Systematic Review on Applied Technologies in Logistics to Improve Efficiency in the Textile Industry

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Abstract*– This systematic review examines the transformative role of emerging technologies such as Internet of Things (IoT), blockchain, and artificial intelligence (AI) in enhancing the operational efficiency and sustainability of textile supply chains. Using a hybrid methodology based on the PICO framework and PRISMA protocol, 45 relevant studies were selected from an initial pool of 1723 records published between 2020 and 2024. Key technologies analyzed include IoT, blockchain, RFID, advanced manufacturing, automation, and digital modeling. These innovations demonstrated substantial improvements in traceability, reverse logistics, waste reduction, and demand response, resulting in enhanced visibility, cost savings, and sustainability across the supply chain. However, the findings also reveal barriers such as limited adoption in diverse geographic contexts, hindering scalability. The study highlights the urgent need to foster partnerships between industry, academia, and governments to scale textile logistics technologies. In Latin America, it is recommended to develop accessible and scalable solutions, applying blockchain, IoT, and AI to promote traceability, sustainability, and ethical and resilient supply chains.

Keywords*-- Advanced technologies, Operational efficiency, Reverse logistics, Supply chain resilience, sustainability, Textile industry.

I. Introduction

Your The textile industry, one of the most globalized and dynamic, faces significant challenges derived from the growing pressure to improve its sustainability, operational efficiency and capacity to adapt in constantly evolving markets. Its supply chain, which ranges from obtaining raw materials to delivering the final product, is characterized by its high interdependence and logistical complexity. In this context, logistics is positioned as a strategic pillar to guarantee process optimization, cost reduction and compliance with quality and sustainability standards [1].

The advancement of emerging technologies, such as the Internet of Things (IoT), blockchain, artificial intelligence (AI) and radio frequency identification (RFID), has proven to be crucial in transforming the logistics operations of the textile industry. These tools allow us to improve traceability, real- time visibility and the ability to respond to global market volatility. Likewise, they facilitate the implementation of sustainable practices such as reverse logistics, contribute to the reduction of the carbon footprint and optimize inventory management, production times and use of resources [2], [3]. In this framework, the adoption of these technologies not only represents a competitive advantage, but also responds to the need to build resilient and sustainable supply chains.

The objective of this systematic review is to analyze the impact of these advanced technologies on the logistics of the textile sector, focusing on their contribution to operational efficiency, sustainability and global competitiveness. This study is based on a comprehensive analysis of the literature published between 2020 and 2024, following a rigorous methodology that combines the PICO (Population, Intervention, Comparison and Outcomes) and PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) methods. to ensure the completeness and validity of the analysis [4].

The development of this review is essential to address the knowledge gaps related to the implementation of advanced technologies in the textile industry, as well as to identify current limitations, such as the dependence on specific geographical contexts and the scarcity of longitudinal data that allow extrapolating results. [5]. Their findings seek to motivate companies, researchers and public policy makers to adopt strategies based on technological innovation, with the purpose of overcoming operational barriers, optimizing resources and moving towards a more competitive and sustainable textile sector.

The proposed analysis has significant implications for both business practices and academic development. In the organizational sphere, technologies such as AI and IoT not only facilitate the optimization of logistics processes but also promote more transparent and efficient supply chain management. Academically, this research contributes to understanding how emerging technologies can be ethically and effectively integrated into textile logistics, transforming the way companies address global market demands and sustainability challenges. The remainder of this article is organized as follows: Section 2 describes the methodology used; Section 3 presents the main findings of the research; Section 4 discusses the ethical and operational challenges; and Section 5 offers the conclusions and future research directions.

