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REGULAR ARTICLE

Traceability in the cotton textile chain: from rural producer to end consumer

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Abstract

This study systematically reviews the literature on traceability in the cotton textile chain to investigate its scope in all chain links and its relationship with adding value to the product. The analysis included 31 articles published between 2014 and 2024, identified on the Scopus database. The results showed a significant emphasis on the Production and Industrialization links, with 87.1% of the articles focusing on these stages, while Retail and Consumer received limited attention. It was found that traceability adds value through transparency, sustainability, authenticity, and technological innovation, but lacks greater integration and communication in the final links. The study highlights the need for a holistic approach that aligns traceability practices with market demands for sustainability, trust, and social responsibility.

Keywords

Traceability; Textile chain; Cotton; Adding Value; Supply chain.

Introduction

The growing demand for transparency and sustainability in production chains has driven companies in various sectors to adopt traceability systems, to ensure the origin and ethical production conditions of their products. In the textile sector, this demand is particularly significant due to the social and environmental impacts associated with the production of natural fibers such as cotton, which is widely used on a global scale (Agrawal et al., 2021; Fraser & Van Der Ven, 2022).

This phenomenon not only responds to regulatory pressures but also reflects a change in consumer behavior, who now values products whose origin and production methods are traceable and transparent, i.e., communicated (McNeill et al., 2023).

Traceability offers several strategic benefits for companies, including the possibility of monitoring the entire supply chain and recording each stage of the process, from agricultural production to arrival at the consumer. According to Bullón Pérez et al. (2020), these systems allow companies to meet market expectations for more ethical and sustainable practices, while strengthening their corporate image.

For companies in the textile sector, the implementation of traceability makes it possible not only to improve quality control processes, but also to comply with global sustainability and social responsibility standards, as illustrated by Hader et al. (2022) in their studies on the integration of Blockchain and Big Data technologies.

These technological innovations not only facilitate the precise tracking of cotton along the chain but also meet the demand for transparency among consumers, who want detailed information about the origin and processes involved in the production of the goods they consume (Liang & Zhang, 2024).

According to Porter (1985), value creation is essential for sustainable competitive advantage, and in the context of production chains, especially in the textile chain, adding value through traceability practices offers a significant differentiator. As elucidated by Zeithaml (1988), the consumer's perception of value is a subjective evaluation, based on a comparison between the benefits received and the perceived costs.

In the case of traceable cotton, this perception is heightened not only by the product's functionality but also by its associated social and environmental values. Liang and Zhang (2024) argue that traceability in the cotton sector meets this growing demand for responsible production practices, which translates into added value that goes beyond the product itself, involving ethical and sustainability issues that are increasingly appreciated by consumers.

This relationship demonstrates how traceability in the cotton textile chain can contribute to a variety of United

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Nations Sustainable Development Goals (SDGs), such as SDG 12 - Responsible Consumption and Production, where traceability is linked to transparency in the production chain, allowing consumers to make more conscious and sustainable choices and SDG 13 - Action against Global Climate Change: where traceability can help monitor and reduce the environmental impact of the cotton production chain, encouraging more sustainable practices and reducing the carbon footprint of textile products. (UN 2022)

The textile sector, however, still faces challenges in implementing fully integrated traceability. As Fraser and Van Der Ven (2022) point out, while cotton production and industrialization have been widely addressed, the final stages, such as retail and final consumption, remain under-explored.

This gap suggests the need for a more holistic approach that encompasses all links in the chain and allows for complete traceability, from the rural producer to the final consumer (Alves et al., 2024). Furthermore, as shown by Kumar et al. (2017), traceability in the cotton sector becomes a fundamental tool not only to monitor sustainability and environmental compliance, but also to build consumer confidence in an increasingly competitive market.

In this context, it is important to investigate how the implementation of traceability systems in the cotton textile chain impacts the value perceived by consumers, and how these practices that are discussed in the literature can contribute to corporate image and sustainability in the sector. To this end, this article aims to investigate the relationship between traceability and added value in the cotton production chain.

Materials and methods

This study consisted of a systematic literature review following the Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) statement 16 with the objective of answering the following question: Has traceability in the cotton textile chain reached all links in the supply chain?

