainability: A computable general equilibrium analysis of material flows. *Journal of Cleaner Production, 421*, 138458.

Observatory of Economic Complexity (2024). *Textile in Vietnam*. Observatory of Economic Complexity. Retrieved from *https://oec.world/en/profile/bilateral-product/textiles/reporter/vnm?bilateralViewSelector=Geomap*

OEC (2024). *Textiles in Vietnam*. OEC. Retrieved from *https://oec.world/en/profile/bilateral-product/textiles/reporter/vnm*

Oxfam & CNCĐ Institute. (2021). *Migrant workers in industrial zones: Access to social services and living conditions.* Oxfam Vietnam and CNCĐ Institute.

Pant, H. (2007). GTEM: global trade and environment model. *Australian Bureau of Agricultural and Resource Economics, Canberra.*

Phuong Thao (2021, November 1). *Nhiều thách thức cho ngành dệt may Việt Nam trong cuộc cách mạng công nghiệp 4.0.* Ministry of Industry and Trade of Vietnam. Retrieved from *https://moit.gov.vn/tin-tuc/phat-trien-cong-nghiep/nhieu-thach-thuc-cho-nganh-det-may-viet-nam-trong-cuoc-cach-mang-cong-nghiep-4.0.html*

Quynh Trang (2023). *50 per cent of textile firms adopt sustainable production.* Vietnam Investment Review. Retrieved from *https://vir.com.vn/50-per-cent-of-textile-firms-adopt-sustainable-production-103599.html*

Rabe, T. & Wiggins, J. (2024, July 10). *Shipping crises 'spanner in works' for inflation fight.* Financial Review. Retrieved from *https://www.afr.com/companies/retail/shipping-crises-spanner-in-works-for-inflation-fight-20240709-p5js7a*

Research and Markets. (2024). *Asia-Pacific Textile - Market Share Analysis, Industry Trends & Statistics, Growth Forecasts (2024 - 2029).* Retrieved from *https://www.researchandmarkets.com/report/asia-pacific-textiles-market?srsltid=AfmBOorV0VFh401Mg0H0tpR3vzhPMYcBbKsOHo4-Qd7Vr_P2MhN35NvC*

Saha, P., Talapatra, S., Belal, H. M., Jackson, V., Mason, A., & Durowoju, O. (2023). Examining the viability of lean production practices in the Industry 4.0 era: an empirical evidence based on B2B garment manufacturing sector. *Journal of Business & Industrial Marketing, 38*(12), 2694-2712.

Schroders. (n.d.). *Climate and net zero frameworks: know your CDPs from your TCFDs.* Schroders. Retrieved from *https://www.schroders.com/en-us/us/individual/insights/climate-and-net-zero-frameworks-know-your-cdps-from-your-tcfds/*

Sharma, A., Jit Singh, B., & Sehgal, R. (2023, March). Strategic Integration of Lean and Six Sigma in Era of Industry 4.0: Navigating the Confluence of Barriers and Enablers. In *International Conference on Production and Industrial Engineering* (pp. 37-50). Singapore: Springer Nature Singapore.

Shi, J., Huang, F., Jia, F., Yang, Z., & Rui, M. (2023). Mass customization: The role of consumer preference measurement, manufacturing flexibility and customer participation. *Asia Pacific Journal of Marketing and Logistics, 35*(6), 1366-1382.

Song, J., White, O., Birsha, M., & Woetz, L. (2024, January 17). *Geopolitics and the geometry of global trade.* Retrieved from McKinsey & Company: *https://www.mckinsey.com/mgi/our-research/geopolitics-and-the-geometry-of-global-trade*

Statista (2023). Export value of textiles and garments from Vietnam from 2012 to 2022. Statista. Retrieved from *https://www.statista.com/statistics/986023/vietnam-export-value-textiles-garments/*

Technavio (2023). Automation Market in Textile industry. Retrieved from https://www.technavio.com/report/automation-market-in-textile-industry-analysis

Technavio (2024). *Custom Apparel Market Analysis APAC, North America, Europe, Middle East and Africa, South America - US, China, UK, Germany, India - Size and Forecast 2024-2028.* Retrieved from *https://www.technavio.com/report/custom-apparel-market-industry-analysis*

Textile Exchange (2024). *Materials Market Report 2024.* Textile Exchange.

Textile Exchange (2024). *The Future of Synthetics.* Textile Exchange. Retrieved from *https://textileexchange.org/app/uploads/2024/04/The-Future-of-Synthetics.pdf*

Thanh Thuy (2024, April 29). *Dệt may Việt Nam gia tăng lợi thế cạnh tranh bằng chiếu sáng xanh.* Retrieved from VnEconomy: *https://vneconomy.vn/det-may-viet-nam-gia-tang-loi-the-canh-tranh-bang-chieu-sang-xanh.htm*

TNG Investment and Trading JSC. (2019). *Energy efficiency initiatives and achievements.* TNG Investment and Trading JSC.

Tuoi Tre News. (2024). *Businesses in Vietnam boost production of recycled goods.* Tuoi Tre News. Retrieved from *https://tuoitrenews.vn/news/business/20240525/businesses-in-vietnam-boost-production-of-recycled-goods/79988.html*

United Nations Framework Convention on Climate Change. (n.d.). *Fashion charter.* United Nations Framework Convention on Climate Change *https://unfccc.int/climate-action/sectoral-engagement-for-climate-action/fashion-charter*

Van Ta, C., Jin, B. E., & Cho, H. J. (2024). Examining the relationship between firm characteristics and Industry 4.0 technology adoption in Vietnam's apparel industry. *International Journal of Fashion Design, Technology and Education*, 1-16.

VEECOM. (2021). Thực trạng tiêu thụ năng lượng trong ngành dệt may ở Việt Nam và tiềm năng giải pháp thúc đẩy sử dụng năng lượng tiết kiệm và hiệu quả [Current situation of energy consumption in the textile industry in Vietnam and potential solutions to promote energy-saving and efficiency]. Retrieved from *https://veecom.vn/a/khcn18-thuc-trang-tieu-thu-nang-luong-trong-nganh-det-may-o-viet-nam-va-tiem-nang-giai-phap-thuc-day-su-dung-nang-luong-tiet-kiem-va-hieu*

Viet Nam News (2022). *Việt Nam to reduce environmental impact of textile and garment industry by 2030*. Viet Nam News. Retrieved from *https://vietnamnews.vn/economy/1400338/viet-nam-to-reduce-environmental-impact-of-textile-and-garment-industry-by-2030.html*

Viet Nam News (2023). *Faslink introduces fashion collection with sustainable materials, innovative technology.* Viet Nam News. Retrieved from *https://vietnamnews.vn/life-style/1546106/faslink-introduces-fashion-collection-with-sustainable-materials-innovative-technology.html*

Vietnam Investment Review (2018). *Garment firms should meet workers' needs.* Vietnam Investment Review. Retrieved from *http://vir.com.vn/garment-firms-should-meet-workers-needs-58365.html*

Vietnam Textile & Apparel Association (2024, April 13). *Chuyển đổi số: Sự lựa chọn tối ưu cho doanh nghiệp dệt may Việt Nam.* Vietnam Textile & Apparel Association. Retrieved from *http://www.vietnamtextile.org.vn/chuyen-doi-so-su-lua-chon-toi-uu-cho-doanh-nghiep-det-may-viet-nam_p1_1-1_2-1_3-597_4-7101_9-2_11-10_12-96_13-979.html*

Vietnam Textile and Apparel Association. (2022). *Green materials - a sustainable step for Vietnam's textile industry.*

Vinatex (2024). *One-stop for sustainable textile & green fashion*, Vinatex. Retrieved from *https://vinatex.com/*.

