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Factors influencing the adoption of sustainable innovations by the textile and apparel industry: a systematic review of the literature

Fatores influenciadores na adoção de inovações sustentáveis pela indústria têxtil e de confecção: uma revisão sistemática da literatura

Factores influyentes en la adopción de innovaciones sostenibles por parte de la industria textil y de la confección: una revisión sistemática de la literatura

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Abstract: The Brazilian Sustainable Development Goal (SDG-9) aims to modernize infrastructure and promote sustainable industries, enhancing resource efficiency and the adoption of clean technologies. Given this context, this study sought to identify the key drivers and barriers to adopting sustainable practices in the textile and apparel industry, a sector of significant economic importance for the country. To achieve this, a systematic literature review (SLR) was conducted, analyzing 63 articles published between 2018 and 2023 using bibliometric analysis to address three research questions. The results revealed an increasing number of publications on the topic, particularly in China, as well as gaps that represent opportunities for future research. These findings can guide the planning and implementation of sustainable practices in industries that use fabric as raw material, contributing to theoretical and practical advancements aligned with SDG-9.

Keywords: *Sustainable Development. Opportunity. Challenge*

Resumo: O Objetivo de Desenvolvimento Sustentável (ODS-9) brasileiro estabelece a missão de modernizar a infraestrutura e reabilitar as indústrias para torná-las sustentáveis, com maior eficiência no uso de recursos e adoção de

tecnologias limpas. Diante desse contexto, este estudo buscou identificar os principais fatores que motivam ou dificultam a adoção de práticas sustentáveis na indústria têxtil e de confecção, setor de relevância econômica para o país. Para isso, foi realizada uma revisão sistemática da literatura (RSL), analisando 63 artigos publicados entre 2018 e 2023 por meio de análise bibliométrica, com o objetivo de responder a três questões de pesquisa. Os resultados revelaram um crescimento nas publicações sobre o tema, especialmente na China, além de apontarem lacunas que representam oportunidades para pesquisas futuras. Essas descobertas podem orientar o planejamento e a implementação de práticas sustentáveis em indústrias que utilizam tecido como matéria-prima, contribuindo para o avanço teórico e prático alinhado ao ODS-9.

Palavras-chave: Desenvolvimento Sustentável. Oportunidade. Desafio.

Resumen: *El Objetivo de Desarrollo Sostenible (ODS-9) brasileño establece la misión de modernizar la infraestructura y promover industrias sostenibles, aumentando la eficiencia en el uso de recursos y la adopción de tecnologías limpias. En este contexto, este estudio buscó identificar los principales factores que motivan o dificultan la adopción de prácticas sostenibles en la industria textil y de confección, un sector de relevancia económica para el país. Para ello, se realizó una revisión sistemática de la literatura (RSL), analizando 63 artículos publicados entre 2018 y 2023 mediante análisis bibliométrico, con el objetivo de responder tres preguntas de investigación. Los resultados mostraron un aumento en las publicaciones sobre el tema, especialmente en China, así como vacíos que representan oportunidades para futuras investigaciones. Estos hallazgos pueden orientar la planificación e implementación de prácticas sostenibles en industrias que utilizan tejido como materia prima, contribuyendo al avance teórico y práctico alineado con el ODS-9.*

Palabras clave: *Desarrollo Sostenible. Oportunidad. Desafío*

Introduction

The major challenge of sustainable development lies in maintaining a balance among the environment, the economy, and society, meeting present needs without compromising the ability of future generations to meet their own (World Commission on Environment and Development, 1991). For industries to sustain this balance, it is necessary to increase resource-use efficiency, adopt environmentally sound technologies and industrial processes, modernize infrastructure, and transform firms into more sustainable organizations (United Nations, 2015).

Innovation, therefore, plays a pivotal role in enabling the provision of products supported by advanced mechanisms of production, marketing, management, and design, which ensure quality and sophistication with minimal environmental impact (Shishoo, 2012). Innovation should not be understood as an isolated action but rather as a set of interrelated elements. It extends beyond the discovery of new knowledge, product or service development, or market creation; it involves the integration of these creative processes towards a common goal (Bathelt et al., 2017).

To align innovation with the demands of Sustainable Development Goal (SDG) 9, which aims to modernize industry and promote inclusive and sustainable industrialization, companies must adapt their processes to minimize environmental impacts. This adaptation requires the adoption of sustainable practices that contribute to environmental preservation (Calazans & Silva, 2016). Such practices not only strengthen corporate reputation within society but also enhance sales and profitability, generating both economic and environmental benefits (Bueno et al., 2022). In this sense, sustainability-oriented innovation acquires strategic importance for firms as well as for academic training (Johann & Silva, 2023).

Traditionally, the textile and apparel industry has emphasized innovations focused on production

efficiency and cost management, often neglecting social and environmental aspects, particularly among micro, small, and medium-sized enterprises (Silva & Menelau, 2021). In developing countries such as Brazil, the sector faces significant challenges, including low workforce qualification, limited automation of production processes, barriers to digital transformation, low adoption of sustainable technologies, and insufficient investment capital. These factors hinder competitiveness and sustainability, demanding innovative solutions in technologies, products, and markets (Shishoo, 2012; Harsanto et al., 2023; Firjan, 2024).

The aim of this study is to identify the main drivers and barriers to the adoption of sustainable practices in the textile and apparel industry through a systematic literature review (SLR).

This research is justified by the relevance of innovation as a tool for improving organizational performance and fostering new business competencies. Furthermore, there is increasing academic interest in studies that integrate sustainable development across its three dimensions (Gonçalves & Mikosz, 2023). SDG 9, focused on industry, innovation, and infrastructure, proposes the construction of resilient infrastructure, the promotion of inclusive and sustainable industrialization, and the fostering of innovation, directly influencing the incorporation of innovative and sustainable technologies in Brazilian industry.