The database used for the research was SCOPUS, which includes a wide range of peer-reviewed scientific literature from various fields, including innovative and recent studies, providing important insights for the textile industry (Elsevier, 2022; Clarivate, 2022).

The search was carried out in July 2024, and included articles published in journals, using a ten-year time window, between (2014 and 2024) that addressed and made a connection between traceability, cotton, and the textile chain, published in English, Spanish and Portuguese.

For the systematic review, search strings were established integrating the different themes related to traceability in the cotton textile chain. The following search strings were used: “traceability” OR “textile supply chain” OR “cotton”.

A total of 64 documents were identified and after reading the abstracts and keywords, 18 articles were excluded as they did not meet the inclusion criteria for the study. The remaining 46 documents were downloaded and of these, 12 were not available for access and were therefore excluded from the review, as shown in Table 1.

The remaining 34 articles were read in full, and it was identified that 3 of them dealt with traceability in the textile industry but analyzed another type of fiber and were therefore excluded. The final sample consisted of 31 articles on traceability in the textile industry, ten of which did not specify cotton fiber, but after reading, it was understood that it could also be used in the cotton textile industry.

The selected articles were analyzed in a descriptive manner, based on a qualitative approach that allows for an in-depth exploration of the practices and challenges of traceability in the cotton textile chain. This process involved the systematic extraction of relevant data, organizing the main results and conclusions about the relationship between traceability and adding value. The methodology used, as proposed by Yin (2022) in his guidelines for qualitative research, enables a comprehensive and detailed analysis, identifying areas that need greater attention to ensure complete and effective traceability.

In addition, Creswell and Creswell (2018) reinforce that descriptive analysis in qualitative studies is essential to capture nuances and specific contexts, which enriches the understanding of how technologies such as Blockchain and Big Data are being applied in the textile sector (Agrawal et al., 2021; Hader et al., 2022). This detailed methodological approach makes it possible to highlight gaps and opportunities, contributing to a more holistic understanding of traceability practices and their implications for sustainability and transparency in the production chain.

Results and discussion

The results of the analysis of the 31 articles selected show a clear trend in relation to the focus of studies on the cotton textile chain. The temporal analysis reveals that most publications are concentrated in recent years, with 25.80% of the articles published in 2024, highlighting a growing interest and relevance of the topic in recent years. The years 2021 and 2022 were also significant, each contributing with12.90% of the publications.

The older articles, such as those by Kubler et al. (2014), Gobbi and Massa (2015) and Kumar, Koehl and Zeng (2016), focus on management methodologies and technological improvements within the textile supply chain, with an emphasis on operational efficiency and compliance with traceability standards. In contrast, more recent articles, such as those by Hader et al. (2022), Tolentino-Zondervan and DiVito (2024), and Wang et al. (2024), reflect a significant advance in the application of emerging technologies, such as Blockchain, Big Data and NFTs, to improve traceability.

These innovations show a clear evolution in the priority given to digitalization and transparency in textile supply chains, aligning with contemporary demands for greater corporate responsibility, as shown in Figure 1.

Table 1. Describes the article selection process in the systematic review.

STAGE	DESCRIPTION	NUMBER OF ARTICLES
1. Identification	Initial search in databases (SCOPUS) using keywords (in Portuguese and English) related to traceability, cotton and the textile chain (2014-2024).	64
2. Initial screening	Reading of titles and abstracts to identify relevance to the topic.	64
3. Exclusion after Screening	Articles excluded because they did not meet the inclusion criteria (topic out of focus, duplicate articles).	18
4. Selection for Full Reading	Articles selected for full reading, after excluding irrelevant ones.	46
5. Exclusion after Full Reading	Articles excluded due to lack of access or because they did not deal directly with traceability in cotton.	115 (12 without access, 3 on other fibers)
6. Final Sample	Total number of articles included in the final analysis, with a focus on traceability in the textile chain, even if they do not specify cotton fiber directly.	31
7. Articles Analyzed and Used	Articles which, after thorough reading, were considered relevant for analysis and met the inclusion criteria.	31