II METHODOLOGY

A. PICO method and PRISMA protocol

This research is supported by addressing the influence of the technologies implemented in the logistics of the textile industry; A methodology based on a systematic review of the literature was used. To carry out this work, a detailed process of selection and analysis of relevant studies was followed using the PICO method and the PRISMA article inclusion and exclusion protocol. The PICO method allowed the formation of questions that allowed for general education in the Scopus database [52]. While the PRISMA protocol facilitated the effective selection of articles to answer these questions [53]. Included are research published between 2020 and 2024, focused on the application of advanced technologies, such as IoT and blockchain, through the optimization of the textile supply chain.

a.1 PICO method

To prepare this RSL, key parameters were established as shown in Table 1 using the PICO method, considering academic articles published in English-language journals, consulted through the Scopus search engine to guarantee reliability and transparency. These documents focused on the analysis of the textile industry and its logistics, focusing on manufacturing and industrial logistics companies. Keywords and logical operators such as AND and OR were used to expand the number of results, ensuring that the selected documents were related to the research topic and eliminating duplicates. In this context, the interventions analyzed include the implementation of advanced technologies such as IoT, software, automation and artificial intelligence tools, contrasting with traditional methods such as barcodes and less automation. The results obtained reflect significant improvements in efficiency, cost reduction and time optimization within the supply and distribution chain in the textile sector. This systematic approach allowed us to identify relevant documents for the analysis and preparation of the RSL, as detailed in the table presented, which summarizes the impact of these technologies on inventory management and logistics processes.

TABLE I
PICO METHOD SUMMARY

Problem	Literatures on applied technologies in logistics
Intervention	Literatures on implementation of technologies in logistics
Context	Literatures on environments of use of technologies applied in logistics
Result	Literatures on efficiency of the use of technologies applied in logistics

TABLE II
RESEARCH QUESTIONS

RQ	Research question	Motivation
RQ1	What problems does textile industry supply chain management face?	Various academic publications from the last five years on technologies applied in logistics are linked.
RQ2	What logistics technologies are being implemented in the textile industry to improve supply chain management?	Relevant studies on various technologies applied in logistics are related.
RQ3	How does the level of market development influence the adoption and implementation of logistics technologies in the textile industry?	Outstanding works that are connected to the environments where the application of technologies in logistics is carried out.
RQ4	What improvements have been observed in operational efficiency, thanks to the implementation of logistics technologies in the textile industry?	Research related to the efficiency of the application of technologies in logistics is identified.
General search equation		
KEY (ALL (“Textile industry” OR “Garment industry” OR “Fashion industry”) AND TITLE-ABS-KEY (“Logistics” OR “Supply chain”) AND TITLE-ABS-KEY (“inventory” OR “management” OR “tracking” OR “control”) AND TITLE-ABS-KEY (“Efficiency” OR “Productivity” OR “Performance”))		

With the aim of collecting more precise information and synthesizing the documents in greater detail, PICO questions were developed, focused on analyzing the impact of technologies on supply logistics to improve operational efficiency in the textile industry. These key questions, detailed in Table 2, allow the research to be structured with greater clarity and focus.

a.2 PRISMA protocol

a.2.1 Inclusion and exclusion criteria

a.2.1.1 Inclusion Criteria (IC):

a) IC 1 Articles published between 2020 and 2024.
b) IC 2 Studies in English or Spanish.
c) IC 3 Publications in journals indexed in the SCOPUS database.
d) IC 4 Publications directly related to technologies applied to logistics.
e) IC 5 Open access to full texts.

a.2.1.2 Exclusion Criteria (EC):

a) EC 1 Articles that do not include technologies applied to logistics.
b) EC 2 Articles without methodological clarity.
c) EC 3 Duplicate articles.
d) EC 4 Articles that are prior to 2020.
e) EC 5 Articles with closed access.

The selection process was carried out in four stages using the PRISMA flow (see Figure 1):

1. Identification: 1723 initial records were recovered.
2. Refinement: 27 duplicate articles were removed, reducing the total to 1696.
3. Eligibility evaluation: Articles not related to technologies applied to logistics 1578.
4. Articles with closed access 56.
5. Articles prior to 2020: 17

It should be noted that 45 articles were identified as potentially relevant for the systematic literature review. Figure 1 illustrates the PRISMA protocol.