W.ELL Fabric. (2024). *100% Bamboo.* W.ELL Fabric. Retrieved from *https://wellfabric.com/product-category/bamboo-fabric-wholesale/*

WTO Center, (2024). *Vietnamese goods confidently conquer domestic market.* WTO Center Retrieved from *https://wtocenter.vn/an-pham/23665-vietnamese-goods-confidently-conquer-domestic-market*

WWF Vietnam. (2022). *Guidelines for Greening the Textile Sector in Viet Nam.* WWF Vietnam.

WWF. (2022). *Feasibility Study Potential Green Credit Line For The Garment And Textile Sector In Viet Nam.*

Zhang, S., Vincent, K., Dank, M., Cole, K., Burke, C., Hughes, A., . . . Steward, S. (2021). *Prevalence of Forced Labor in Vietnam's Apparel Industry.* Global Fund to End Modern Slavery.

APPENDIX

Appendix 1: Methodology for interviews

The interview process was designed to gather insights into the megatrends influencing Vietnam's textile and garment industry. The interviews followed an open-ended, conversational format. While a set of core questions was prepared, the discussions allowed flexibility for participants to explore topics in more depth. Each interview lasted approximately 45 - 60 minutes. Participants were asked for consent to record the conversation, with all information treated confidentially. No personal attributions were made in the final report, ensuring that all responses were anonymized. Nine interviews were conducted with high-level executives from various textile companies and industry associations in Vietnam, ensuring that the findings reflected a wide spectrum of expertise and industry roles (Table 1).

Interviewees were first asked to describe their organizations, including key products, markets, and their roles within the companies. This established the context for their responses and provided insights into their expertise related to the textile and garment industry. The core of the interview focused on identifying and discussing significant trends shaping the industry. Open-ended questions encouraged interviewees to share their perspectives on various topics related to megatrends and their impact on Vietnam's textile and garment industry. The interviews captured a broad range of opinions and experiences, which were used to identify key challenges and opportunities for the future of Vietnam's textile and garment industry.

TABLE 1

INTERVIEW PARTICIPANTS

No.	Job Title	Gender	Organization	Date of the interview (VN time)
1	Vice General Director	Female	PPJ Group	25/04/2024
2	Vice General Director	Male	Dong Xuan Doximex	26/04/2024
3	General Director	Male	NASIKLMEX	09/05/2024
4	Vice General Director	Male	Hanosimex	14/05/2024
5	Director of Product Development and Business Hub	Male	Vinatex	14/05/2024
6	Former Director	Male	Vietnam Textile Research Institute	15/05/2024
7	Vice President/ General Secretary	Male	Vietnam Textile and Apparel Association	15/05/2024
8	Vice Director	Male	Vinatex Nam Dinh Yarn Factory	23/05/2024
9	Vice Director (Compliance and Sustainable Development)	Female	Aqua Linea	07/06/2024

Appendix 2: GTEM model and database

This study employs the Global Trade and Environment Model (GTEM) – a recursive dynamic, multi-country, and multi-region computable general equilibrium (CGE) framework developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) – to analyze economic activities (Nong et al., 2023, Lu et al., 2024). The GTEM model is grounded in neoclassical economic theory, where rational agents operate in markets to maximize utility (for consumers) and profits (for firms) subject to income and input constraints.

In GTEM, productive sectors—such as services and manufacturing—require inputs to generate outputs. Some inputs, like labor or raw materials, are essential and cannot be substituted, meaning reductions in their use directly reduce output. Others, such as coal and gas, are substitutable. For instance, when the price of coal rises, industries may opt to use more gas to reduce production costs. The model's production structure reflects these dynamics, grouping substitutable inputs to capture such behavior. Substitution occurs at various levels, where inputs (e.g., A1, A2, ... An and X1, X2, ... Xn) can be substituted for one another if they serve similar functions. Substitution rules, governed by elasticity parameters, determine how industries switch between inputs, such as shifting from coal to gas when the price differential reaches a certain threshold.

On the demand side, GTEM models consumer preferences for goods and services. Some consumers exhibit flexibility, substituting similar goods like T-shirts and collared shirts based on price and income. In contrast, preferences may be more specific in certain contexts, such as a preference for T-shirts over collared shirts for sports activities. The model simulates demand using a representative consumer, with demand functions that allow for varying levels of substitution between similar goods or commodities. These functions incorporate substitution mechanisms to account for changes in price or income. Common substitution functions include the constant elasticity of substitution (CES), Leontief, constant ratios of elasticity of substitution–homothetic (CRESH), and constant difference of elasticities (CDE).

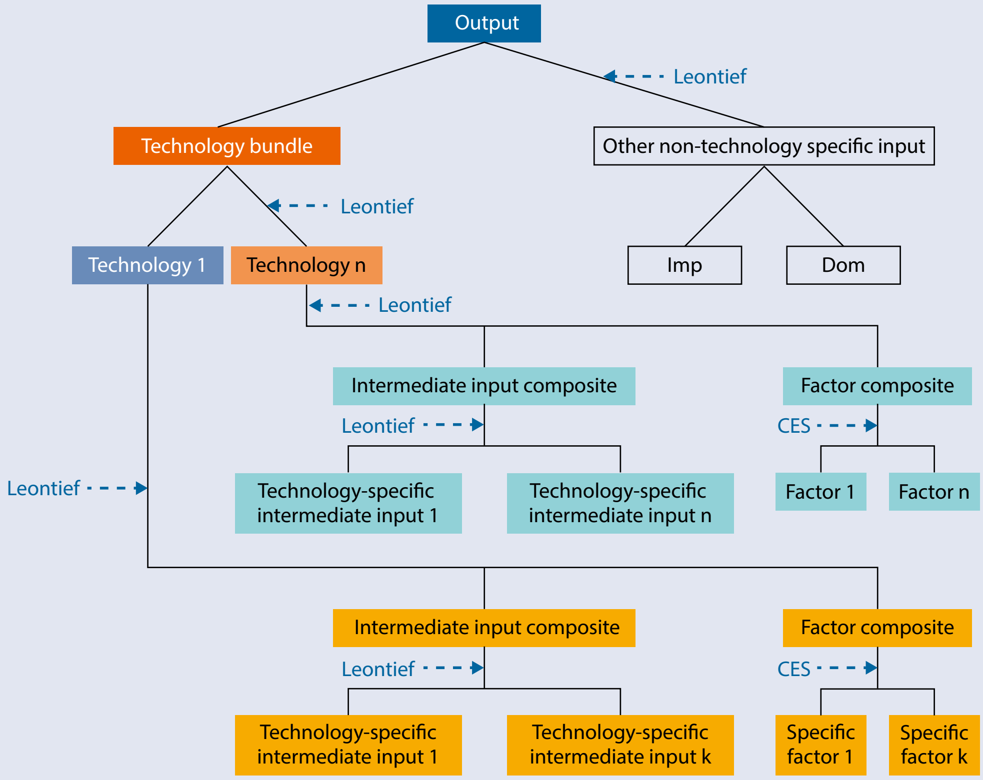
In GTEM, various technologies are represented, including 15 electricity generation methods (e.g., coal, gas, solar, wind, hydroelectric), five land transportation technologies (ranging from conventional internal combustion engine (ICE) vehicles to hybrids and non-fossil alternatives), two iron-steel manufacturing technologies, and specialized sectors such as ruminant meat and fish processing.