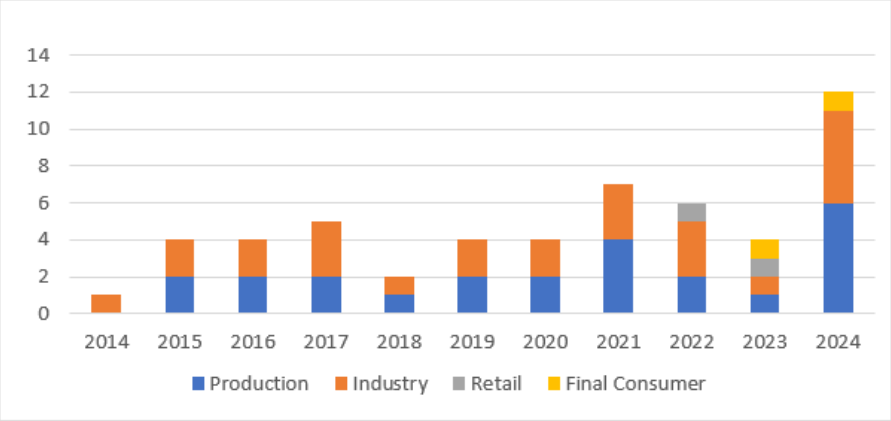

Figure 1. Links in the textile chain studied from the point of view of traceability over a 10-year period (2014-2024).

Production was covered in 24 of the 31 articles, while industry was covered in 25 articles. This reflects significant emphasis on the initial stages of the production chain, possibly due to the complexity and challenges associated with tracing the entire textile chain. The focus of these articles is on the development and application of technologies (forms) for the traceability of cotton, seeking to guarantee the identification of lots in the event of problems at the production stage, highlighting the use of emerging technologies such as Blockchain, RFID, and deep learning to improve efficiency and transparency throughout the textile supply chain.

According to Hader et al. (2022), the integration of Blockchain and Big Data facilitates the detailed tracking of each lot, ensuring that all relevant data is available for the identification of possible problems. Similarly, Agrawal et al. (2021) reinforce that Blockchain-based frameworks provide continuous traceability, ensuring that information on the origin and route of cotton lots is accessible to all links in the chain.

Wang et al. (2019) demonstrate that the use of pattern recognition and deep learning in coding labels improves lot identification accuracy, while Oliveira et al. (2017) emphasize the importance of RFID technology to ensure real-time tracking. In addition, Foroughi et al. (2020) highlight the use of wearable sensors to signal the source of products, adding an additional level of security and reliability to the traceability of cotton lots. These technological innovations have proved crucial in ensuring that, in the event of production problems, lots can be quickly identified and traced, minimizing negative impacts along the textile chain.

Retail was only mentioned in the article by Fraser and Van Der Ven (2022), which talks about transparency in global supply chains, especially in the fast fashion industry. The authors highlight how traceability has played an essential role in improving sustainable practices and reducing environmental impacts, and how the implementation of

technologies such as blockchain could be a solution to improving traceability throughout the supply chain.

The end consumer appears in isolation in a single article published in 2023, where McNeill, Potdar and McQueen (2023) discuss the preferences of high-volume fashion consumers for sustainable clothing choices. The authors highlight the importance of prioritizing sustainability in these consumers' purchasing decisions, exploring factors that influence these choices.

In addition, only one article published by Luís Alves et al. (2024) addressed all links in the chain, discussing the creation of a traceability platform aimed at monitoring environmental and social sustainability in the textile and clothing value chain. The authors propose using Blockchain technology to trace batches of textile products along the chain.

This disparity in the coverage of the links in the textile chain indicates that, although traceability is being widely discussed, there is concentration on the production and industrialization phases, with little emphasis on the final stages that connect the product to the consumer. This may point to the need for a more holistic approach that includes all the links in the chain, ensuring that traceability covers everything from the origin of cotton to the moment the product reaches the hands of the end consumer. The analysis also reveals that the final links in the chain, such as retail and the consumer, remain relatively unexplored (Fraser & Van Der Ven, 2022; McNeill et al., 2023).