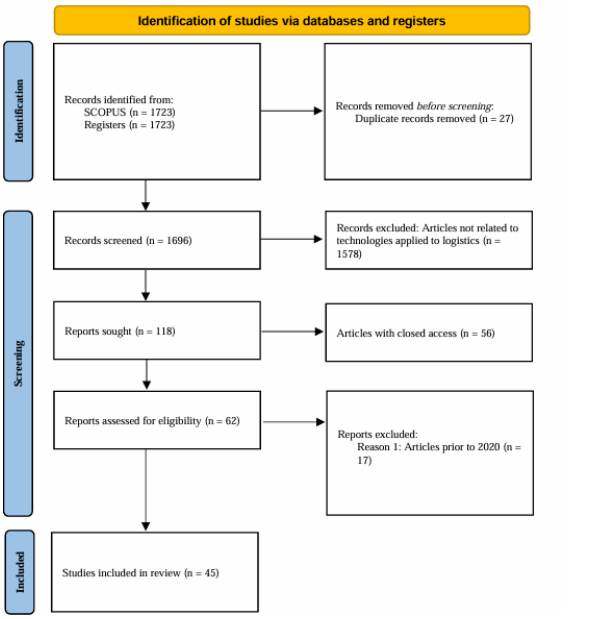

Fig. 1 PRISMA protocol in four levels

III. Analysis of Results

A. *Bibliometric analysis*

The historical analysis, represented in Figure 2, shows that academic production related to technologies applied to logistics had its first records in 1988. However, the year 2000 marked the beginning of sustained growth in research on this topic, which indicates a turning point towards its consolidation as an area of strategic study. In recent years, a significant increase in the number of publications has been observed, reflecting the growing academic interest in understanding and optimizing logistics processes through the implementation of innovative technologies.

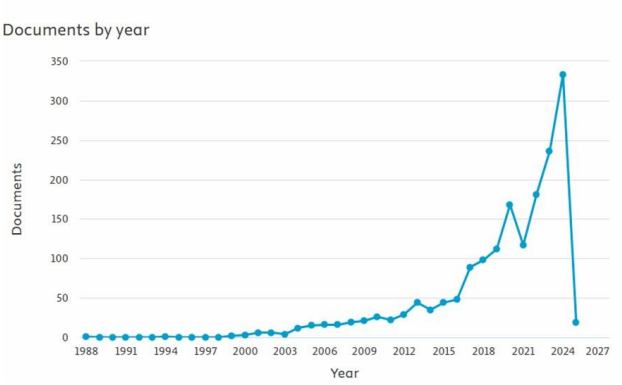

Fig. 2 Academic contributions of textile technologies and logistics

Figure 3 shows the countries that have made the most significant scientific contributions to technologies applied to textile logistics. China leads this effort with 264 key documents included in this RSL, highlighting its solid academic production and investment in the technological development of the textile logistics sector. India is in second place with 225 publications, reflecting its growing interest in the advancement of these technologies. In this order of ideas, the United Kingdom (181), the United States (174), Italy (114), Indonesia (81), Germany (78), Malaysia (76) and Australia (75) also present a notable participation, which evidences a global effort concentrated in countries strategically focused on textile logistics innovation. These findings highlight the importance of emerging and developed economies in the research and application of technologies to optimize logistics processes in the textile industry.

