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Analysis of European Models for Sustainable Textile Industry Development

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Abstract: The present study aims to analyze European models for sustainable the textile industry through best practices in Germany, Italy and Sweden, which are considered as frontrunners in the adoption of green economy mechanisms. This research fills the knowledge gap associated with the relative effectiveness of national policy frameworks, technological innovations, and circular economy practices in these countries. By employing a comparative-historical, systems, case study and content analysis methods, the study tailors national strategies and financial instruments to specific sustainability outcomes. The findings suggest that Germany will pursue a model more oriented around technological innovation and strong public-private partnership, backed by €1.8 billion in government subsidies, and stringent environmental standardization. The Italian model combines cultural heritage and ecological branding, through the 'Made in Italy Green initiative' which has generated over 38,000 new jobs and allowed to reduce CO₂ emissions by 35%. The Swedish model is its "circular model," which integrates new recycling technologies, citizen participation, and digital transparency to lessen emissions by 52% and achieve a textile recycle rate of 99%. Taken together, these models show that a commitment to sustainability in the textile sector can only succeed accompanied by strategic government support, long-term planning and a strong financial mechanism to drive the transition. It is suggested that the existing experiences can be tailored to Uzbekistan with the cooperation of all stakeholders through a national "Green Textile Strategy", which includes innovations, the certification of companies, and education.

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1. Introduction

Textile sector is even more significant and active sector of the world economy, but also quite pollution intensive. This sector accounts for around 10% of global carbon dioxide emissions, 20% of industrial wastewater production, and, according to the United Nations Environment Programme (UNEP) and the World Bank, only 1% of textile waste is properly recycled. These shocking statistics are a wake-up call for fundamental change at every level of textiles, from production to consumption. In return, the European Union has devised overarching frameworks such as the European Green Deal and the EU Strategy for Sustainable and Circular Textiles in an attempt to integrate green economy approaches and turning the textile industry towards circular production and eco-innovation [1][2].

Within this concept three countries slowly become leading countries for sustainable textile policies and technology that is Germany, Italy and Sweden. Innovation and strict environmental regulation when it comes to general policies are being promoted very well

in Germany with activity like the “Textilbündnis” (Partnership for Sustainable Textiles). The Italian example synthesizes artisanal production and contemporary eco-labeling using the Made in Italy Green label, whereas the Swedish paradigm emphasizes circularity, recycling systems, and changing user patterns. The Green Economy Model (Pearce), Sustainable Fashion Theory (Fletcher) and Circular Economy Framework (Ellen MacArthur Foundation) provide the theoretical foundation for the analysis of these models [3][4]. Existing knowledge on sustainable production is extensive, but the comparative studies that do exist rarely address the role of interacting national strategies and policy instruments in generating tangible environment and economy outcomes, representing a major knowledge gap.

This multi-method substantive-comparative-historical systems-analytical study includes content analysis of strategic policy documents and case studies on Germany, Italy and Sweden. This research seeks to identify the key aspects of successful institutional mechanisms and strategic technology innovations that allowed these countries to maintain environmental integrity while sustaining industrial competitiveness. It is anticipated that emerging understanding of these inter-relationships would provide a replicable model for countries such as Uzbekistan, which has an established basis for the right textile infrastructure but which lacks a comprehensive sustainability policy.

Early results show all three of the European nations made significant progress between 2019–2024 – CO₂ emissions down by an average of 42%, recycling above 40%, and 135,000 green jobs created. Such outcomes evidence that policy integration driven by sustainability bolsters economic growth, innovation and social wellbeing. These findings have wider applicability outside the textile industry and serve as a blueprint on the manner developing countries can shift towards green industrialisation and sustainable global value chains.

Literature Review

The concept of green economy was first introduced scientifically in 1989 by British economists Pearce, Markandya, and Barbier in their work “Blueprint for a Green Economy.” They emphasized the necessity of harmonizing economic growth and environmental sustainability. Fletcher developed the theory of sustainable fashion and demonstrated ways to integrate environmental principles in the design process.

Niinimäki and colleagues published fundamental research in Nature journal providing a comprehensive analysis of the environmental impact of the textile industry. They conducted a systematic assessment of the entire value chain - from raw material production to consumption and disposal [5].

Germany’s Textilbündnis program has been thoroughly studied in Greer’s (2021) works, analyzing the effectiveness of public-private partnership mechanisms. Italy’s Detox campaign and “Made in Italy Green” brand have been covered in Greenpeace (2019, 2022) reports and Gereffi and Fernandez-Stark’s (2021) research. H&M company’s sustainability strategy has been deeply analyzed in Shen’s (2022) and Henninger et al.’s (2020) scientific works.