The integration of all links is essential to meet the transparency, and sustainability demands of the modern market, enabling a more comprehensive and detailed view of the entire production process (Hader et al., 2022; Liang & Zhang, 2024). This is crucial to ensure that the end consumer has access to complete and reliable information about the origin and trajectory of cotton textile products, increasing trust and perception of value (Foroughi et al., 2020; Agrawal et al., 2021).

Traceability and value adding

The analysis of the 31 articles selected shows the relationship between traceability in the cotton textile chain and adding value to the product, as can be seen in Table 2. The review revealed that 87.10% of the articles use the terms “traceability” and “textiles”, while the term “cotton” appears in only 25.8% of the articles (Foroughi et al., 2020; Fraser; Van Der Ven, 2022). This disparity in frequency suggests that, although traceability is widely discussed, the word cotton is not as recurrent as expected, even if the published article is talking about this type of fiber, highlighting the need for greater emphasis on the specific added value for this fiber in the context of the global textile industry (Hader et al., 2022).

In addition, 74.20% of the articles explicitly mention the terms “added value” or “product increase in value”, which points to a considerable interest in product appreciation along the textile chain (Agrawal; Pal, 2021; Ahmed; Maccarthy, 2021). However, 25.80% of the articles do not directly address the concept of added value, which suggests a gap in the literature regarding the explicit connection between traceability and economic or market benefits, especially in the final stages of the chain (Bullón Pérez et al., 2020).

It was also found that 90.30% of the articles (28 out of 31) make a clear connection between traceability and a factor that adds value to the product, Transparency. Traceability allows consumers and companies to follow the origin of materials and production processes, promoting a perception of transparency and social responsibility. This factor is often cited as a competitive differentiating factor that generates consumer confidence, especially in sectors where ethical practices are a growing concern (Alves, 2024; Hader et al., 2022).

Sustainability: The association between traceability and sustainable practices adds value to the product by showing an environmental commitment. Technologies such as Blockchain and Big Data help to document sustainable practices at all stages of production, especially in the production and industrialization phases (Oliveira; Pinotti; Lopo, 2017). Product Quality and Safety: Traceability ensures that the product meets quality and safety standards, which can add value to the eyes of consumers. RFID, for example, is used to monitor the quality and integrity of products throughout the supply chain, minimizing risks of contamination or adulteration (Mao; Wang; Li, 2024). Authenticity and Combating Counterfeiting: For products such as cotton, where authenticity is a concern, traceability helps to confirm the origin and authenticity of the material. This factor is particularly relevant in combating fraud and strengthening brand image (Chen et al., 2024). Innovation and Technology: The incorporation of advanced technologies such as Blockchain, Big Data and RFID also contributes to the company's image of innovation, adding value through differentiation in the market.

Emphasizing the perception that traceability not only guarantees transparency but is also a competitive differentiator that adds value to the product (Alves., 2024; Mao; Wang; Li, 2024). The application of technologies such as Blockchain, Big Data and RFID shows that traceability is mainly associated with the production and industrialization stages, where the aim is to ensure the origin and quality of products, as well as guaranteeing sustainability (Oliveira; Pinotti; Lopo, 2017; Hader et al., 2022).

On the other hand, 9.70% of the articles (3 out of 31) do not directly associate traceability with adding value. The three articles that do not directly associate traceability with adding value, Kubler et al. (2014), Huang et al. (2024), and Mao et al. (2024), share some common characteristics that help explain this absence. They all have a technical focus on material performance and analysis, with an emphasis on data classification methodologies and optimizing fabric use. Kubler et al. (2014) and Mao et al. (2024) focus mainly on the analysis of material characteristics, such as the state of performance and resistance, without exploring how these technical aspects could contribute to a product's market value through traceability.

Table 2 shows the distribution of the articles reviewed over the years, indicating the focus of each article on the different links in the textile chain, such as Production, Industrialization, Retail and Consumer, demonstrating research trends and the links most explored in relation to traceability and added value in the cotton textile chain.

Table 2. Distribution of articles analyzed by year and link in the cotton textile chain (2014-2024).