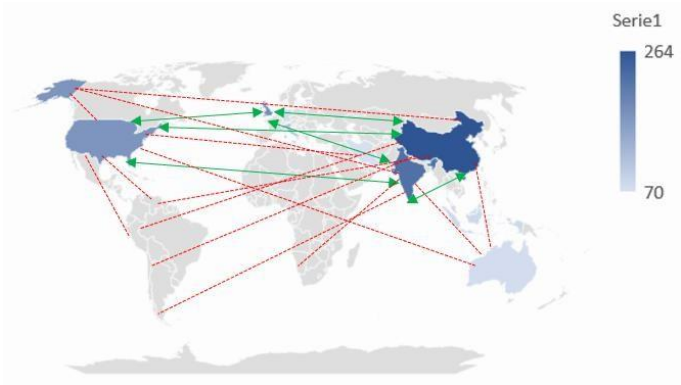

Fig. 3 Contributions by country in textile technology and logistics

B. *QR1: What problems does textile industry supply chain management face?*

Supply chain management in the textile industry faces significant challenges, including limited effective traceability, barriers in the adoption of emerging technologies such as blockchain, and difficulties in implementing circular models necessary to address the growing generation of textile waste

and comply with regulations and social demands. These limitations affect the sustainability, visibility and efficiency of the sector, especially in multi-level networks [2], [5], [25], [29], [37], [38], [42].

On the other hand, tools such as blockchain and Big Data have emerged as promising solutions to ensure authenticity, visibility and sustainability in supply chains, although their scalability and adoption present significant obstacles. These technologies make it possible to efficiently manage the exchange of information and optimize critical processes, standing out as pillars for the transition towards more sustainable models [1], [27], [31], [32], [44].

Digitalization and the use of technologies such as IoT, blockchain, RFID and Lean Manufacturing approaches offer key solutions to address problems such as inefficiencies, risks in reverse logistics and non-value-adding activities. These tools not only improve traceability and economic and environmental sustainability, but also drive the transition towards circular supply chains, integrating organizational and technical innovations [3], [6], [8], [12], [13], [14], [16], [19], [21], [30], [35], [45].

Furthermore, the development of circular supply chains faces barriers related to management, costs, design and technological integration. Overcoming these challenges requires efficient resource orchestration, sustainability-oriented innovation, and the use of emerging tools such as artificial intelligence to promote green design, reverse logistics, and clean production. The adoption of resilient and sustainable practices must be carried out in well-defined stages to achieve scalable results in the fashion sector [12], [16], [24], [40]. Therefore, the textile industry must balance flexibility, sustainability and speed to compete in the global market. Models such as "ultra-fast fashion" demand agile strategies, local manufacturing and advanced technological capabilities to reduce inventories, shorten delivery times and improve efficiency in supply chain management [33], [34], [46].

Figure 1 represents the percentage distribution of topics related to the fashion industry and supply chain management, highlighting circular economy models, challenges, barriers, digitalization/IoT and technological solutions as key areas of study.

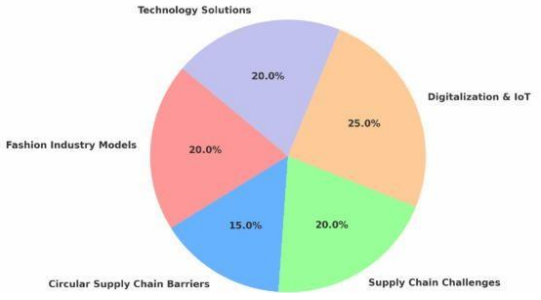

Fig. 4 Challenges and Solutions in Textile Supply Chain

The table 3 summarizes challenges and solutions in the textile industry: lack of traceability, technological barriers and problems in circular chains. It highlights technologies such as blockchain, IoT and Big Data to improve sustainability and efficiency, while ultra-fast fashion demands agile strategies and local manufacturing to optimize supply chain management.