Among existing studies, Roy et al. (2020) examined the factors driving sustainability adoption in the textile and apparel sector but do not explore in depth the barriers to implementing such practices. Conversely, Harsanto et al. (2023) discussed sustainable innovation in the textile industry but limit their analysis to a qualitative perspective on categories of innovation, focusing narrowly on the environmental dimension of sustainable development. Thus, the present study addresses underexplored aspects in the literature, offering a broader view of the drivers and obstacles to the adoption of sustainable practices in the textile and apparel industry.

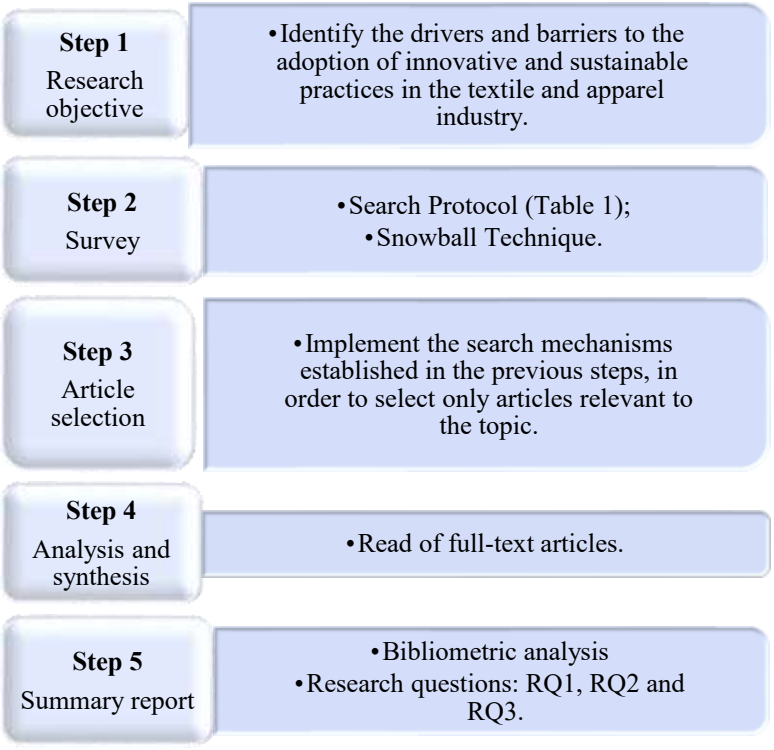
Methodological Elements of the Research

This study is descriptive and exploratory in nature. To conduct the research, a systematic literature review (SLR) was performed, following the methodology proposed by Denyer and Tranfield (2009), as illustrated in Figure 1. An SLR aims to gather empirical evidence that meets predefined eligibility criteria in order to address specific research questions (Ravindran & Shankar, 2015).

Scientific articles were selected from the CAPES Journals database, which provides free access to scholarly publications for the Brazilian academic community. The selected articles were analyzed using bibliometric techniques, with the purpose of addressing the following three research questions:

- ✓ *RQ1 – What constitutes an innovative and sustainable organizational process in the textile and apparel industry?*
- ✓ *RQ2 – What are the driving factors for adopting more innovative and sustainable organizational processes in the textile and apparel industry?*
- ✓ *RQ3 – What are the barriers to adopting more innovative and sustainable organizational processes in the textile and apparel industry?*

Figure 1 – **Steps followed in this Systematic Literature Review**



Source: Adapted from Denyer & Tranfield (2009).

According to the search protocol (Table 1), a total of 279 articles were initially retrieved. These were screened by title and abstract, leading to the exclusion of 207 articles based on the exclusion criteria, leaving 72 for further review. After full-text reading, an additional 18 articles were excluded, resulting in 225 exclusions overall and leaving 54 articles for the complete SLR analysis.

Table 1 - **Search protocol**

Procedure	**Description**
Keywords	*Textile and apparel industry* *Sustainability* *Innovation*
Boolean Operators	AND / OR
String	*("Textile industry" OR "clothing industry" OR "Apparel") AND ("sustainability" OR Triple-bottom-line OR "Triple bottom line") AND ("Technology" OR "Innovation").*
Database	CAPES
Language	English
Period	2018 to 2023
Inclusion Criteria	Articles published in scientific journals; Articles focused on the textile and apparel industry.
Exclusion Criteria	Literature review articles; Articles that do not address the textile and apparel industry; Articles that do not address the context of the research

questions (RQ1, RQ2, and RQ3).

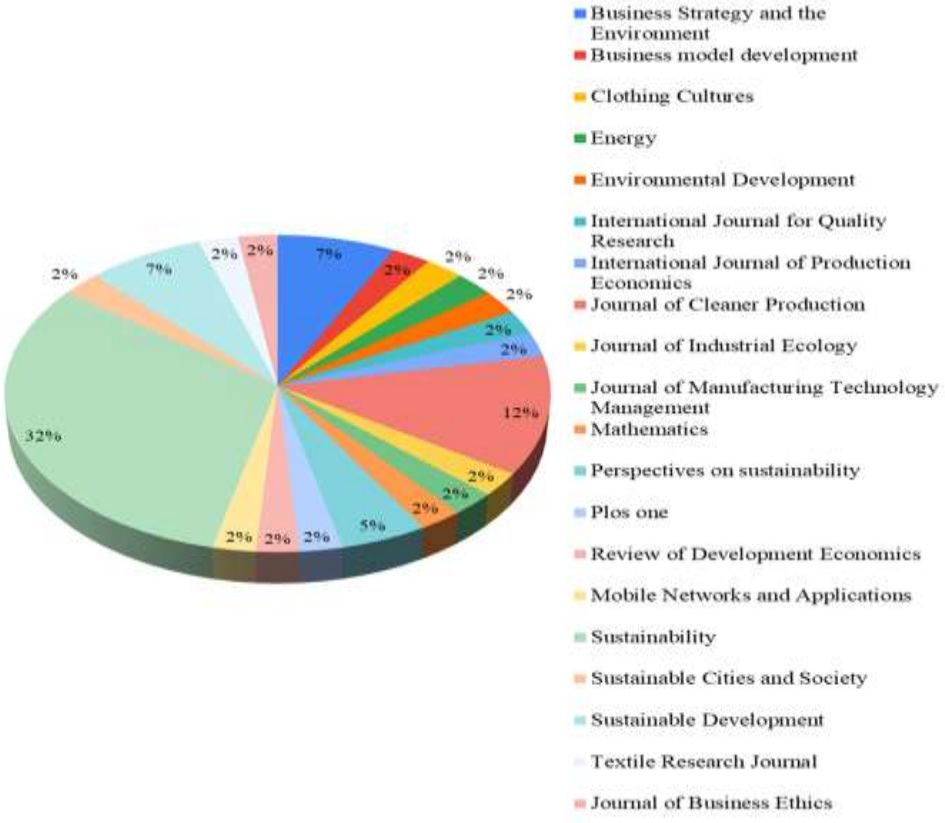
Source: The authors.