ARTICLE TITLE	AUTHORS	YEAR	SECTOR STUDIED	EXPRESSION "ADDING VALUE" OR "VALORIZATION"	RELATIONSHIP BETWEEN TRACEABILITY AND ADDING VALUE	STAGE OF THE TEXTILE CHAIN
Group fuzzy AHP approach to embed relevant data on "communicating material"	Kubler, Voisin, Derigent, Thomas, Rondeau, Främling	2014	Textile Industry and Communication Technology	No	No directly	Industry
Supply Chain Transparency as a Consumer or Corporate Tool: The Case of Nudie Jeans Co	Egels-Zandén, Hansson	2015	Textile Industry (Jeans and Clothing)	Yes	Yes, transparency and traceability are presented as factors that can increase consumers' willingness to buy, adding value to the product.	Production and Industry
Supply chain management in textile sector: the case of the Italian T-fashion traceability system	Laura Gobbi, Ilaria Massa	2015	Textile Industry	Yes	Yes, traceability is discussed as a mechanism that can increase consumer confidence and improve transparency, adding value to textile products.	Production and Industry
Supply Chain Strategies for Quality Inspection under a Customer Return Policy: A Game Theoretical Approach	Kumar, Ekwall, Wang	2016	Textile Supply Chain	No	Yes, traceability is discussed as an ex-post quality control technique that can improve the efficiency of the supply chain and indirectly add value to the product	Production and Industry
A fully yarn integrated tag for tracking the international textile supply chain	Kumar, Koehl, Zeng	2016	Textile Supply Chain	Yes	Yes, traceability is discussed as an element that can increase product safety and, consequently, add value to the textile supply chain.	Production and Industry
Developing a Framework for Traceability Implementation in the Textile Supply Chain	Vijay Kumar, Carina Hallqvist, Daniel Ekwall	2017	Textile Supply Chain	Yes	Yes, traceability is presented as a factor that can improve supply chain management, adding value to the product.	Production and Industry
Evaluation of the implementation of RFID technology in the sector of processing of a textile industry	Oliveira, Pinotti, Lopo	2017	Textile Processing Sector	No	Yes, traceability is discussed as a factor that improves production management and can contribute to efficiency, which can be seen as adding value to the product.	Industry
Coded yarn based tag for tracking textile supply chain	Kumar, Koehl, Zeng, Ekwall	2017	Textile Supply Chain	Yes	Yes, traceability is presented as a mechanism that increases the safety and authenticity of products, adding value to the textile supply chain.	Production and Industry
A secured tag for implementation of traceability in textile and clothing supply chain	Agrawal, Koehl, Campagne	2018	Textile and clothing supply chain	Yes	Yes, traceability is discussed as an element that can increase the safety and authenticity of products, adding value to the textile supply chain	Production and Industry
Development of a Textile Coding Tag for the Traceability in Textile Supply Chain by Using Pattern Recognition and Robust Deep Learning	Kaichen Wang, Vijay Kumar, Xianyi Zeng, Ludovic Koehl, Xuyuan Tao, Yan Chen	2019	Textile Supply Chain	Yes	Yes, traceability is presented as a factor that improves authenticity and efficiency, which can add value to the product.	Production and Industry