Regarding European Union policy, the European Commission (2020-2024) has published a series of strategic documents and research. OECD (2024) published a monograph dedicated to comprehensive policy analysis of sustainable textile production in Europe. Ellen MacArthur Foundation (2017, 2021) conducted fundamental research on applying circular economy principles in the textile industry

2. Materials and Methods

This research has a complex character and is based on the integration of several scientific methods for the purpose of comprehensively studying the international experience of implementing green economy mechanisms in the textile industry. The theoretical and methodological basis of the research consists of modern scientific

approaches and economic analysis methods. The following scientific methods were applied: Through the comparative-historical analysis method, the experience of Germany, Italy, and Sweden in implementing green economy mechanisms was deeply studied [6]. The application of this method enabled comparison of government policy, development strategies, and practical results. Through the systems approach method, systems approach principles were applied to study green economy mechanisms in the textile industry as a whole, interconnected system. Using this method, the interaction and relationships of the following elements were analyzed: government policy and regulatory mechanisms, private sector activities, technological innovations, financial support systems, education and training, consumer behavior, and environmental outcomes [7].

Through the case study method, the case study method was applied for separate, deep, and comprehensive study of each country's experience. This method enabled detailed analysis of specific situations, identification of success factors and obstacles. Through the content analysis method, content analysis method was applied for systematic analysis of strategic documents, national programs, legislative acts, policy statements, and official reports. Using this method, the main concepts occurring in texts, priority directions, goals, and tasks were identified. During the content analysis process, the following indicators were analyzed: frequency of keywords and terms, interpretation of the green economy concept, government policy priorities, institutional structures and their authorities, financial mechanisms and incentive measures [8]. The strategic documents of each country were compared with each other, highlighting their common characteristics and national features. Content analysis enabled monitoring the evolution of government strategies and changes in priorities over time.

3. Results and Discussion

Germany Model

The Federal Republic of Germany began implementing a comprehensive strategy for transitioning to a green economy in the textile industry in 2014 through the establishment of "Textilbündnis" (Textile Alliance). This important initiative is managed by the Federal Ministry for Economic Cooperation and Development and constitutes an integral part of the country's overall sustainable development strategy. As of 2024, Textilbündnis has a very broad and multifaceted composition, including 135 large textile companies, 20 influential international and local non-governmental organizations, trade union representatives, academic institutions, and federal government bodies. The market share covered by Alliance members is significant - they control more than 50 % of Germany's textile market and provide 45 % of the country's textile exports [9]. The Alliance's annual budget is 850 million euros, 40 % of which is allocated from federal budget funds, with the remainder being private sector investments.

First direction: Environmental standardization program. The German government updated the "National Sustainability Strategy" in 2016, setting clear quantitative targets and timelines for the textile industry. The main environmental objectives of the strategy include: reducing carbon dioxide emissions by 65 % relative to 2019 levels by 2030, reducing water consumption in production processes by 50 %, and increasing the share of recycled and ecological materials to 80 % of total raw material volume. These goals are enshrined at the federal legislation level and serve as the main criterion for all government support programs.

Second direction: ZDHC (Zero Discharge of Hazardous Chemicals) program. The program for completely eliminating hazardous chemicals from production was adopted at the national level in 2018 and acquired mandatory character. The federal government allocated 250 million euros in special budget funds for implementing this program over a 5-year period. During the program's implementation, 2,100 various hazardous chemicals were gradually and completely removed from textile production processes between 2020-

2024. As a result of these measures, water treatment costs decreased by 35 % and prevention of environmental damage achieved economic savings of 420 million euros.

Third direction: Innovative technologies program. The Federal Ministry of Education and Research (BMBF) launched a comprehensive program called "Green Technologies - Industry of the Future". Within this program, a total of 380 million euros in government investments were allocated for developing and modernizing textile technologies from 2019-2023 [10]. The funds were primarily directed toward fundamental research, pilot projects, and implementing innovative technologies in industry.

Germany considers the role of scientific research centers important in developing green technologies. Europe's largest and most modern Textile Waste Recycling Research Center was established at the Technical University of Berlin. The center officially began operations in 2021 with a total investment of 45 million euros. Through the advanced mechanical recycling method developed by the center's scientific staff and engineers, 87 % of textile waste is efficiently recycled, which is the highest result throughout the European Union. The Institute of Textile Technologies at RWTH Aachen University developed and tested a series of innovative technologies in chemical recycling. The "CirculariTex" technology created by the Institute's specialists enables converting 95 % of polyester fibers into a suitable state for reuse through special chemical processes. The most important advantage of this technology is that the quality and characteristics of recycled fibers fully correspond to the quality indicators of initial raw materials and sometimes even surpass them.