In the second phase of the research, using the snowball technique, the references of the 54 previously selected articles were examined. Applying the same inclusion and exclusion criteria, with the exception of the time frame, an additional nine articles were identified, resulting in a total of 63 articles analyzed in step 4.

Results and Discussion

The distribution of articles across scientific journals is presented in Graphic 1, with Sustainability standing out as the journal with the highest number of relevant publications on the topic, followed by the Journal of Cleaner Production.

Graphic 1 - **Publication by scientific journal**



Source: The authors.

This finding (Figure 2) highlights the academic outlets most dedicated to the theme of sustainable innovations in the textile sector, serving as a reference for researchers. It also reveals an expected alignment, as both journals are well recognized for their focus on sustainability and responsible

production, thereby validating the pertinence of the studies mapped within the research field. The concentration of publications in high-impact journals in this specific area suggests that the topic has been gaining relevance in quality academic outlets.

To provide a clearer view of the most relevant subjects, the keywords of the articles were analyzed, and a word cloud was generated (Figure 3).

Figure 2 - **Most frequently discussed topics in the SLR articles**

Source: The authors.

This lexical analysis reinforces that the literature on sustainable innovations in the textile industry is strongly aligned with the principles of the circular economy, corporate sustainability practices, and the integration of economic, environmental, and social performance.

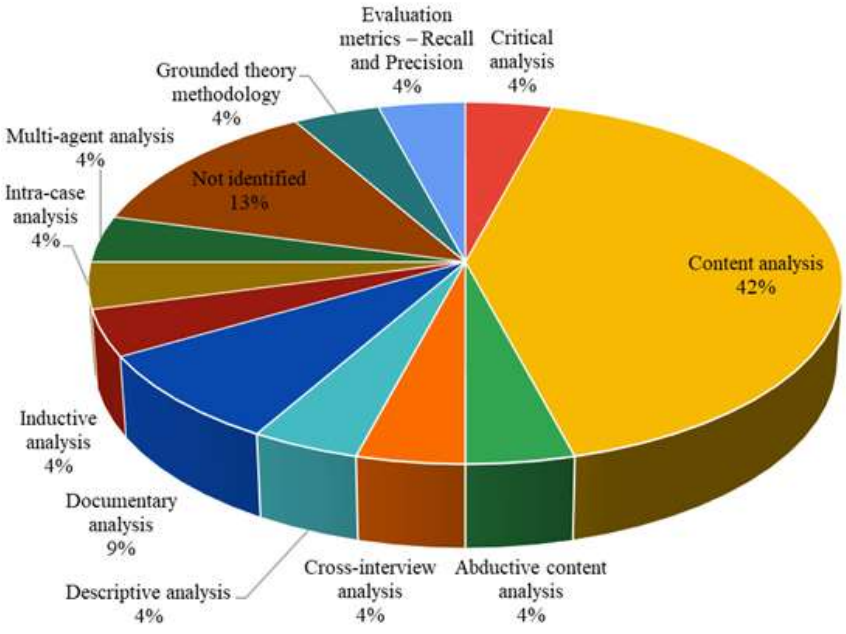
Regarding methodological approaches, 57.14% of the studies adopted a qualitative approach, 36.5% a quantitative approach, and 6.3% a mixed-methods approach. Concerning research procedures, all articles employed the case study method, either single-case or multiple-case, applied to populations composed of firms from the same sector, located in the same geographic area, or across different countries.

Graphic 2 (qualitative) and 3 (quantitative) illustrate the main methodological techniques employed in the reviewed articles, by qualitative and quantitative approach, respectively, offering insights into how research on sustainable innovations in the textile sector has been conducted.

Most qualitative studies adopted content analysis, indicating a predominance of research aimed at interpreting discourses, documents, or interviews to extract patterns and meanings. In the quantitative studies, the most recurrent techniques were inferential statistics and regression analysis, demonstrating that part of the research has advanced to hypothesis testing and causal relationship analysis, moving