Traceability in Textile and Clothing Supply Chains: Classifying Implementation Factors and Information Sets via Delphi Study	Agrawal, Pal	2019	Textile and clothing supply chain	Yes	Yes, traceability is presented as a way of increasing transparency and consumer confidence, adding value to the product.	Production and Industry
Advances in Wearable Sensors: Signalling the Provenance of Garments Using Radio Frequency Watermarks	Foroughi, Safaei, Raad, Mitew	2020	Textile Industry	Yes	Yes, traceability is presented as a factor that adds value by guaranteeing the origin and authenticity of the product.	Production and Industry
Traceability of Ready-to-Wear Clothing through Blockchain Technology	Pérez, Queiruga-Dios, Martínez, del Rey	2020	Textile and clothing industry (Ready-to-wear clothes)	Yes	Yes, traceability is presented as an important factor in guaranteeing authenticity and adding value to the product in the clothing chain.	Production and Industry
Blockchain-based framework for supply chain traceability: A case example of textile and clothing industry	Tarun Kumar Agrawal, Vijay Kumar, Rudrajeet Pal, Lichuan Wang, Yan Chen	2021	Textile Supply Chain	Yes	Yes, the study mentions that traceability improves transparency and authenticity, adding value to the product, especially in the context of organic cotton.	Production and Industry
Blockchain-Enabled Supply Chain Traceability in the Textile and Apparel Supply Chain: A Case Study of the Fiber Producer, Lenzing	Ahmed, MacCarthy	2021	Textile and clothing supply chain	Yes	Yes, traceability is presented as an important factor in guaranteeing sustainability and authenticity, which adds value to the product.	Production and Industry
Traceability system applied to seed production under the minimum scheme for semi-annual crops in the inter-Andean valleys	Flórez-Gómez, Medina-Mérida, Osorio-Guerrero, Vargas-Ramírez, Jaramillo-Bonilla, Ortegón-Herrera, Sarmiento-Moreno	2021	Seed Production	Yes	Yes, traceability is discussed as a factor in guaranteeing the quality and increasing the competitiveness of cotton seeds	Production
Three Digital Agriculture Problems in Cotton Solved by Distributed Ledger Technology	Griffin, Harris, Ward, Goeringer, Richard	2021	Agriculture, Cotton Production and Processing	Yes	Yes, traceability is discussed as an essential factor in guaranteeing quality and transparency, which can add value to the cotton product.	Production and Industry
Applying integrated Blockchain and Big Data technologies to improve supply chain traceability and information sharing in the textile sector	Hader, Tchoffa, El Mhamedi, Ghodous, Dolgui, Abouabdellah	2022	Textile Sector, with a focus on the supply chain	No	Yes, traceability is presented as a way of improving efficiency, transparency and reducing risks, which adds value to the product and the supply chain as a whole.	Industry
Increasing Transparency in Global Supply Chains: The Case of the Fast Fashion Industry	Fraser, van der Vem	2022	Fast Fashion	Yes	Yes, there is mention that traceability and transparency can add value to the product by improving sustainability practices.	Retail
Internet of things: Cotton harvesting and processing	Hardin IV, Barnes, Delhom, Wanjura, Ward	2022	Cotton Harvesting and Processing	Yes	Yes, traceability is discussed as a factor that can improve competitiveness and add value to the product on the market	Production and Industry
Blockchain Adoption for Sustainable Supply Chain Management: Economic, Environmental, and Social Perspectives	Munir, Habib, Hussain, Ali Shahbaz, Qamar, Masood, Sultan, Mujtaba, Imran, Hasan, Akhtar, Muhammad Ayub, Salman	2022	Supply Chain various industrial sectors, agriculture, food and textiles.	Yes	Yes, traceability is presented as a feature that improves transparency and efficiency, adding value to the supply chain.	Production and Industry