Figures 2.1 and 2.2 illustrate the production structure in GTEM. At the top level, input demand is split into two components: an assembly service and a technology bundle. These components are combined using a Leontief function, meaning they are not substitutable. The assembly service aggregates intermediate inputs through a Leontief function, a common feature in CGE models (Hertel, 1997). The technology bundle, on the other hand, comprises specific inputs unique to each technology. For example, coal-fired and nuclear electricity generation rely on distinct inputs, which are substitutable through a CRESH function (Pant, 2007, Cai et al., 2015).

Each technology is characterized by a specific set of intermediate inputs with no substitution allowed between them, as represented by the Leontief function. For example, coal-fired electricity relies on coal and coal-specific inputs, while gas-fired electricity depends on natural gas and gas-specific inputs. The primary factors of production, such as labor and capital, are combined using a CES function, allowing for a degree of substitutability among them.

FIGURE 2.1

PRODUCTION STRUCTURE OF A 'TECHNOLOGY BUNDLE' INDUSTRY

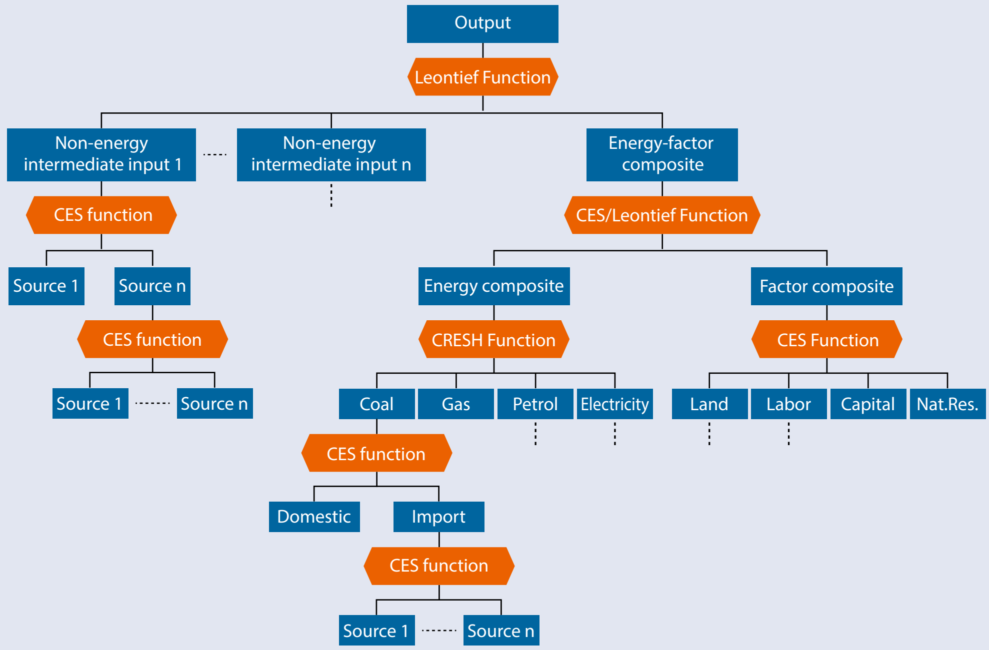


Note: The technology bundle sectors are electricity generation, land transportation, iron & steel manufacturing, ruminant meat processing, and fish processing. The supply of technology-specific inputs to the 'technology bundle' industries follow the mechanism applied for all other sectors (i.e., 'non-technology bundle' industries). When a technology-specific input is allocated to a 'technology bundle' industry, it cannot be substituted for other inputs or the same type of inputs from other sectors. In other words, we only differentiate the demand for inputs.

The production structure for industries outside the 'technology' and 'processing' bundles in GTEM, as shown in Figure 2.2, includes sectors such as mining, manufacturing, agriculture, food processing, and services. These industries employ production technologies that optimize input selection using various functional forms, with the goal of minimizing production costs.

FIGURE 2.2

THE PRODUCTION STRUCTURE OF NON-PROCESSING BUNDLE AND NON-TECHNOLOGY BUNDLE INDUSTRIES.



Source: Pant (2007); Cai et al. (2015)

In this study, we employ the GTAP database version 10a (which represents the world economy in 2014), with 141 countries and regions[1] and 65 sectors[2] (Aguiar et al., 2019). The database is then aggregated into 22 countries/regions, including Vietnam and its trading partners of textile and garment, and 46 industrial sectors, including supply chains of textile and garment industries (Table 2.1).

1 https://www.gtap.agecon.purdue.edu/databases/regions.aspx?version=10
2 https://www.gtap.agecon.purdue.edu/databases/contribute/detailedsector.asp