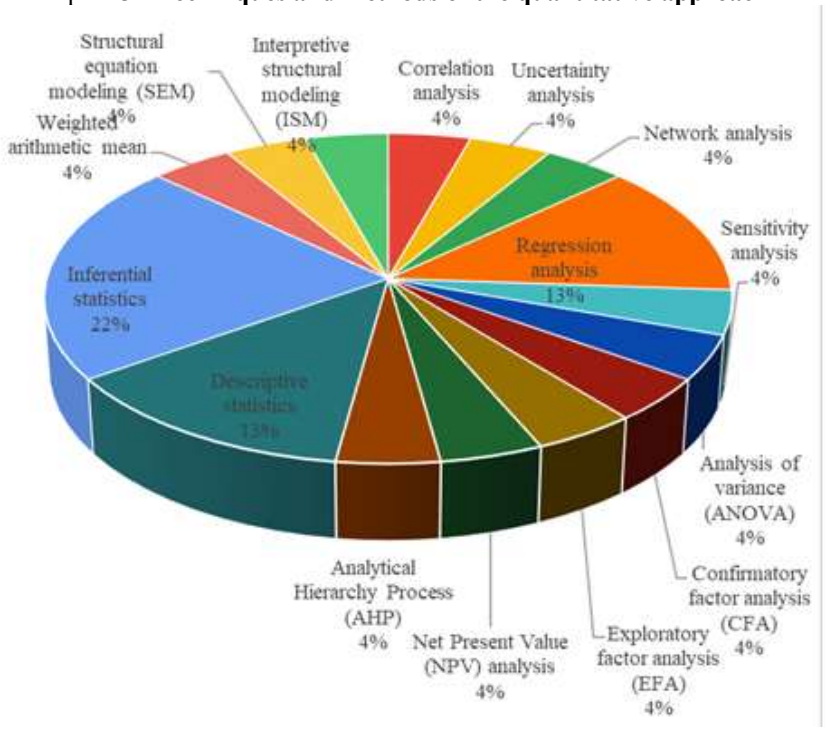
beyond the purely exploratory stage.

Graphic 2 - **Techniques and methods of the qualitative approach**



Source: The authors.

Graphic 3 - **Techniques and methods of the quantitative approach**

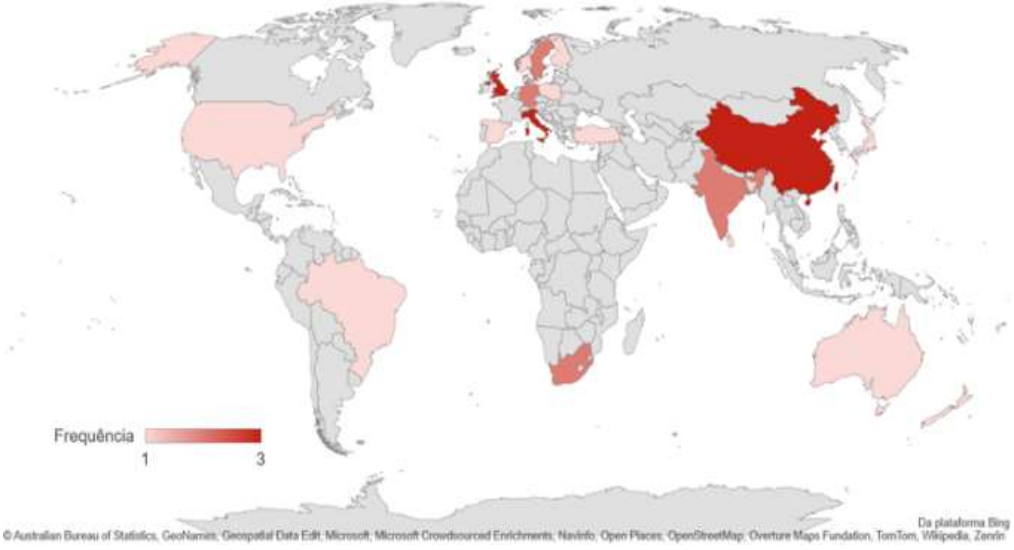


Source: The authors.

To map the geographical distribution of academic production on sustainable innovations in the

textile industry, a density map was generated (Figure 3), in which color intensity reflects the concentration of publications by the country of affiliation of the first author. The results highlight the United Kingdom, China, Italy, and Taiwan as the countries with the highest number of studies on the topic.

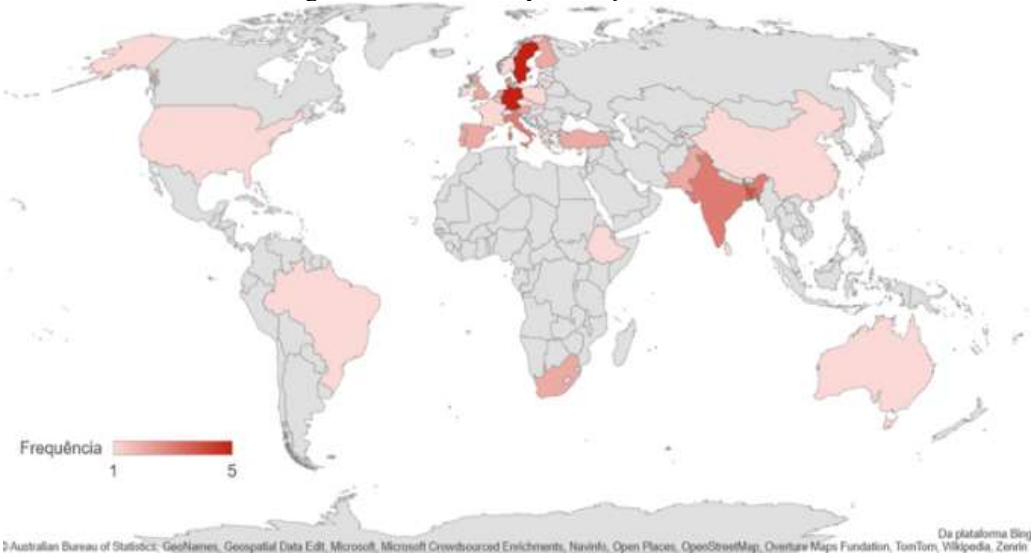
Figure 3 - **Países dos primeiros autores**



Source: The authors.

As shown in Figure 4, the countries with the greatest representativeness of companies studied in the analyzed articles are Germany, Sweden, Bangladesh, India, and Italy. This pattern both complements and contrasts with the geographical distribution of the authors (Figure 6), offering valuable insights into the relationship between academic research and practical application in the sustainable textile industry.