Toward product transparency: communicating traceability information to consumers	Ospital, Masson, Beler, Legardeur	2023	Fashion Industry and Supply Chain	Yes	Yes, traceability is presented as a crucial element for increasing transparency and, consequently, adding value to products.	Production and Industry
Prioritising sustainable garment choice among high-volume fashion consumers	McNeill, Potdar, McQueen	2023	Fashion Industry and Sustainable Consumption	No	Yes, traceability is discussed as a factor that can influence consumer behavior towards more sustainable fashion choices.	Production, Industry and Consumer
Application of Rare Earth Marking on Anti-Counterfeiting Waterless/Less-Water Dyeing Technology	Chen, Pei, Shi, Asad, Jiao, Zhang, Wang	2024	Textile industry, specifically in the area of fabric dyeing	No	Yes, traceability is presented as a way of guaranteeing authenticity and combating counterfeiting, which adds value to the product.	Industry
ulti-Source Data-Driven Framework for Work State Classification in Fabric Pilling and Linting Performance Assessment	Yuanqing Mao, Qingchun Jiao, Zifan Qian, Chuncong Wang, Tingting Sun	2024	Textile Industry (Pilling and Lint Performance)	No	No directly	Production
Study on the Quality Characteristics and Origin Traceability of Cotton in the Aksu, Xinjiang	Huixiang Liang, Lijie Zhang	2024	Cotton production	Yes	Yes, the study suggests that traceability can improve the quality of cotton and the efficiency of blending, which adds value to the product.	Production
Fabric tearing performance state perception and classification driven by multi-source data	Huang, Jiao, Zhang, Xu, Wang, Yue	2024	Textile Industry (Fabric Tear Performance)	No	No directly	Production
A Non-Fungible Token and Blockchain-Based Cotton Lint Traceability Solution	Lixin Wang, Wenlei Sun, Jintao Zhao, Xuedong Zhang, Cheng Lu, Hao Luo	2024	Cotton Supply Chain and Textile Industry	Yes	Yes, blockchain-based traceability is presented as a way of guaranteeing the authenticity and quality of cotton, adding value to the product.	Production and Industry
A Traceability Platform for Monitoring Environmental and Social Sustainability in the Textile and Clothing Value Chain: Towards a Digital Passport for Textiles and Clothing	Alves, Sá, Cruz, Alves, Alves, Oliveira, Santos, da Cruz	2024	Textile and clothing supply chain	Yes	Yes, the traceability platform is proposed as a way of increasing transparency and sustainability, which adds value to products in the textile chain.	Production, Industry and Consumer
Sustainability performance of Dutch firms and the role of digitalization: The case of textile and apparel industry	Tolentino-Zondervan, DiVito	2024	Textile and clothing industry	Yes	Yes, traceability is discussed as an important factor in improving transparency and sustainability, which adds value to the product.	Production and Industry
Supplier-customer relationships for sustainability-led innovation in the textile industry	Dominidiato, Guercini, Milanesi, Tunisini	2024	Textile Industry	Yes	Yes, traceability is discussed as an essential factor for sustainability-oriented innovation, which adds value to the product and the supply chain.	Industry

Many of the reviewed articles focus on improving the efficiency and technical performance of textile materials, prioritizing aspects such as fabric quality and functionality (Chen et al., 2024; Kubler et al., 2014). This focus on internal issues in the production chain, while important, tends to overlook the connection between traceability, transparency and sustainability, which are often seen as elements that add value from the consumer's point of view (Agrawal et al., 2019; Bullón Pérez et al., 2020).

By emphasizing the improvement of the technical performance of materials, these studies do not prioritize the communication of traceability practices to the end consumer, an essential factor for adding value in the market, as suggested by Egels-Zandén and Hansson (2015), who explore transparency as a mechanism for consumer engagement.

Finally, traceability is often associated with transparency and sustainability practices, directly impacting consumers' perception of value, as evidenced by Ospital et al. (2023) and McNeill et al. (2023).

The absence of an association between traceability and adding value in many of the studies analyzed seems to be linked to the technical and internal focus of their investigations, in contrast to articles that explore traceability from a market and sustainability perspective, such as those by Fraser and Van Der Ven (2022) and Munir et al. (2022). The latter emphasizes the importance of traceability as a tool to strengthen consumer trust and perceived value in relation to sustainability and ethical practices in the textile chain.

This fact may reflect limitations in the application of technologies or a lack of integration along the links in the chain, especially at the retail and final consumer stages, which indicates challenges in ensuring that traceability translates into value perceived by the consumer (Figure 2) (Mcneill; Potdar; Mcqueen, 2023). This gap suggests that there needs to be a greater focus on communicating the benefits of traceability to the end consumer, since the perception of added value is directly related to the understanding of these benefits (Canavari et al., 2010; Fraser; Van Der Ven, 2022).

Traceability, when implemented and communicated properly, has significant potential to add value to the product, especially in the cotton textile chain. Full integration of all links in the chain and effective communication of the benefits are essential to maximize added value and promote sustainability and trust in the market (Alves et al., 2024).

Based on the quantitative data, there is a clear predominance of studies focused on the initial stages of Production and Industrialization in the textile chain. The great emphasis on these links suggests that the literature to date is mostly concerned with technical and operational aspects of the chain, such as quality control, process efficiency and the use of emerging technologies to improve traceability (Chen et al., 2024; Kubler et al., 2014). This concentration also indicates a gap in the study of the links closest to the consumer, especially Retail and Consumer, which are explored in a very limited way.

As discussed by Fraser and Van Der Ven (2022) and McNeill et al. (2023), traceability becomes particularly relevant to the end consumer when there is a commitment to transparency and sustainability, aspects that strengthen trust and perceived value.