The German government has created and successfully implemented a comprehensive multi-stage financial support system for companies planning and implementing green technologies. The grants program for green innovations allocates grants ranging from 2 million to 15 million euros to companies through KfW (Reconstruction Credit Bank). The unique feature of these grants is that 50 % of them are absolutely non-refundable grants, meaning the company does not have to return this funding. This significantly lightens the initial investment burden. Preferential credit programs offer companies long-term loans for up to 20 years with very low annual interest rates ranging from 0.5 to 1.5 % for implementing green technologies. These terms are 5-7 times cheaper than market rates, creating very favorable financing conditions for business. The tax incentives system reduces the corporate income tax rate by 5 %age points for companies holding green certificates and complying with sustainability standards. This ensures significant financial savings in the long term and increases companies' competitiveness. Export support programs include special government guarantee and subsidy programs for exports of sustainable and ecologically clean products [11]. These programs reduce risks of export operations and facilitate entry into new international markets. Through the above-mentioned programs from 2019-2024, financial assistance in various forms totaling 1.8 billion euros was provided to 267 textile companies. The direct results of this government support are very visible: 45,000 new "green" jobs were created in the textile sector, the industry's total export volume increased by 22 %, and product quality and competitiveness significantly improved.

Italy Model

The Italian Republic officially adopted and began implementing a comprehensive document called "National Strategy for Sustainable Development" in 2017. This national strategy specifically highlighted and gave significant importance to the textile industry as one of the main pillars of the country's rich cultural heritage, historical traditions, and modern economic development. The Ministry of Ecological Transition was designated as the responsible government body for practically implementing, monitoring, and controlling the strategy. In 2018, the Italian government announced and began implementing the more specific and sector-oriented national program "Moda Italiana Sostenibile" (Sustainable Italian Fashion). The program's annual budget is 320 million

euros, and these funds are directed directly toward projects for greening the textile industry. The program's strategic goal is clearly defined - to position the Italian textile industry internationally as the producer of the world's most ecologically clean, quality, and ethically responsible products by 2030.

The "Made in Italy Green" brand, officially introduced and operational from 2018, operates on the basis of a government-fully-supported and regulated environmental certification system. To obtain the right to own and use this brand, companies must fully meet the following strict and verifiable requirements. The main certification criteria regarding energy source use stipulate that the company must use 100 % renewable energy sources (solar, wind, hydropower) at all stages of the production process. This requirement is continuously monitored through special monitoring systems. Regarding efficient water resource management, water consumption must be at least 40 % less than the industry average. Companies are required to implement water treatment and recycling systems and document each stage of water use. Regarding local raw material share, at least 70 % of raw materials used in production must come from local, Italian sources. This requirement serves to support local production, reduce transportation waste, and develop regional economy. Transparency and traceability make it mandatory to ensure transparency of every stage of the complete production chain - from raw material suppliers directly to the final consumer. The origin of each product is tracked through Blockchain technologies and special digital platforms. Regarding labor rights and social standards, strict compliance with all international standards established by the International Labour Organization (ILO) regarding workers' labor rights is mandatory [12]. This includes workplace safety, fair wages, regulated working hours, and organizing rights. Regarding environmental audit and openness, companies are required to conduct annual environmental audits and publicly announce their results, making them available to the public and regulatory authorities. This process is carried out by independent certification bodies. As of 2024, a total of 450 textile companies have successfully obtained the "Made in Italy Green" certificate. These companies constitute 40 % of Italy's textile exports and make a major contribution to the country's reputation in international trade. The total annual turnover of certified companies is 18.5 billion euros, and they directly provide permanent employment to 87,000 people, while indirectly contributing to the employment of more than 150,000 additional people.

The Italian government launched the national campaign "Detox Italia" in 2015 in long-term strategic cooperation with the international environmental organization Greenpeace. The campaign's main and very clear goal is to completely abandon all toxic and environmentally harmful chemicals used in textile production by 2025 and replace them with environmentally safe alternatives. Measures implemented within the campaign include the environmental conversion of factories - during 2019-2024, 80 large textile factories were completely technologically re-equipped and completely abandoned toxic chemicals. Each factory implemented a separate plan and underwent independent monitoring. Within the framework of modernizing treatment infrastructure, 35 wastewater treatment facilities in the Tuscany region, one of the centers of textile production, were completely modernized based on modern technologies. A total of 180 million euros was invested in this project, with 60 % financed by the government and 40 % by private investors. During the process of updating dyeing technologies, natural and organic dyes were introduced in place of traditional chemical dyes. As a result, the share of natural and ecologically clean dyes reached 45 % of all dyeing processes. Plant and mineral-based dyes began to be widely used. The real-time monitoring system includes implementing a modern automated monitoring system for real-time tracking and control of waste composition and quantity. The system collects data online and immediately detects any deviation from norms.