Figure 4 - **Países com publicações da RSL**



Source: The authors.

It is noteworthy that many researchers examine companies located in other countries, such as Germany and Sweden. This suggests that scholars from countries with a strong academic tradition are investigating cases in nations recognized either for technological innovations (Germany and Sweden) or for socio-environmental challenges in the textile supply chain (Bangladesh and India).

RQ1 – Sustainable Practices

Social Dimension

Within the internal environment of organizations, people play a central role in enhancing and implementing sustainable practices. This becomes evident when new technologies adopted by textile and apparel industries require more intensive work routines and the development of new skills by employees. Such processes enable organizational learning through shared practices, in which all actors exchange experiences related to their activities (Patora-Wysocka & Sułkowski, 2019). To ensure employees' quality of life, it is essential to promote reduced working hours in partner firms across the supply chain as well as to mitigate occupational risks (Brydges, 2021).

Externally, an alternative for remaining competitive and sustainable is the replacement of seasonal collections with timeless ones, thereby reducing solid waste. Other initiatives include the development of programs that encourage clothing rental or resale, and partnerships with emerging companies striving to achieve higher levels of sustainability. These actions extend the life cycle of garments, raise consumer awareness regarding care and preservation, and foster take-back programs (Brydges, 2021). In this sense, customers become decisive agents in organizational decision-making. Patora-Wysocka and Sułkowski (2019) emphasize that many decisions regarding sustainable practice implementation are driven by consumer demands.

When contracting suppliers, organizations adopt stricter selection criteria to minimize the distance between their teams and supply chain partners. The shorter the transportation routes, the fewer resources are required, making transactions more sustainable (Brydges, 2021; Colucci & Vecchi, 2021).

Economic Dimension

Textile and apparel companies are directly linked to material procurement, working closely with suppliers to develop sustainable products (Ashby, 2018; Christie et al., 2021).

Regarding industrial processes and materials, the reduction of energy consumption in manufacturing and the minimization of packaging use stands out as critical practices (Ahmed et al., 2018). Moreover, reducing the environmental impact of water consumption is essential, given the high demand in wet processes. Solutions such as closed-loop water systems in textile dyeing or advanced oxidation processes, which degrade biologically persistent pollutants, are available. However, such methods often entail high costs and energy consumption (Patora-Wysocka & Sułkowski, 2019). Energy consumption can be mitigated through alternatives such as solar energy, although this requires substantial investment in generation infrastructure.

Environmental Dimension

Product-focused strategies, from production to delivery, aim at implementing environmentally responsible design, reflecting a continuous improvement perspective that is common among organizations committed to environmental concerns (Ahmed et al., 2018). Consequently, hazardous chemicals must be handled responsibly, and wastewater should either be adequately treated before disposal or minimized (Patora-Wysocka & Sułkowski, 2019; Brydges, 2021).

Priority is also given to fibers with low chemical content, low energy and water demand for dyeing, and those not involving animal exploitation. Incorporating technologies that enhance the quality of eco-friendly materials is therefore critical (Patora-Wysocka & Sułkowski, 2019).

Technologies enabling greater use of renewable resources, elimination of hazardous or toxic substances in products and processes, waste reduction or reuse, and recycling whenever possible are also fundamental (Ahmed et al., 2018; Brydges, 2021; Nunes et al., 2019).

This dynamic extends to machinery: companies frequently seek more efficient engines to improve energy performance. Additional initiatives include replacing lighting systems, upgrading cooling and heating practices for machinery, improving fuel use, and replacing fossil fuels with more eco-friendly alternatives such as biomass and solar energy (Shiwanthi et al., 2018). The use of biomass as an energy source in the textile industry can reduce dependence on imported fuels, reinforcing sustainability, and can be enhanced through IoT technologies that monitor energy and water consumption (Nunes et al., 2019).

Organizational Dimension

From a management perspective, communication with suppliers is a key factor, especially through the establishment of traceability systems. This practice enables transparency, providing the organization with information on the internal processes of its partners and ensuring that raw materials are sustainably sourced, from extraction to delivery. Such monitoring allows companies to verify compliance with their sustainability requirements and guarantees that customers receive products aligned with their business models (Warasthe et al., 2020; Friedrich, 2021).

In this context, monitoring and control through the Internet of Things (IoT) have become increasingly common in both internal and external processes (Nunes et al., 2019). Likewise, blockchain technology has emerged as a tool for ensuring transparency and traceability, supporting sustainability in the textile and apparel supply chain, although its adoption is still at an early stage (Haddud et al., 2017; Ahmed & MacCarthy, 2021). Another promising practice is the redesign of supply chain networks to reduce carbon emissions, which has proven to be a feasible alternative for achieving sustainability (Ahmed et al., 2018).

Such practices support the strengthening of long-term relationships within the supply chain, supplier development, and improved communication, factors regarded as essential for economic sustainability and valued by both retailers and manufacturers. Conversely, in terms of environmental and social sustainability, cooperation among supply chain actors is considered a key element (Warasthe et al., 2020).

The positioning of partnerships within the production chain is also highly relevant to

sustainability. For instance, reducing the social impact of firms can involve shorter working hours and improved occupational safety, such as increasing the availability of fire extinguishers, thus reinforcing the social pillar of sustainability (Brydges, 2021).

In the same vein, Brydges (2021) highlights the use of natural fibers and the reduction of fabric blends as sustainable practices. Other recommendations include assessing the impact of production processes to support managerial decision-making regarding the implementation of textile recycling programs. Such initiatives promote circularity and reduce the amount of textile waste sent to landfills, a critical practice for industries pursuing recycling as a sustainability strategy.

Finally, the implementation of ISO 14001 certification is presented as an alternative for embedding sustainable practices. This certification fosters the adoption of shared practices and promotes environmental education among managers and employees (Zimon, 2020). Considering that the textile and apparel industry is recognized for its high pollution potential, investment in sustainable practices is indispensable (Moreira et al., 2023).