This gap in the final links suggests that traceability initiatives are not being fully communicated or exploited in terms of their direct impact on the consumer. Studies such as those by Ospital et al. (2023) and Munir et al. (2022) reinforce that transparency in the supply chain is a growing factor in consumers' purchasing decisions, especially in industries facing sustainability and social responsibility issues.

However, with only two articles focusing directly on the Consumer link and a single article discussing Retail, there is still little understanding of how traceability practices impact consumer perception and behavior.

The analysis also suggests that the temporal evolution of the studies reflects a response to market demands for more sustainable practices. In 2024, the year with the highest number of publications (8 articles), there was an attempt to integrate more links in the analysis with an article addressing Production, Industrialization and Consumer simultaneously. This movement indicates a tendency to approach traceability in a more holistic way, although it is still insufficient to guarantee complete coverage of all the links.

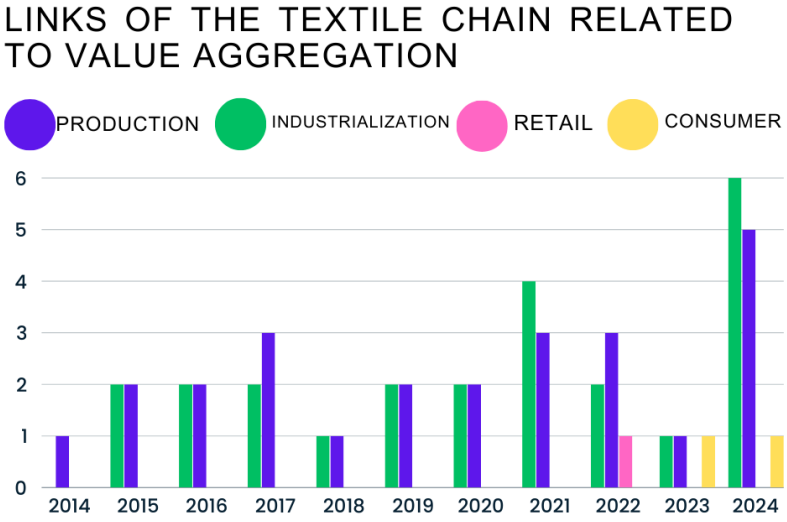

Figure 2. Links in the textile chain studied where there is talk of adding value over the 10-year period (2014-2024).

Conclusions

Despite the growing interest in traceability in the cotton textile chain, most of the literature still focuses predominantly on the initial links in the chain, such as Production and Industrialization. Of the thirty-one articles analyzed, 87.1% address these stages, while only 6.5% investigate the Consumer link and 3.2% include Retail. This scenario highlights a significant gap in literature, as the final links in the chain, those most directly linked to the perception of value by the consumer, remain largely unexplored.

The implementation of traceability technologies, such as Blockchain, Big Data and RFID, has shown promise in promoting transparency and improving quality and sustainability processes. However, the application of these technological resources is mostly focused on ensuring compliance in the production and industrialization phases, without a robust strategy for communicating the added value to the consumer. Studies such as Fraser & Van Der Ven, (2022); McNeill et al., (2023) point out that traceability can become a powerful tool for consumer engagement when combined with transparency and sustainability practices, factors that strengthen trust and the perception of value.

It is understood that there is a need for a more holistic approach to traceability, involving all links in the textile chain, from the producer to the consumer. For traceability to be fully effective and contribute to the creation of perceived value, it is essential that future research and practical initiatives explore the Retail and Consumer links in greater depth. In addition, it is recommended that companies develop communication strategies aimed at the consumer, highlighting the benefits of traceability in terms of social and environmental responsibility.

Finally, it contributes to the field by highlighting gaps in the literature and suggesting future directions for research. Future work could investigate how traceability can be used to increase consumer confidence and improve the reputation of companies in the textile market, as well as exploring emerging technologies that can be applied throughout the production chain for effective integration.

In this way, it will be possible to ensure that traceability not only generates value at the operational level, but also translates into a competitive edge in the market, in line with the demands of an increasingly aware and demanding public in relation to sustainable and ethical practices.

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