TABLE 2.1

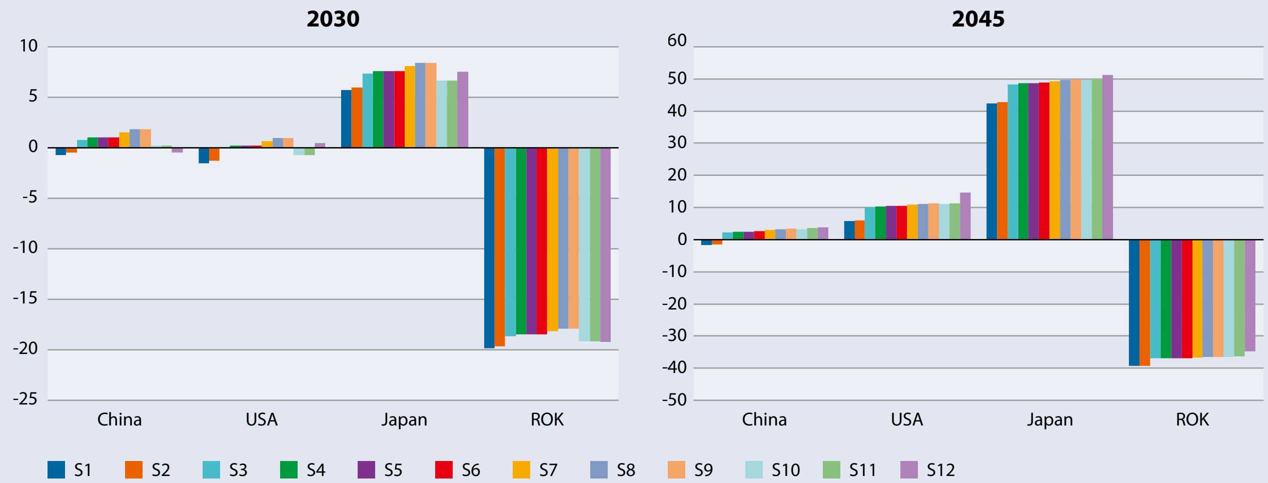
REGIONS AND SECTORS USED IN THIS STUDY

Regions		Sectors			
1	China	1	Paddy rice	24	Beverage & tobacco
2	India	2	Wheat	25	Coal
3	Germany	3	Other grains	26	Oil
4	Italy	4	Vegetable & fruit	27	Gas
5	Vietnam	5	Oil seeds	28	Petroleum product
6	Bangladesh	6	Cane beet	29	Electricity generation
7	Turkiye	7	Fiber crops	30	Other mining
8	USA	8	Other crops	31	Iron & steel
9	Mexico	9	Live cattle	32	Textile
10	Indonesia	10	Live pig	33	Wearing
11	Australia	11	Live poultry	34	Leather wood
12	Japan	12	Raw milk	35	Paper related
13	Republic of Korea (ROK)	13	Cattle (meat)	36	Other manufacturing
14	Thailand	14	Pork (meat)	37	Chemicals
15	UK	15	Poultry (meat)	38	Non-metallic
16	Canada	16	Fishery	39	Electronic
17	Africa	17	Wool	40	Furniture
18	Rest of European Union	18	Forestry	41	Water & waste
19	Rest of Europe	19	Vegetable oils	42	Warehouse
20	Middle East	20	Dairy milk	43	Information & communication
21	Rest Asia	21	Processed rice	44	Land transport
22	Rest of America	22	Sugar	45	Other transport
		23	Other foods	46	Services

Appendix 3: Baseline values and changes relative to these baselines for each scenario

FIGURE 3.1

IMPACT ON IMPORT OF NON-METALLIC MINERALS BY VIETNAM FROM MAJOR TRADING PARTNERS IN SELECTED YEARS ACROSS SCENARIOS (% DEVIATIONS FROM THE BASELINE)



Note: The bars from left to right indicate scenarios S1-S12 in each country/region.

TABLE 3.1

BASELINE VALUES OF VIETNAM'S TEXTILE OUTPUT LEVEL AND CHANGES IN EACH SCENARIO RELATIVE TO THE BASELINE VALUES (USD BILLION).

	Year	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Values (USD billion)	Base	65	70	75	79	83	86	89	92	94	96	98
Change (USD billion)	S1	0.195	0.448	0.555	0.577	0.490	0.301	-0.009	-0.524	-1.213	-2.122	-3.342
Change (USD billion)	S2	0.767	1.680	2.430	3.065	3.611	4.008	4.272	4.324	4.136	3.734	3.028
Change (USD billion)	S3	1.008	2.247	3.398	4.456	5.428	6.226	6.880	7.084	7.022	6.720	6.096
Change (USD billion)	S4	1.586	3.514	5.325	7.031	8.640	10.010	11.232	11.978	12.380	12.547	12.397
Change (USD billion)	S5	1.586	3.514	5.325	7.031	8.640	10.010	11.232	11.978	12.380	12.547	12.397
Change (USD billion)	S6	1.586	3.514	5.325	7.031	8.640	10.010	11.232	12.273	12.953	13.382	13.475
Change (USD billion)	S7	2.490	5.488	8.325	10.973	13.479	15.635	17.569	19.210	20.370	21.245	21.776
Change (USD billion)	S8	3.075	6.769	10.245	13.477	16.517	19.101	21.413	23.350	24.722	25.805	26.538
Change (USD billion)	S9	3.075	6.769	10.245	13.477	16.517	19.101	21.413	23.837	25.624	27.062	28.106
Change (USD billion)	S10	1.190	2.506	4.043	5.625	7.279	8.875	10.440	12.190	13.743	15.168	16.415
Change (USD billion)	S11	1.190	2.506	4.043	5.625	7.279	8.875	10.440	12.190	13.743	15.168	16.415
Change (USD billion)	S12	1.931	4.179	6.735	9.417	12.251	15.041	17.880	20.488	22.823	25.066	27.136
	Year	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Values (USD billion)	Base	99	100	100	100	99	97	96	93	91	87	85
Change (USD billion)	S1	-4.910	-7.140	-9.770	-13.030	-15.998	-18.702	-21.658	-23.752	-26.126	-27.301	-28.798
Change (USD billion)	S2	1.901	0.080	-2.240	-5.190	-8.009	-10.689	-13.632	-15.959	-18.564	-20.201	-22.066
Change (USD billion)	S3	5.000	3.210	0.860	-2.230	-5.366	-8.517	-12.038	-15.085	-18.418	-20.802	-23.341
Change (USD billion)	S4	11.712	10.320	8.270	5.540	2.594	-0.504	-3.946	-7.208	-10.729	-13.589	-16.533
Change (USD billion)	S5	11.712	10.320	8.270	5.790	3.069	0.165	-3.101	-6.222	-9.628	-12.441	-15.343
Change (USD billion)	S6	13.028	11.850	10.000	7.700	5.128	2.318	-0.835	-3.943	-7.326	-10.223	-13.192
Change (USD billion)	S7	21.671	20.840	19.200	17.170	14.642	11.756	8.573	5.124	1.511	-1.958	-5.398
Change (USD billion)	S8	26.572	25.890	24.330	22.410	19.899	16.946	13.747	10.109	6.379	2.584	-1.241
Change (USD billion)	S9	28.413	27.970	26.610	24.890	22.503	19.613	16.502	12.853	9.127	5.116	0.791
Change (USD billion)	S10	17.216	17.540	17.260	16.720	16.008	14.987	13.843	12.425	10.884	9.205	7.727
Change (USD billion)	S11	17.216	17.540	17.260	20.040	22.711	25.036	27.408	29.165	30.949	31.981	33.516
Change (USD billion)	S12	28.641	29.550	29.620	32.360	34.670	36.443	38.218	39.060	39.985	40.037	40.834

TABLE 3.2

BASELINE VALUES OF VIETNAM'S WEARING OUTPUT LEVEL AND CHANGES IN EACH SCENARIO RELATIVE TO THE BASELINE VALUES (USD BILLION).