Internal and External sustainable practices the textile and apparel industry were categorized into four dimensions (social, economic, environmental, and organizational) and are summarized in Tables 2 and 3, respectively.

Table 2 - **Internal sustainable practices**

	Description	**Author (year)**
Social	New worker capability routines.	Patora-Wysocka & ZSułkowski (2019).
	Shared organizational learning.	
	Supplier selection.	Colucci & Vecchi (2021).
	Reducing the distance between the team and raw material suppliers.	Brydges (2021).
Economic	Reduction of energy consumption in manufacturing.	Ahmed *et al.* (2018).
	Reduction in the amount of packaging.	
Environmental	Proper handling of chemical materials.	Patora-Wysocka & Zsułkowski (2019).
	Use of fibers with low chemical content.	
	Low energy use.	
	Low water uses in dyeing processes.	
	Fibers that do not affect animal existence.	
	Increase the use of renewable sources.	Ahmed *et al.* (2018).
	Eliminate/reduce hazardous/toxic materials in products.	
	Eliminate, reduce, or reuse manufacturing waste.	
	Eliminate/reduce hazardous/toxic chemicals in manufacturing processes.	
	Recycling of materials.	
	Promote the use of natural fibers while reducing the use of fabric blends.	Brydges (2021).
	Reduce the use of chemicals.	
	Limit the use of wastewater.	

	Biomass as an energy source.	Nunes *et al.* (2019).
	Monitoring and control through the Internet of Things (IoT).	
	Technologies to improve the quality of eco-friendly materials.	Patora-Wysocka & Zsułkowski (2019).
Organizational	Measuring the impact of production processes.	Brydges (2021).
	Introduce textile recycling programs to support textile circularity and reduce landfilling.	
	Partnerships with intermediaries to improve monitoring.	
	Replace seasonal collections with seasonless collections.	
	Blockchain technology.	Haddud *et al.* (2017) Ahmed & MacCarthy (2021).
	Implementation of environmentally oriented design in product development.	Ahmed *et al.* (2018).
	Redesign the supply chain network to reduce carbon emissions.	
	Optimization of transportation operations.	
	Process-optimizing business engines.	Shiwanthi *et al.* (2018).
	Supply chain relationships.	Warasthe *et al.,* (2020). Brydges (2021).
	Production chain relationships.	

Source: The authors.

Table 3 - **External sustainable practices**

	Description	**Author (year)**
Social	Reduction of working hours for supply chain partners' labor.	Brydges (2021).
	Reduction of risks to workers.	
	Develop programs that encourage clothing rental or resale, or partnerships with growing companies to extend clothing life cycles.	
	Raise consumer awareness about practices to extend product lifespan.	
	Introduce or expand take-back programs for clothing.	
Economic	Engagement of companies and suppliers in purchasing more sustainable materials.	Ashby (2018); Christie *et al.* (2021).
	Reduce the impact of water resource use.	Patora-Wysocka & Zsułkowski (2019).
Environmental	NOT IDENTIFIED IN THIS RSL	
Organizational	Implementation of ISO 14001.	Zimon (2020).
	Supplier management systems.	Friedrich (2021).
	Supply chain traceability.	Warasthe *et al* (2020).
	Self-monitoring.	

Source: The authors.

RQ2 – Drivers

Social Dimension

Organizations seek to adopt or enhance sustainable practices due to both internal and external factors (Köhler & Som, 2014; Armstrong et al., 2015; Schellenberger et al., 2019). Among these factors, Peters & Simaens (2020) highlight that employees' personal values and the top management's environmental commitment directly influence decision-making.

Another relevant factor for the implementation of such practices is the observation of the external environment, particularly customers' preferences at the time of purchase. Increasing consumer awareness has evolved from indifference to demanding more sustainable products, becoming a decisive criterion in purchasing decisions (Ashby, 2018; Patora-Wysocka & Sułkowski, 2019; Peters & Simaens, 2020; Oelze et al., 2020; Warasthe et al., 2020; Moreira et al., 2023).

Thus, customers act as key drivers of sustainable measures in companies (Warasthe et al., 2020), along with society at large. Social pressures, as well as those from suppliers and non-governmental organizations (NGOs), contribute to enhancing organizational legitimacy and compliance with sustainable regulations (Peters & Simaens, 2020).

Economic Dimension

Sustainable design can be an essential factor for achieving cost savings in production and ensuring consumer acceptance of prices (Sandvik & Stubbs, 2019). Moreover, the implementation costs of sustainability-oriented actions directly affect companies' receptivity to such changes. The lower the investment required for adopting sustainable innovations, the greater the likelihood that companies will embrace them (Angelis-Dimakis et al., 2016).

These economic drivers create competitive advantage, foster firm internationalization, and generate commercial benefits arising from sustainable supply chain management (GSCM), thereby reinforcing the decision to adopt sustainable practices (Peters & Simaens, 2020).

Environmental Dimension

Among the environmental drivers, energy savings—such as those resulting from the adoption of photovoltaic energy—stand out, along with the acquisition of more efficient machinery with lower water consumption (Moreira et al., 2023), the use of biodegradable materials, and the replacement of synthetic fibers with natural ones. These actions have been further encouraged by government interventions, such as the promotion of bioplastics, which have a reduced environmental impact. Hence, public regulations emerge as significant enablers of sustainable innovation in the textile and apparel industry (Sandvik & Stubbs, 2019; Achabou et al., 2020; Friedrich, 2021).