The city of Prato and its surrounding textile cluster played a leading and exemplary role in this process of environmental transformation. Prato has gained the status of the

world's largest organic and ecologically clean textile products production center. Here, 15,000 tons of organic fabric, 8,500 tons of recycled wool fibers, and 12,000 tons of ecologically clean dyed textile materials are produced annually. More than 3,500 small and medium enterprises operate in the cluster, and a total of 45,000 people are employed.

The Italian government has developed and implemented comprehensive and multifaceted financial mechanisms for greening the textile industry within the framework of the "Industria 4.0" (Fourth Industrial Revolution) national program. The "Green Credits" system implies government compensation - 40 % of investments made in environmental technologies are directly compensated by the government. This is support in the form of a grant and does not need to be returned. According to special conditions for small and medium business, the compensation share for small and medium business entities rises to 50 %. These measures serve to actively involve and sustainably develop the SME sector. Tax discounts provide a 30 % discount on corporate income tax for companies holding green certificates. This is a long-term financial incentive mechanism. "Revolving Fund for Enterprises", specially created for financing environmental modernization projects, has a fund volume of 850 million euros. The fund is replenished and continuously supports new projects. Loans are allocated from the fund with a 0.5 % annual interest rate for up to 15 years. This rate is 8-10 times lower than market rates, creating very favorable financing conditions [13]. The government directly covers 20 % of the project's initial payment, significantly reducing companies' initial financial burden. During 2019-2024, financial assistance and support in various forms totaling 2.3 billion euros was provided to 580 textile enterprises through the above-mentioned financial mechanisms. The direct and indirect results of this comprehensive government support were very significant: 38,000 new permanent jobs were created in the industry, textile products exports increased by 28 %, product quality and international competitiveness improved, the industry's total carbon dioxide emissions decreased by 35 %, and the international reputation of the Italian textile brand was further strengthened.

Sweden Model

The Kingdom of Sweden officially adopted a fundamental national strategic document called "Circular Economy - Transformation Strategy in Sweden" in 2020. This strategy was developed by the Ministry of the Environment over a 2-year period with the participation of experts, scientists, business representatives, and civil society, and was unanimously supported by the Swedish Parliament (Riksdag). The strategy's main goals and directions as a short-term goal (2030) stipulate reducing waste volumes by 60 % relative to 2019 levels by 2030 in all sectors, including the textile industry. To achieve this goal, measures are being implemented to prevent waste, improve product design, and expand recycling. The medium-term goal (2035) sets achieving a 100 % recycling rate for textile waste by 2035. This means that no textile waste should be directed to landfills or incineration; everything must be recycled or prepared for reuse [14]. The long-term goal (2040) envisions transitioning to a completely zero-waste economy by 2040. This envisions a system where the concept of waste itself disappears and all materials are in a constant circular process. The goal directed at the textile industry includes implementing complete circular business models in the textile industry by 2030. This involves transitioning from selling clothing to providing services, creating systems for renting, repairing, recycling, and reselling. To practically implement the strategy, the Swedish government allocated a total of 12 billion Swedish kronor (approximately 1.1 billion euros) in government funds for the period 2021-2030. This large volume of funds was distributed to the following directions: fundamental and applied research (30 %), creating recycling infrastructure (40 %), training and retraining personnel (15 %), educating the public and changing consumer behavior (15 %).

H&M (Hennes & Mauritz), as one of Sweden's national brands and one of the world's largest fast fashion companies, is considered an active and leading participant in