	Year	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Values (USD billion)	Base	47	53	59	63	66	69	72	75	77	79	81
Change (USD billion)	S1	0.301	0.641	1.003	1.329	1.624	1.904	2.174	2.415	2.603	2.797	2.940
Change (USD billion)	S2	0.710	1.595	2.555	3.503	4.422	5.375	6.358	7.328	8.216	9.140	10.028
Change (USD billion)	S3	0.682	1.585	2.655	3.774	4.917	6.120	7.380	8.513	9.533	10.578	11.583
Change (USD billion)	S4	1.100	2.560	4.278	6.073	7.913	9.874	11.952	13.920	15.747	17.633	19.497
Change (USD billion)	S5	1.100	2.560	4.278	6.073	7.913	9.874	11.952	13.920	15.747	17.633	19.497
Change (USD billion)	S6	1.100	2.560	4.278	6.073	7.913	9.874	11.952	14.258	16.447	18.707	20.955
Change (USD billion)	S7	2.040	4.791	7.995	11.359	14.824	18.533	22.471	26.670	30.646	34.744	38.840
Change (USD billion)	S8	2.656	6.259	10.455	14.862	19.411	24.274	29.434	34.868	39.978	45.228	50.463
Change (USD billion)	S9	2.656	6.259	10.455	14.862	19.411	24.274	29.434	35.865	42.004	48.293	54.554
Change (USD billion)	S10	2.336	5.279	9.145	13.438	18.110	23.322	29.095	35.888	42.812	50.363	58.498
Change (USD billion)	S11	2.336	5.279	9.145	13.438	18.110	23.322	29.095	35.888	42.812	50.363	58.498
Change (USD billion)	S12	3.591	8.295	14.467	21.439	29.146	37.888	47.722	58.283	69.077	80.880	93.677

	Year	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Values (USD billion)	Base	83	85	86	87	88	88	88	87	87	86	85
Change (USD billion)	S1	2.955	2.644	1.901	0.383	-1.408	-3.626	-6.292	-9.135	-12.711	-15.712	-18.624
Change (USD billion)	S2	10.807	11.229	11.085	10.118	8.782	6.838	4.356	1.479	-2.097	-5.272	-8.424
Change (USD billion)	S3	12.442	12.937	12.788	11.649	10.006	7.586	4.470	0.835	-3.611	-7.697	-11.730
Change (USD billion)	S4	21.248	22.576	23.100	22.559	21.393	19.210	16.210	12.432	7.882	3.474	-0.944
Change (USD billion)	S5	21.248	22.576	23.100	22.933	22.114	20.249	17.530	13.972	9.622	5.358	1.037
Change (USD billion)	S6	23.099	24.820	25.705	25.865	25.344	23.690	21.138	17.644	13.363	9.082	4.709
Change (USD billion)	S7	42.820	46.232	48.349	49.529	49.658	48.136	45.417	41.221	36.340	31.029	25.526
Change (USD billion)	S8	55.544	59.925	62.685	64.354	64.715	63.087	60.113	55.323	49.947	43.886	37.587
Change (USD billion)	S9	60.648	65.960	69.488	71.784	72.609	71.201	68.306	63.380	57.881	51.497	44.761
Change (USD billion)	S10	67.164	76.228	84.383	92.220	99.915	105.618	110.440	112.726	114.449	114.819	114.597
Change (USD billion)	S11	67.164	76.228	84.383	92.733	101.006	107.307	112.772	115.675	118.094	119.076	119.459
Change (USD billion)	S12	107.502	122.052	135.622	148.370	161.058	170.940	179.238	183.927	188.033	190.008	191.012

TABLE 3.3

BASELINE VALUES OF TEXTILE EXPORT FROM VIETNAM AND CHANGES IN EACH SCENARIO RELATIVE TO THE BASELINE VALUES (USD BILLION).

		2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Values (USD billion)	Base	49	52	55	58	61	63	65	67	68	69	70
Change (USD billion)	S1	0.300	0.640	0.740	0.730	0.590	0.350	-0.010	-0.570	-1.290	-2.210	-3.410
Change (USD billion)	S2	1.180	2.400	3.240	3.880	4.350	4.660	4.800	4.700	4.400	3.890	3.090
Change (USD billion)	S3	1.550	3.210	4.530	5.640	6.540	7.240	7.730	7.700	7.470	7.000	6.220
Change (USD billion)	S4	2.440	5.020	7.100	8.900	10.410	11.640	12.620	13.020	13.170	13.070	12.650
Change (USD billion)	S5	2.440	5.020	7.100	8.900	10.410	11.640	12.620	13.020	13.170	13.070	12.650
Change (USD billion)	S6	2.440	5.020	7.100	8.900	10.410	11.640	12.620	13.340	13.780	13.940	13.750
Change (USD billion)	S7	3.830	7.840	11.100	13.890	16.240	18.180	19.740	20.880	21.670	22.130	22.220
Change (USD billion)	S8	4.730	9.670	13.660	17.060	19.900	22.210	24.060	25.380	26.300	26.880	27.080
Change (USD billion)	S9	4.730	9.670	13.660	17.060	19.900	22.210	24.060	25.910	27.260	28.190	28.680
Change (USD billion)	S10	1.830	3.580	5.390	7.120	8.770	10.320	11.730	13.250	14.620	15.800	16.750
Change (USD billion)	S11	1.830	3.580	5.390	7.120	8.770	10.320	11.730	13.250	14.620	15.800	16.750
Change (USD billion)	S12	2.970	5.970	8.980	11.920	14.760	17.490	20.090	22.270	24.280	26.110	27.690
		2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Values (USD billion)	Base	71	71	71	70	68	66	65	62	60	56	54
Change (USD billion)	S1	-4.960	-7.140	-9.770	-13.030	-16.160	-19.280	-22.560	-25.540	-28.710	-31.380	-33.880
Change (USD billion)	S2	1.920	0.080	-2.240	-5.190	-8.090	-11.020	-14.200	-17.160	-20.400	-23.220	-25.960
Change (USD billion)	S3	5.050	3.210	0.860	-2.230	-5.420	-8.780	-12.540	-16.220	-20.240	-23.910	-27.460
Change (USD billion)	S4	11.830	10.320	8.270	5.540	2.620	-0.520	-4.110	-7.750	-11.790	-15.620	-19.450
Change (USD billion)	S5	11.830	10.320	8.270	5.790	3.100	0.170	-3.230	-6.690	-10.580	-14.300	-18.050
Change (USD billion)	S6	13.160	11.850	10.000	7.700	5.180	2.390	-0.870	-4.240	-8.050	-11.750	-15.520
Change (USD billion)	S7	21.890	20.840	19.200	17.170	14.790	12.120	8.930	5.510	1.660	-2.250	-6.350
Change (USD billion)	S8	26.840	25.890	24.330	22.410	20.100	17.470	14.320	10.870	7.010	2.970	-1.460
Change (USD billion)	S9	28.700	27.970	26.610	24.890	22.730	20.220	17.190	13.820	10.030	5.880	0.930
Change (USD billion)	S10	17.390	17.540	17.260	16.720	16.170	15.450	14.420	13.360	11.960	10.580	9.090
Change (USD billion)	S11	17.390	17.540	17.260	20.040	22.940	25.810	28.550	31.360	34.010	36.760	39.430
Change (USD billion)	S12	28.930	29.550	29.620	32.360	35.020	37.570	39.810	42.000	43.940	46.020	48.040

TABLE 3.4

BASELINE VALUES OF WEARING EXPORT FROM VIETNAM AND CHANGES IN EACH SCENARIO RELATIVE TO THE BASELINE VALUES (USD BILLION).