Organizational Dimension

It is inevitable that companies pursue sustainable business strategies, as globalization acts as a

pressure factor for adapting to the sustainable system. This occurs, for example, through the implementation and control of the value chain, which drives organizations' strategic repositioning (Ashby, 2018; Patora-Wysocka & Sułkowski, 2019; Oelze et al., 2020; Peters & Simaens, 2020; Warasthe et al., 2020). Another strategy involves the mechanization of raw material separation processes, which contributes to greater efficiency in product delivery (Moreira et al., 2023).

The internal and external drivers that may foster the implementation of sustainable practices in the textile and apparel industry are summarized in Tables 4 and 5, respectively.

Table 4 - **Drivers: Internal Factors**

	Description	**Author (year)**
Social	Employees' personal values	Peters & Simaens (2020).
	Environmental commitment of top management	
Economic	Source of competitive advantage	Peters & Simaens (2020).
	Expected commercial benefits from GSCM implementation	
Environmental	Reduction of energy expenditure	Moreira *et al.* (2023).
Organizational	Efficiency in product delivery	Moreira *et al.* (2023).

Source: The authors.

Table 5 - **Drivers: External Factors**

	Description	**Author (year)**
Social	Social pressure	Peters & Simaens (2020).
	Gaining legitimacy and regulatory compliance	
	Pressure from suppliers	
	Pressure from NGOs	
	Pressure from customers	
	Regulatory bodies requiring waste treatment and filtration	Brydges (2021); Saha *et al.* (2021).
	Consumer demands	
	Customer requirements	Ashby (2018); Patora-Wysocka & ZSułkowski (2019); Peters & Simaens (2020). Oelze *et al.* (2020); Warasthe *et al.* (2020); Moreira *et al.* (2023).

Economic	Cost savings in production and consumer price acceptance	Sandvik & Stubbs (2019).
	Implementation costs	Angelis-Dimakis *et al.* (2016).
Environmental	Use of biodegradable materials	Brydges (2021).
	Replacement of synthetic fibers	
	Government regulations	Achabou *et al.* (2020). Sandvik & Stubbs (2020). Friedrich (2021).
Organizational	Globalization	Ashby (2018); Peters & Simaens (2020).

Source: The authors.

RQ3 – Barriers

Social Dimension

Textile and apparel industry companies face internal barriers, such as technological limitations, financial constraints, lack of know-how, and resistance from top management, as well as external barriers, including insufficient economic support, customer pressures, government policies, and difficulties in accessing technology. Additionally, there are factors that can manifest both internally and externally, such as management and decision-making, workforce challenges, design constraints, material selection, regulations, technical infrastructure, knowledge about the socio-environmental impacts of innovation, awareness of sustainability's importance, costs, and the need for integration and collaboration among partners (Stevenson & Cole, 2018; Kazancoglu et al., 2020; Muhardi et al., 2020).

One of the main social obstacles is the lack of awareness among professionals regarding sustainable demands, hindering decision-making (Saha et al., 2021). On the institutional side, although governments establish regulatory policies, they still pose barriers in the context of global supply chains, as they vary between countries in terms of labor and environmental legislation (Kazancoglu et al., 2020).

In this scenario, some companies adopt technological solutions, such as radio-frequency identification (RFID), to optimize goods flow and retail distribution (Patora-Wysocka & Sułkowski, 2019). However, suppliers resistant to sustainable requirements can become an additional obstacle, requiring companies to persuade them to adopt more responsible practices.

Other barriers include inadequate infrastructure, poor working conditions, challenges in value chain management, and the trade-off between quality and durability (Peters & Simaens, 2020). A significant portion of production is concentrated in Asian countries, where labor law enforcement is limited, increasing the need for corporate oversight to ensure socially responsible practices. This effort, however, raises labor costs, creating tensions between social and ecological objectives (Peters & Simaens, 2020; Colucci & Vecchi, 2021).

On the consumption side, barriers include customer behavior, which often rejects alternative

models such as clothing rentals due to cultural perceptions of personal garment use and price comparisons between rented and purchased clothing (Holtström et al., 2019; Kazancoglu et al., 2020). Consumers' lack of understanding of sustainability information also compromises purchasing decisions, hindering the consolidation of sustainable strategies.

Economic Dimension

The adoption of sustainable practices is often limited by a lack of knowledge and economic feasibility. Implementing the circular economy requires high investments, restricting companies' ability to adapt (Saha et al., 2021). Low-priced products represent another barrier, as they encourage consumers to choose conventional, non-sustainable alternatives (Peters & Simaens, 2020; Roy et al., 2019).

In this context, cost functions as a trade-off: sustainable practices entail high costs and uncertain returns, while conventional practices preserve profit margins. Often, additional costs cannot be passed on to consumers, compromising competitiveness (Peters & Simaens, 2020; Colucci & Vecchi, 2021). More than the high prices of sustainable products, the issue lies in the excessive affordability and low prices of conventional products (Brydges, 2021).

The economic conditions of producing countries also play a role, as each market has its own pricing and competitiveness dynamics (Peters & Simaens, 2020). Additionally, companies lack economic support and access to sustainable technologies, both of which remain insufficient to enable the transition (Kazancoglu et al., 2020).

Environmental Dimension

In the environmental sphere, stakeholders play an ambiguous role, either supporting or hindering sustainability. A recurring factor is the distance between suppliers and retailers, which compromises supply chain efficiency and amplifies social and environmental impacts. Thus, shorter supply chains are seen as essential to strengthening sustainability (Warasthe et al., 2020; Peters & Simaens, 2020).

Another challenge is the difficulty in measuring environmental impacts. Although many companies recognize the importance of monitoring indicators such as carbon emissions, time and resource constraints limit their ability to conduct consistent measurements, delaying the implementation of circular practices (Brydges, 2021).

Organizational Dimension

Internally, organizational barriers are related to technological limitations (data processing and technical infrastructure), financial constraints (high investments in equipment and processes), and cultural factors, such as resistance from top management and owners. These resistances hinder both decision-making and the development of long-term sustainable business models (Kazancoglu et al., 2020; Peters & Simaens, 2020).