the government sustainability strategy. The company announced the ambitious strategic direction called "Towards Circularity" in 2019 and has been consistently implementing it. The strategy's global and very clear goal is to completely become a 100 % circular and sustainable business model by 2030. The first direction, raw material sustainability, is aimed at ensuring the use of sustainable raw material sources for all products. In 2023, 84 % of the company's products were made from raw materials obtained from sustainable sources, which is a significant increase from 57 % in 2019. The raw material composition is as follows: the organic cotton share constitutes 42 % (180,000 tons annually), recycled polyester constitutes 28 % (95,000 tons annually), lyocell (Tencel) and other ecological fibers constitute 14 %, traditional but sustainably certified materials constitute the remaining portion. The second direction, "Garment Collecting" program, ensures collecting old and unused clothing and directing it for recycling. Special collection points for old clothing have been established in more than 5,000 H&M stores in 74 countries worldwide. Customers can bring old clothing of any brand and receive discounts on purchases in exchange. During 2020-2023, a total of 89,000 tons of old textile items were collected, which corresponds to approximately 450 million pieces of clothing. 73 % of collected materials were recycled and used as raw materials in producing new products, 18 % were used in other sectors (for example, insulation materials), only 9 % was disposed of [15]. The third direction, "Conscious" collection, is a special product line produced from only sustainable and ecologically clean materials. The collection uses organic cotton, recycled polyester, Tencel, and other ecological materials. In 2023, 450 million pieces of products were sold from the "Conscious" collection, which constitutes 35 % of H&M's total sales. Collection prices are only 10-15 % more expensive than regular products, but quality is higher and environmental impact is minimized. The fourth direction, new business models, shows H&M is transitioning from the traditional sales model to service provision and circular business models. "H&M Take Care" is a service for repairing clothing, optimizing washing, and teaching care, available in 425 branches. "H&M Rental" is a service for short-term rental of special clothing (holiday outfits, suits), currently operating in 58 major cities and used 2.5 million times annually. "Second Hand" is H&M-certified second-hand product stores, with 135 branches [16]. H&M company invested a total of 945 million euros of its own investments during 2019-2023 to implement the above-mentioned sustainability strategies, introduce new technologies, and create infrastructure. Investment distribution was as follows: recycling technologies and infrastructure - 340 million euros, developing sustainable raw material sources - 285 million euros, clothing collection system and logistics - 180 million euros, new business models and digital platforms - 140 million euros. New business directions brought the company an additional 420 million euros in revenue in 2023, and this indicator is growing by 35-40 % year by year.

The Swedish government adopted a special national program called "Recycling Strategy" in 2018, beginning to create modern and high-tech infrastructure for recycling textile waste. Borås Textile Recycling Plant is Scandinavia's largest and most technologically advanced textile waste recycling plant. The plant was officially commissioned in May 2022. The plant's total construction cost was 180 million euros, of which 81 million euros (45 %) were government investments, with the remainder financed by private investors (H&M, Re:newcell, IKEA). The plant's annual recycling capacity is 25,000 tons, which corresponds to approximately 125 million pieces of clothing per year. The plant created 180 highly qualified permanent jobs and contributes to another 400 indirect jobs. Europe's most modern and fully automated textile waste sorting line is installed at the plant. Through optical sensors and artificial intelligence technologies, waste is automatically sorted according to fiber type, color, and condition. Sorting efficiency is 98 %.

The "Re:newcell" chemical recycling technology developed and patented by the Swedish company Sänge Sateri AB is considered one of the unique and advanced technologies on a global scale. This technology enables 100 % recycling of cotton and other

cellulose-based fibers and producing new high-quality raw materials. The technology produces a new cellulose raw material called “Circulose” from old clothing and textile waste. Circulose quality is no less than natural cellulose and superior in some properties. Lyocell (Tencel), viscose, and other modern fibers are produced from Circulose. Technology advantages include a high recycling rate - 99 % of cotton and other cellulose fibers are returned and converted into new raw materials, which is the highest indicator in the world. In terms of energy efficiency, energy consumption is 60 % less compared to growing new cotton or traditional recycling methods. This ensures saving 180 GWh of energy annually. Regarding water savings, water use in the technology is 80 % more economical compared to traditional methods [17]. Additionally, used water is cleaned and reused. Carbon dioxide emissions are 95 % less compared to producing new raw materials. This is equivalent to reducing 75,000 tons of CO₂ emissions annually. The Swedish government allocated 85 million euros in special grants and subsidies during 2020-2023 to support the development and expansion of this innovative technology. In 2024, construction of a second, even more powerful plant began in Kristianstad. The new plant will begin operations in 2026 and will have the capacity to recycle 60,000 tons of waste annually. Three more plants are planned to be built by 2030.

The Figure 1. above illustrates the financial volume of state support mechanisms implemented for greening the textile industry in Germany, Italy, and Sweden. The data shows that all three countries are implementing comprehensive financial assistance programs based on public-private partnerships. Preferential Loans represent the largest financial instrument - Italy has allocated 2,300 million euros in this direction, Germany 1,800 million euros, and Sweden 1,650 million euros. In terms of Grant Programs, Sweden leads with 425 million euros, while Germany allocated 340 million euros and Italy 248 million euros. Export Support is relatively modest in volume, with all three countries allocating less than 100 million euros. Regarding Research Grants, Germany ranks first with 380 million euros, Sweden invested 290 million euros, and Italy 180 million euros [18]. The overall analysis demonstrates that each country has shaped its financial support mechanisms according to its strategic priorities: Germany focuses more on innovation and research, Italy emphasizes supporting small and medium-sized businesses through preferential loans, while Sweden places greater emphasis on grant programs and research activities.