		2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Values (USD billion)	Base	41	47	52	56	59	61	64	67	68	70	72
Change (USD billion)	S1	0.640	1.210	1.700	2.110	2.460	2.760	3.020	3.220	3.380	3.540	3.630
Change (USD billion)	S2	1.510	3.010	4.330	5.560	6.700	7.790	8.830	9.770	10.670	11.570	12.380
Change (USD billion)	S3	1.450	2.990	4.500	5.990	7.450	8.870	10.250	11.350	12.380	13.390	14.300
Change (USD billion)	S4	2.340	4.830	7.250	9.640	11.990	14.310	16.600	18.560	20.450	22.320	24.070
Change (USD billion)	S5	2.340	4.830	7.250	9.640	11.990	14.310	16.600	18.560	20.450	22.320	24.070
Change (USD billion)	S6	2.340	4.830	7.250	9.640	11.990	14.310	16.600	19.010	21.360	23.680	25.870
Change (USD billion)	S7	4.340	9.040	13.550	18.030	22.460	26.860	31.210	35.560	39.800	43.980	47.950
Change (USD billion)	S8	5.650	11.810	17.720	23.590	29.410	35.180	40.880	46.490	51.920	57.250	62.300
Change (USD billion)	S9	5.650	11.810	17.720	23.590	29.410	35.180	40.880	47.820	54.550	61.130	67.350
Change (USD billion)	S10	4.970	9.960	15.500	21.330	27.440	33.800	40.410	47.850	55.600	63.750	72.220
Change (USD billion)	S11	4.970	9.960	15.500	21.330	27.440	33.800	40.410	47.850	55.600	63.750	72.220
Change (USD billion)	S12	7.640	15.650	24.520	34.030	44.160	54.910	66.280	77.710	89.710	102.380	115.650
		2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Values (USD billion)	Base	74	75	76	77	78	78	78	77	76	76	74
Change (USD billion)	S1	3.560	3.110	2.210	0.440	-1.600	-4.120	-7.150	-10.500	-14.610	-18.270	-21.910
Change (USD billion)	S2	13.020	13.210	12.890	11.630	9.980	7.770	4.950	1.700	-2.410	-6.130	-9.910
Change (USD billion)	S3	14.990	15.220	14.870	13.390	11.370	8.620	5.080	0.960	-4.150	-8.950	-13.800
Change (USD billion)	S4	25.600	26.560	26.860	25.930	24.310	21.830	18.420	14.290	9.060	4.040	-1.110
Change (USD billion)	S5	25.600	26.560	26.860	26.360	25.130	23.010	19.920	16.060	11.060	6.230	1.220
Change (USD billion)	S6	27.830	29.200	29.890	29.730	28.800	26.920	24.020	20.280	15.360	10.560	5.540
Change (USD billion)	S7	51.590	54.390	56.220	56.930	56.430	54.700	51.610	47.380	41.770	36.080	30.030
Change (USD billion)	S8	66.920	70.500	72.890	73.970	73.540	71.690	68.310	63.590	57.410	51.030	44.220
Change (USD billion)	S9	73.070	77.600	80.800	82.510	82.510	80.910	77.620	72.850	66.530	59.880	52.660
Change (USD billion)	S10	80.920	89.680	98.120	106.000	113.540	120.020	125.500	129.570	131.550	133.510	134.820
Change (USD billion)	S11	80.920	89.680	98.120	106.590	114.780	121.940	128.150	132.960	135.740	138.460	140.540
Change (USD billion)	S12	129.520	143.590	157.700	170.540	183.020	194.250	203.680	211.410	216.130	220.940	224.720

TABLE 3.5

BASELINE VALUES OF EXPORT OF FIBERS FROM MAIN TRADING PARTNERS TO VIETNAM AND CHANGES IN EACH SCENARIO RELATIVE TO THE BASELINE VALUES (USD MILLION).

	Scenario	2030				2045			
		India	USA	Africa	Latin America	India	USA	Africa	Latin America
Value (USD million)	Base	634	1,810	1,432	757	651	3,584	3,436	1,558
Changes (USD million)	S1	-167	-62	132	-28	-474	-296	790	-122
Changes (USD million)	S2	-156	-28	164	-13	-469	-233	876	-93
Changes (USD million)	S3	-142	19	210	7	-465	-158	986	-58
Changes (USD million)	S4	-130	53	243	21	-459	-92	1,076	-28
Changes (USD million)	S5	-130	53	243	21	-458	-81	1,092	-22
Changes (USD million)	S6	-130	53	243	21	-456	-59	1,120	-13
Changes (USD million)	S7	-114	103	290	44	-450	20	1,228	24
Changes (USD million)	S8	-104	134	320	57	-446	68	1,294	46
Changes (USD million)	S9	-104	134	320	57	-443	103	1,340	62
Changes (USD million)	S10	-145	5	194	1	-447	-2	1,184	11
Changes (USD million)	S11	-145	5	194	1	-431	138	1,370	72
Changes (USD million)	S12	-102	101	200	46	-392	371	1,349	140

TABLE 3.6

BASELINE VALUES OF EXPORT OF CHEMICALS FROM MAIN TRADING PARTNERS TO VIETNAM AND CHANGES IN EACH SCENARIO RELATIVE TO THE BASELINE VALUES (USD MILLION).