The transition to more sustainable materials also represents an organizational challenge. Replacing synthetic fibers with natural ones, for example, involves technical design barriers and performance

limitations (Patora-Wysocka & Sułkowski, 2019; Kazancoglu et al., 2020). Furthermore, differing rules and regulations between countries directly impact value chain management, exacerbating difficulties related to the trade-off between quality and durability (Patora-Wysocka & Sułkowski, 2019; Kazancoglu et al., 2020; Peters & Simaens, 2020).

Both internal and external barriers are summarized in the Tables 6 and 7, respectively.

Table 6 - **Barriers: Internal Factors**

	Description	**Author (year)**
Social	Know-how.	Stevenson & Cole (2018); Kazancoglu, *et al.* (2020); Muhardi *et al.* (2020).
	Integration between companies.	
	Collaboration between companies.	
	Sustainability awareness.	Stevenson & Cole (2018); Kazancoglu, *et al.* (2020); Muhardi *et al.* (2020); Saha *et al.* (2021).
Economic	Cost.	Kazancoglu *et al.* (2020).
	Economic and financial feasibility.	Saha *et al.* (2021).
	Price.	Holtström *et al.* (2019); Peters & Simaens (2020); Brydges (2021).
	High-cost water recovery procedures.	Patora-Wysocka & Zsułkowski (2019).
Environmental	Time for carbon emission measurement.	Brydges (2021).
Organizational	Technological barriers.	Kazancoglu *et al.* (2020).
	Financial barriers.	
	Resistance from top management.	
	Management and decision-making.	
	Design challenges.	
	Technical infrastructure.	
	Circular economy model.	Kazancoglu *et al.* (2020); Peters & Simaens (2020).
	Data processing.	Saha *et al.* (2021).
	Tratamento de dados.	Peters & Simaens (2020).

Source: The authors.

Table 7 - **Barriers: External Factors**

	Description	**Author (year)**
Social	Government.	Kazancoglu *et al.* (2020).
	Customers.	Holtström *et al.* (2019); Kazancoglu *et al.* (2020).
	Stakeholders.	Holtström *et al.* (2019).
	Distance between suppliers and retailers.	Warasthe *et al.* (2020); Peters & Simaens (2020).
	Consumer behavior.	Peters & Simaens (2020).
	Labor laws in producing countries.	Peters & Simaens (2020); Colucci & Vecchi (2021).

Economic o	Lack of economic support.	Kazancoglu *et al.* (2020).
	Access to technology.	
	Economic situation of producing countries.	Peters & Simaens (2020).
Environmental	Rules and regulations.	Warasthe *et al.* (2020); Peters & Simaens (2020).
Organizational	Materials.	Kazancoglu *et al.* (2020); Peters & Simaens (2020).
	Trade-off between quality and durability.	
	Value chain management.	Patora-Wysocka & Sułkowski (2019); Kazancoglu *et al.* (2020); Peters & Simaens (2020).
	Trade-off entre qualidade e durabilidade.	
	Gestão da cadeia de valor.	Peters & Simaens (2020).

Source: The authors.

Final considerations

This systematic literature review identified various sustainable actions, or practices, adopted by the textile and apparel industry to minimize negative impacts and meet stakeholder demands. The main motivations and barriers associated with implementing these practices were also analyzed.

Some practices are introduced to optimize workflows, promoting organizational learning. Reducing working hours, for example, has proven effective in decreasing fatigue and improving workers' quality of life. Another optimization strategy is mitigating environmental impacts by sourcing from suppliers that share the same sustainability goals and are geographically closer, reducing fossil fuel consumption in material transportation.

To enhance control over the origin and handling of sustainable materials, many organizations have adopted tracking systems and blockchain technology to ensure the sustainability of raw materials and final products. Thus, transparency and stronger supply chain relationships become fundamental pillars for promoting sustainability in this sector.

Regarding production processes, the industry has been striving to align with the 5R's of sustainability (Reduce, Reuse, Recycle, Rethink, and Refuse). Efforts include reducing non-renewable energy and water consumption, as well as minimizing pollutant generation. Initiatives such as wastewater pre-treatment and closed-loop recycling systems have been adopted, though the latter still entails high costs. Additionally, there is a growing trend of replacing synthetic fibers with natural ones, which require less water for dyeing and consume less energy. Promoting material circularity is also a priority.

Among the key drivers for adopting sustainable practices, consumers stand out. Increasing demand for sustainable products and active monitoring of corporate practices by customers pressure the industry to adopt more responsible positions. This scrutiny across the supply chain pushes all stakeholders to align with sustainability principles. Furthermore, leadership commitment and employee engagement also play crucial facilitating roles, though a lack of knowledge and awareness remains a significant barrier in some organizations.

The government's role is ambiguous: while it acts as an enforcer by demanding more sustainable practices and imposing stricter environmental and social regulations, it can also be a barrier, particularly when norms and legislation vary significantly between countries. For instance, in Asia, low wages and skilled labor keep production costs down but compromise the social aspects of sustainable development.

Another key aspect is the pursuit of energy cost reduction. The adoption of photovoltaic energy has intensified as a long-term resource-saving alternative. However, the high initial implementation cost remains an obstacle for many organizations. This challenge also extends to sustainable goods production: to offer an environmentally responsible product, companies must invest in exclusive processes, which may increase the final price. Consequently, sustainable products compete in the market with cheaper conventional alternatives, potentially influencing consumer purchasing decisions negatively.

Thus, this systematic literature review provided a comprehensive overview of how the textile and apparel industry has responded to demands for innovation and sustainability, in line with sustainable development principles. The key drivers and barriers influencing the adoption of sustainable practices in this sector were highlighted. For future research, conducting local case studies with primary data collection is suggested to investigate emerging practices and deepen the understanding of factors that facilitate or hinder their implementation.

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