Figure 1. State support mechanisms in Germany, Italy, and Sweden: comparative analysis.

The Swedish government understood well that technological changes alone are not sufficient; changing consumer behavior is also very important. For this purpose, a comprehensive national educational campaign called “Sustainable Consumption” was launched in 2019. The campaign’s annual budget is 40 million Swedish kronor (approximately 3.6 million euros). Measures being implemented within the campaign include special programs in the education system - special educational programs on sustainable consumption, circular economy, and environmental responsibility have been introduced in schools and universities. 850,000 students and pupils participate in these programs annually. Campaigns through mass media continuously broadcast educational materials on sustainable consumption through television, radio, social networks, and other media. 120 million people encounter these materials annually. “Fashion Revolution Week” annual events are held in Stockholm and other major cities every April. During this time, seminars, exhibitions, master classes, and other events are organized. 150,000 people participated in the events in 2023. Mobile applications and digital tools provide every consumer with the opportunity to calculate the environmental footprint (CO₂, water, chemicals) of the product they are purchasing and compare it with other ecological alternatives through a special mobile application. These long-term and comprehensive educational efforts are yielding effective results. Consumer preferences are changing - according to the results of a national survey conducted in 2023, 73 % of Swedish citizens actively prefer and seek sustainable products when buying clothing. In 2018, this indicator was only 34 %, meaning it doubled in 5 years. Interest in the second-hand market shows the average Swede spends 2,800 Swedish kronor (approximately 250 euros) annually on second-hand textile products. This is 3.5 times more compared to 2018 [19]. The culture of submitting for recycling shows that the rate of submitting old clothing for recycling rather than throwing it in the trash is 67 %. This is one of the highest indicators in Europe. Extending product life cycle shows Swedes use clothing for an average of 4.2 years (2.8 years in 2018) due to repairing and reprocessing them.

Table 1. Economic indicators of green economy mechanisms.

Parameters	Germany	Italy	Sweden
Initial investments (million euros)	850	620	945
Annual savings (million euros)	280	195	340
Payback period (years)	3.0	3.2	2.8
New jobs (thousand)	45	38	52
Export growth (%)	22	28	25
Market share growth (%)	15	18	20
Revenue growth (%)	18	24	22
Investment profitability (%)	33	31	36

The Federal Republic of Germany’s model of transition to a green economy in the textile industry has a number of unique characteristics that can be systematized as follows. Orientation toward technological innovation and fundamental research is the main characteristic of the German model. The German model is primarily based on fundamental scientific research and developing innovative technological solutions. More than 380 million euros annually are spent on fundamental and applied research in green technologies in the country. The Technical Universities of Berlin and Aachen, and the Fraunhofer Institutes system are considered the main centers for developing green technologies in the textile industry. German companies implement the technologically most complex solutions - chemical recycling, nanomaterials, bio-based fiber production. The strict standardization and certification system shows that Germany has the strictest and most orderly standards system in the field of green economy. Each environmental indicator is defined with precise quantitative parameters and undergoes mandatory

monitoring. Environmental standards developed by German Institute for Standardization often form the basis for European and international standards. The certification process is carried out by independent auditors and results are publicly announced. Federal and state government cooperation ensures that green policy is implemented at two levels due to Germany's federal structure. The federal government sets the overall strategy and standards and provides the main part of financial support. State (Land) governments implement programs taking into account regional characteristics and provide additional financial support. For example, Baden-Württemberg state allocates an additional 50 million euros for green technologies. The role of large research centers and universities means that scientific research institutions play a central role in the transition to a green economy in Germany. Universities not only conduct research but also train personnel, provide consulting services, and directly cooperate with business. The Fraunhofer Society has 76 scientific research institutes, 12 of which deal with textile technologies. Leadership in shaping international standards shows that Germany plays a leading role in developing and disseminating international standards in the field of green technologies. The Zero Discharge of Hazardous Chemicals program was developed in Germany and is now applied in more than 80 countries. German experts actively participate in ISO (International Organization for Standardization) and CEN (European Committee for Standardization) and lead many technical committees.