		2030										
		China	India	Germany	USA	Indonesia	Japan	ROK	Thailand	UK	Middle East	Rest Asia
Value (USD million)	Base	14,584	1,635	739	3,292	4,838	2,184	5,547	3,469	492	4,658	18,354
Changes (USD million)	S1	-6,828	620	-277	-1,560	-2,016	1,419	4,391	2,681	-222	3,356	376
Changes (USD million)	S2	-6,799	629	-275	-1,554	-2,003	1,431	4,424	2,703	-221	3,385	444
Changes (USD million)	S3	-6,878	611	-280	-1,572	-2,029	1,407	4,352	2,670	-224	3,337	295
Changes (USD million)	S4	-6,856	618	-279	-1,567	-2,019	1,417	4,377	2,687	-223	3,359	347
Changes (USD million)	S5	-6,856	618	-279	-1,567	-2,019	1,417	4,377	2,687	-223	3,359	347
Changes (USD million)	S6	-6,856	618	-279	-1,567	-2,019	1,417	4,377	2,687	-223	3,359	347
Changes (USD million)	S7	-6,815	631	-276	-1,558	-2,001	1,434	4,423	2,717	-222	3,400	440
Changes (USD million)	S8	-6,786	640	-274	-1,552	-1,988	1,446	4,455	2,738	-221	3,429	505
Changes (USD million)	S9	-6,786	640	-274	-1,552	-1,988	1,446	4,455	2,738	-221	3,429	505
Changes (USD million)	S10	-6,996	577	-287	-1,599	-2,066	1,349	4,195	2,574	-228	3,210	-6
Changes (USD million)	S11	-6,996	577	-287	-1,599	-2,066	1,349	4,195	2,574	-228	3,210	-6
Changes (USD million)	S12	-7,118	553	-289	-1,593	-2,154	1,363	4,176	2,522	-228	3,244	-114
		2045										
Value (USD million)	Base	40,038	4,412	1,052	3,857	20,202	4,491	9,990	5,777	1,023	15,440	27,953
Changes (USD million)	S1	-31,858	10,465	-785	-3,287	-11,691	13,172	23,742	17,473	-775	15,707	-10,530
Changes (USD million)	S2	-31,834	10,507	-784	-3,286	-11,667	13,221	23,832	17,534	-775	15,786	-10,491
Changes (USD million)	S3	-31,698	10,822	-780	-3,277	-11,481	13,579	24,423	17,839	-771	16,383	-10,222
Changes (USD million)	S4	-31,690	10,838	-779	-3,276	-11,471	13,600	24,456	17,862	-770	16,408	-10,208
Changes (USD million)	S5	-31,686	10,843	-779	-3,276	-11,467	13,605	24,466	17,869	-770	16,417	-10,206
Changes (USD million)	S6	-31,682	10,850	-779	-3,276	-11,463	13,613	24,479	17,879	-770	16,430	-10,200
Changes (USD million)	S7	-31,658	10,894	-779	-3,274	-11,438	13,664	24,569	17,939	-770	16,507	-10,161
Changes (USD million)	S8	-31,646	10,918	-778	-3,273	-11,426	13,693	24,619	17,973	-769	16,549	-10,139
Changes (USD million)	S9	-31,638	10,931	-778	-3,273	-11,418	13,708	24,646	17,991	-769	16,573	-10,127
Changes (USD million)	S10	-31,738	10,762	-782	-3,281	-11,511	13,468	24,200	17,708	-772	16,155	-10,354
Changes (USD million)	S11	-31,742	10,749	-782	-3,282	-11,505	13,448	24,155	17,689	-773	16,104	-10,385
Changes (USD million)	S12	-31,890	10,629	-780	-3,263	-11,749	13,190	23,907	17,560	-772	16,400	-10,169

TABLE 3.7

BASELINE VALUES OF EXPORT OF NON-METALLIC MINERALS FROM MAIN TRADING PARTNERS TO VIETNAM AND CHANGES IN EACH SCENARIO RELATIVE TO THE BASELINE VALUES (USD MILLION).

		2030				2045			
		China	USA	Japan	ROK	China	USA	Japan	ROK
Value (USD million)	Base	2,306	228	591	295	7,771	564	2,688	889
Changes (USD million)	S1	-17	-3	34	-59	-138	32	1,140	-349
Changes (USD million)	S2	-11	-3	35	-58	-120	34	1,148	-348
Changes (USD million)	S3	18	0	43	-55	176	57	1,299	-328
Changes (USD million)	S4	24	0	45	-55	193	59	1,307	-328
Changes (USD million)	S5	24	0	45	-55	197	59	1,308	-328
Changes (USD million)	S6	24	0	45	-55	203	59	1,311	-327
Changes (USD million)	S7	35	2	48	-54	236	62	1,327	-325
Changes (USD million)	S8	43	2	50	-53	255	63	1,335	-325
Changes (USD million)	S9	43	2	50	-53	265	64	1,340	-324
Changes (USD million)	S10	4	-2	39	-57	257	63	1,334	-324
Changes (USD million)	S11	4	-2	39	-57	280	64	1,344	-323
Changes (USD million)	S12	-10	1	45	-57	298	83	1,376	-309

TABLE 3.8

BASELINE VALUES OF EXPORT OF TEXTILE FROM MAIN TRADING PARTNERS TO VIETNAM AND CHANGES IN EACH SCENARIO RELATIVE TO THE BASELINE VALUES (USD MILLION).

		2030						
		China	India	Turkiye	Indonesia	Japan	ROK	Thailand
Value (USD million)	Base	38,912	4,223	535	2,351	1,294	6,072	2,369
Changes (USD million)	S1	-1,735	-898	32	1,088	2,499	2,641	266
Changes (USD million)	S2	-459	-781	52	1,214	2,649	2,990	359
Changes (USD million)	S3	47	-736	60	1,271	2,723	3,148	394
Changes (USD million)	S4	1,397	-612	82	1,406	2,884	3,521	492
Changes (USD million)	S5	1,397	-612	82	1,406	2,884	3,521	492
Changes (USD million)	S6	1,397	-612	82	1,406	2,884	3,521	492
Changes (USD million)	S7	4,066	-368	124	1,671	3,191	4,229	685
Changes (USD million)	S8	5,790	-210	151	1,842	3,390	4,688	810
Changes (USD million)	S9	5,790	-210	151	1,842	3,390	4,688	810
Changes (USD million)	S10	2,020	-554	92	1,470	2,939	3,652	536
Changes (USD million)	S11	2,020	-554	92	1,470	2,939	3,652	536
Changes (USD million)	S12	5,249	174	219	1,701	2,253	4,265	1,264
		2045						
Value (USD million)	Base	46,464	7,826	444	4,570	744	4,125	2,692
Changes (USD million)	S1	-5,957	-2,626	117	2,876	6,759	1,398	626
Changes (USD million)	S2	-3,661	-2,312	149	3,305	7,210	1,732	813
Changes (USD million)	S3	-3,234	-2,273	155	3,410	7,288	1,767	824
Changes (USD million)	S4	-836	-1,942	188	3,861	7,763	2,115	1,018
Changes (USD million)	S5	-400	-1,885	194	3,944	7,849	2,178	1,053
Changes (USD million)	S6	409	-1,774	205	4,095	8,007	2,295	1,119
Changes (USD million)	S7	4,577	-1,208	262	4,874	8,816	2,889	1,457
Changes (USD million)	S8	6,956	-883	295	5,319	9,280	3,229	1,649
Changes (USD million)	S9	8,331	-697	314	5,577	9,546	3,424	1,759
Changes (USD million)	S10	11,658	-190	358	6,207	10,145	3,875	2,028
Changes (USD million)	S11	13,247	101	379	6,554	10,605	4,214	2,162
Changes (USD million)	S12	25,272	5,729	830	8,040	4,516	2,562	4,742

TABLE 3.9

BASELINE VALUES OF EXPORT OF WEARING FROM MAIN TRADING PARTNERS TO VIETNAM AND CHANGES IN EACH SCENARIO RELATIVE TO THE BASELINE VALUES (USD MILLION).