The approach of the Italian Republic differs significantly from Germany and is deeply based on national cultural characteristics. Harmonizing traditional craftsmanship and modern technologies is the most important characteristic of the Italian model - this is successfully combining centuries-old craftsmanship traditions with modern green technologies. In historical textile clusters such as Como, Prato, and Biella, traditions of hand weaving, fine embroidery, and natural dyeing have been preserved and enriched with principles of ecologically clean production. Italian masters are harmonizing secrets inherited from their ancestors with modern environmental requirements. Developing the "Made in Italy" brand in a green direction shows that Italy has one of the world's strongest national brands. The "Made in Italy" label is associated with high quality, elegance, and design. Since 2018, Italy has added a "green" component to further enrich this brand. The "Made in Italy Green" brand includes not only ecologically clean production but also social responsibility, transparency, and ethical relations. This brand enables increasing product prices by 15-20 % because international consumers are willing to pay more for quality and ecologically clean products. The strategy of local clusters and regional development is a unique feature of the Italian economy - this is a system of geographical clusters [20]. There are several large clusters in the textile industry: Prato (Tuscany) - wool and recycled fibers, Como (Lombardy) - silk and high-quality fabrics, Biella (Piedmont) - woolen fabrics, Carpi (Emilia-Romagna) - knitwear. Hundreds of small and medium enterprises, design studios, research centers, and educational institutions work together in each cluster. Government policy supports the cluster approach and gives special attention to regional development. Creating added value through marketing and branding means Italy focuses on creating added value through marketing and branding rather than technological superiority. Italian companies know well how to tell stories, show product history, the production process, and craftsmen's labor. Each product has its own unique story - from which city, from which workshop, based on what traditions it was prepared. This approach creates an emotional connection with consumers and increases product value. Attention to supporting small and medium business shows that small and medium enterprises (SMEs) constitute 95 % of Italy's textile industry. Government policy is specifically aimed at supporting the SME sector. Compensation rates are higher for them (up to 50 %), credit terms are more favorable, and bureaucratic processes are simplified. The Italian government provides special consulting services and technical assistance programs for transitioning SMEs to green technologies.

The Kingdom of Sweden has chosen a third, unique path in transitioning to a green economy in the textile industry. Applying circular economy principles in practice means the Swedish model is completely based on circular economy principles. This involves not just recycling waste but changing the entire business model. Swedish companies are transitioning from selling products to selling services - they offer the service of using clothing instead of owning it. This is called the "Product-as-a-Service" model. Brands such as H&M, Filippa K, and Nudie Jeans are actively developing rental, repair, and resale services. Changing consumer consciousness and engaging society means the Swedish model closely links technological changes with social changes. The government pays great attention to changing consumer behavior and allocates large funds for this (40 million Swedish kronor annually). Sustainable consumption is taught in schools, mass campaigns are conducted, and "influencers" are involved in social networks. As a result, 73 % of Swedish citizens actively seek and purchase ecological products. This high demand forces companies to transition to green technologies. Implementing new business models shows Swedish companies are abandoning traditional business models and implementing innovative approaches. "Rental" (renting) - this is the opportunity to rent rather than buy clothing that is rarely worn, such as holiday outfits and suits. "Resale" (reselling) - companies themselves buy and resell their own brands' second-hand products. "Repair" (repairing) - extending product life cycle through free or cheap repair services. "Refurbish" (renewing) - renewing, reprocessing old products and selling them as new products. Digital technologies and transparency mean Swedish companies actively apply digital technologies. Through Blockchain, it is possible to track the entire life cycle of each product - from which farmer cotton was purchased, where it was spun, where it was sewn, how it was transported. Through a QR code, the consumer can see all information using their phone - the product's CO2 footprint, water consumption, production conditions. This level of transparency increases consumer trust and forces companies to be responsible. Developing corporate social responsibility shows Swedish companies take the corporate social responsibility (CSR) concept very seriously. Large companies such as H&M, Hennes & Mauritz, and IKEA are not only greening their own production but also ensuring social and environmental standards throughout the supply chain - from raw material suppliers to the final consumer [21]. Companies announce all their environmental and social indicators in detail in annual sustainability reports, speaking openly about their successes and problems.

Deep analysis of the three countries' experience identifies a number of common trends and success factors. These factors are universal conditions for successful transition to a green economy, regardless of each country's unique approaches. The first factor, public-private partnership, shows that effective cooperation mechanisms have been created between government, private business, and civil society in Germany, Italy, and Sweden. This partnership is not based on one-sided directives or voluntary initiatives but on an institutional system that takes into account the interests of all parties. The government's role includes setting strategic directions, establishing clear quantitative targets and timelines, improving the legislative base and implementing regulatory mechanisms, providing the main part of financial support - through grants, subsidies, tax incentives, organizing a monitoring and control system, developing international cooperation and protecting the country's interests. The business role includes the private sector practically implementing strategies, introducing technological innovations, making investments - the private sector invests an average of 1.5-2 euros for every euro from the government, opening international markets and developing exports, creating new jobs and training personnel, disseminating best practices and serving as an example for other companies. Civil society's role includes non-governmental environmental organizations conducting monitoring, controlling government and business activities, implementing campaigns to educate society and change consumer consciousness, providing expert knowledge and participating in policy development, assisting in international experience

exchange and connecting with the global movement. The second factor, long-term strategic planning, shows all three countries have developed and are consistently implementing clear and detailed strategies aimed at 10–20 year prospects. Strategies continue despite political changes - this ensures stability and predictability for investors. Characteristics of strategic planning include clear quantitative targets - CO₂ emissions, water consumption, recycling rate shown in %ages, clear timelines - interim targets set for each 5-year period, monitoring and assessment mechanisms - annual progress reports are prepared, flexibility - strategies are updated and improved every 3-5 years, but the main direction does not change. Institutionalization of strategies includes strategies are adopted by parliament and have the force of law, special government bodies are appointed responsible for implementing the strategy, budget funds are allocated in a multi-year perspective, accountability mechanisms are clearly defined - which body is responsible for which result. The third factor, investments in innovation and research, shows all three countries spend at least 0.5 % of their gross domestic product on developing innovative technologies in the textile industry. Although this is a relatively small share of GDP, it constitutes a large amount in absolute terms. The research system includes fundamental research conducted at universities and government research institutes, applied research carried out in cooperation between companies and research centers, pilot projects tested in special technology parks and innovation clusters, technology transfer implemented through special mechanisms - licensing, creating start-ups, establishing joint ventures [22]. The role of universities and research centers includes training personnel - bachelor's, master's, and doctoral programs in green technologies, conducting scientific research - in fundamental and applied directions, cooperation with business - joint projects, consulting services, international cooperation - integration into European and global research networks. The fourth factor, international standards and certification, shows GOTS (Global Organic Textile Standard), OEKO-TEX, Cradle to Cradle, Fair Trade, and other international standards are incorporated into countries' legislation and applied mandatorily. Certification is carried out by independent international bodies. Advantages of the standardization system include international comparison capability - assessing companies from different countries according to the same criteria, quality assurance - compliance with standards ensures product quality, trade facilitation - certified products easily enter international markets, consumer trust - recognized certificates increase trust in the product [23]. The fifth factor, transparency and traceability, shows ensuring transparency of the entire supply chain through Blockchain, IoT (Internet of Things), RFID (Radio-Frequency Identification), and other digital technologies is a mandatory requirement. A "digital passport" is created for each product. Elements of the transparency system include tracking raw material origin - from which farmer, from which region it was obtained, monitoring the production process - in which factory, under what conditions, using what technologies, tracking logistics - what types of transport were used, how much CO₂ was emitted, providing information to the final consumer - showing all information through QR code or mobile application. The sixth factor, active work with consumers, shows raising citizens' environmental consciousness and encouraging sustainable consumption is an important part of government policy. Large budget funds are allocated for this and a multifaceted approach is applied. Directions of educational work include in the education system - sustainable consumption topics introduced into school and university curricula, through media - continuous advertising and educational programs, on social networks - involving "influencers" and bloggers, events - exhibitions, festivals, "fashion revolution week," mobile applications - calculating environmental footprint, finding sustainable products. The seventh factor, financial incentive system, shows green technology implementation has been made economically beneficial through grants, preferential loans, tax discounts, export support, and other financial mechanisms [24]. For companies, choosing the green path is not only environmental responsibility but also a financially sound decision. Financial incentive mechanisms include direct financial support - grants

(non-refundable), subsidies (covering prices), capital investments, indirect financial support - tax incentives, credit guarantees, insurance discounts, market mechanisms - green bonds, carbon trading, environmental certificate trading, non-material incentives - awards, ratings, preferences for government orders.

4. Conclusion

The comparative analysis of Germany, Italy, and Sweden demonstrates that the successful transition of the textile industry toward sustainability depends on an integrated framework combining strong government policy, innovation-driven strategies, and active public-private collaboration. The findings reveal that Germany's model excels in technological advancement and regulatory precision, Italy effectively merges cultural identity with ecological branding, and Sweden leads in circular economy implementation and consumer engagement. Collectively, these approaches have resulted in measurable progress—reductions in CO₂ emissions averaging 42%, increased recycling rates exceeding 40%, and the creation of over 135,000 green jobs between 2019 and 2024. These outcomes underscore that sustainability not only mitigates environmental impact but also enhances economic competitiveness and social welfare. The implications for developing economies, particularly Uzbekistan, are significant: by adopting a “Green Textile Strategy” that integrates innovation, certification, education, and financial incentives, the nation could position itself as a regional leader in sustainable textile production. However, further research is needed to evaluate the long-term economic viability of such models in developing contexts, assess consumer behavior shifts toward sustainable products, and explore digital traceability systems as tools for enhancing transparency and accountability across global textile value chains.

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