		2030			2045		
		China	ROK	Thailand	China	ROK	Thailand
Value (USD million)	Base	20,501	742	80	24,705	530	113
Changes (USD million)	S1	1,080	-7	-12	2,547	-264	-47
Changes (USD million)	S2	1,669	17	-10	3,553	-253	-44
Changes (USD million)	S3	2,103	35	-8	4,024	-250	-44
Changes (USD million)	S4	2,739	62	-6	5,092	-238	-42
Changes (USD million)	S5	2,739	62	-6	5,287	-236	-41
Changes (USD million)	S6	2,739	62	-6	5,655	-232	-40
Changes (USD million)	S7	4,127	117	-2	7,713	-210	-35
Changes (USD million)	S8	5,045	154	1	8,931	-198	-32
Changes (USD million)	S9	5,045	154	1	9,657	-190	-31
Changes (USD million)	S10	3,686	96	-3	11,881	-166	-26
Changes (USD million)	S11	3,686	96	-3	12,538	-154	-24
Changes (USD million)	S12	5,593	361	28	18,094	19	80

TABLE 3.10

BASELINE VALUES OF VIETNAM'S GDP AND CHANGES IN EACH SCENARIO RELATIVE TO THE BASELINE VALUES (USD MILLION).

		2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Value (USD billion)	Base	510	569	597	625	656	687	721	750	781	814	847
Changes (USD billion)	S1	1.73	4.10	7.10	10.50	14.37	18.69	23.50	28.35	33.50	39.07	44.81
Changes (USD billion)	S2	1.99	4.67	7.94	11.63	15.81	20.47	25.60	30.68	36.16	42.00	48.02
Changes (USD billion)	S3	5.10	11.44	18.69	26.69	35.56	45.14	55.59	65.33	75.52	86.37	97.49
Changes (USD billion)	S4	5.36	12.01	19.58	27.94	37.13	47.06	57.82	67.88	78.49	89.62	101.05
Changes (USD billion)	S5	5.36	12.01	19.58	27.94	37.13	47.06	57.82	67.88	78.49	89.62	101.05
Changes (USD billion)	S6	5.36	12.01	19.58	27.94	37.13	47.06	57.82	68.03	78.72	90.03	101.64
Changes (USD billion)	S7	5.81	13.09	21.25	30.25	40.08	50.70	62.15	73.05	84.35	96.30	108.42
Changes (USD billion)	S8	6.12	13.77	22.33	31.75	42.05	53.04	64.96	76.20	87.94	100.20	112.65
Changes (USD billion)	S9	6.12	13.77	22.33	31.75	42.05	53.04	64.96	76.50	88.57	101.10	113.84
Changes (USD billion)	S10	5.61	12.52	20.60	29.63	39.75	50.70	62.73	74.40	86.77	99.96	113.58
Changes (USD billion)	S11	5.61	12.52	20.60	29.63	39.75	50.70	62.73	74.40	86.77	99.96	113.58
Changes (USD billion)	S12	5.71	12.80	21.19	30.56	41.07	52.49	65.11	77.40	90.44	104.35	118.75

		2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Value (USD billion)	Base	882	916	951	987	1,025	1,064	1,101	1,139	1,178	1219.000	1262.000
Changes (USD billion)	S1	50.89	56.88	63.15	69.09	75.34	81.50	87.75	93.85	100.01	106.42	112.95
Changes (USD billion)	S2	54.42	60.73	67.14	73.43	79.75	86.18	92.59	98.75	105.08	111.54	118.25
Changes (USD billion)	S3	109.10	120.64	132.28	142.92	153.75	164.49	174.84	184.86	194.72	204.79	214.79
Changes (USD billion)	S4	112.98	124.76	136.56	147.46	158.47	169.28	179.68	189.76	199.67	209.67	219.59
Changes (USD billion)	S5	112.98	124.76	136.56	147.56	158.57	169.50	180.01	190.10	200.02	210.03	220.09
Changes (USD billion)	S6	113.60	125.49	137.42	148.54	159.59	170.67	181.11	191.24	201.08	211.13	221.10
Changes (USD billion)	S7	120.92	133.28	145.60	156.93	168.31	179.39	189.92	200.01	209.80	219.79	229.68
Changes (USD billion)	S8	125.42	138.04	150.54	161.97	173.33	184.50	194.99	205.02	214.75	224.66	234.48
Changes (USD billion)	S9	126.92	139.69	152.35	163.94	175.38	186.52	196.97	206.96	216.75	226.49	236.25
Changes (USD billion)	S10	127.80	142.16	156.63	170.36	184.09	197.69	210.62	223.02	235.01	246.85	258.46
Changes (USD billion)	S11	127.80	142.16	156.63	171.15	185.73	200.14	213.81	226.89	239.61	252.09	264.14
Changes (USD billion)	S12	133.89	149.03	164.52	180.03	195.47	210.78	225.04	238.73	251.86	264.52	276.76

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GLOSSARIES

Conditional Frontier Model

A model that assesses an industry's performance relative to its most efficient firms, considering existing barriers such as limited technology access or capital. This conditional frontier represents the maximum productivity achievable under these constraints.

Energy Efficiency

A measure of the amount of energy used relative to the output produced. In the textile and garment industry, it reflects how effectively energy is utilized in production, impacting both sustainability and cost.

Frontier Model

A model that determines the relative efficiency of similar decision-making units (DMUs) by comparing their input-output performance against a best-practice frontier. This frontier represents the optimal input-output combinations, allowing for efficiency comparisons across DMUs.

Labor Productivity

The ratio of total output per hour worked. It measures how efficiently labor input is combined with other production factors to generate output. In the textile and garment sector, labor productivity indicates workforce utilization efficiency and competitiveness.

Technical Efficiency

The ability to either reduce input quantities proportionally without affecting output (input-oriented) or increase output proportionally without changing input quantities (output-oriented) to achieve cost, revenue, or profit efficiency within a system.

Total Factor Productivity (TFP)

TFP reflects the overall efficiency with which labor and capital inputs are used together in the production process. Changes in TFP indicate effects from improved management practices, branding, organizational changes, knowledge, network effects, spillovers from production factors, adjustment costs, economies of scale, imperfect competition, and measurement errors.

Unconditional Frontier Model

A model that estimates industry productivity if all barriers to technology and capital were removed, reflecting the highest efficiency achievable without current constraints.

LIST OF FIGURES

LIST OF TABLES