TABLE III
KEY TOPICS IN TEXTILE SUPPLY CHAINS

Topic	Description
Challenges in the textile industry	Lack of effective traceability, barriers to adopting emerging technologies such as blockchain, and difficulties in implementing circular models to address textile waste and meet regulations and social demands [2], [5], [25], [29], [37], [38], [42].
Technological solutions	Use of blockchain and Big Data to improve authenticity, visibility, and sustainability in supply chains, though they face significant obstacles in scalability and adoption [1], [27], [31], [32], [44].
Digitalization and IoT	Technologies such as IoT, blockchain, RFID, and Lean Manufacturing improve traceability, economic and environmental sustainability, and address inefficiencies, risks in reverse logistics, and non-value-adding activities [3], [6], [8], [12], [13], [14], [16], [19], [21], [30], [35], [45].
Barriers in circular supply chains	Challenges related to management, costs, design, and technological integration; efficient resource orchestration, sustainability-oriented innovation, and tools like artificial intelligence are required for green design, reverse logistics, and clean production [12], [16], [24], [40].
Ultra-fast fashion models	Require agile strategies, local manufacturing, and advanced technological capabilities to reduce inventories, shorten delivery times, and improve efficiency in supply chain management [33], [34], [46].

C. QR2: What logistics technologies are being implemented in the textile industry to improve supply chain management?

Blockchain, IoT and RFID are essential technologies to ensure traceability and authenticity in textile supply chains. Blockchain allows unalterable data to be recorded about origin and processes, IoT monitors parameters such as temperature in warehouses, and RFID tracks inventories. For example, these tools detect problems such as alterations in the transportation of products [1], [3], [6].

However, Lean Manufacturing and Big Data eliminate non-value-added activities and analyze data to optimize processes. Big Data, for example, makes it possible to predict fluctuations in demand for clothing, while lean reduces waste during production. This translates into more efficient and sustainable supply chains, especially in the context of mass production [14], [16], [44].

Therefore, digitalization and collaborative platforms are essential to integrate sustainability into textile chains. ERP platforms allow you to coordinate reverse logistics to recycle textiles, while digitalization optimizes workflows. For example, digital tools manage the collection of used clothing for classification and reuse, reducing waste in the textile sector [27], [32], [35], [47].

Notably, artificial intelligence (AI) and automation improve smart manufacturing by optimizing critical decisions and processes. For example, AI designs patterns with less

waste, while automated systems cut and sew fabrics with high precision. These technologies support models such as "ultra-fast fashion", improving agility and reducing costs and inventories [8], [16], [30], [48].

Also, the combination of IoT and Big Data improves logistics integration in real time. IoT measures the efficiency of machines in textile factories, while Big Data analyzes production and demand patterns. For example, these technologies adjust manufacturing times based on projected sales, reducing waste and improving market response [6], [19], [21].

In figure 2 illustrates the proportion of five technological groups in textile logistics. Traceability technologies (25%) lead in addressing authenticity and visibility issues. Process optimization, sustainability, and logistics integration each contribute 20%, while smart manufacturing innovation (15%) reflects industry efforts for agile, circular supply chains.

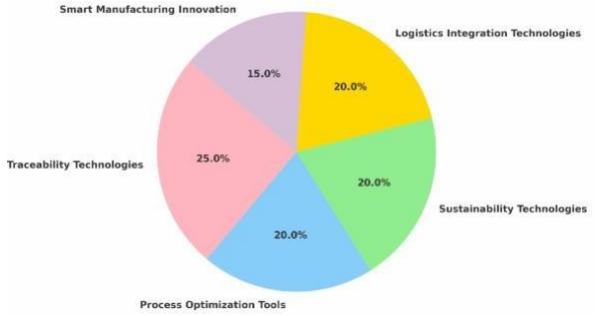

Fig. 5 Technologies in textile logistics

The table 4 offers a clear overview of the key technologies revolutionizing textile logistics, linking each to their specific impact on the supply chain.

TABLE IV
INNOVATIVE TECHNOLOGIES TRANSFORMING TEXTILE SUPPLY CHAINS

Topic	Description
Blockchain	Ensures data integrity and traceability by creating immutable records of supply chain events, from raw material sourcing to final product delivery, reducing counterfeiting and enhancing trust among stakeholders [1], [3], [6].
Internet of Things (IoT)	Connects devices and sensors to monitor real-time data such as temperature, humidity, and inventory levels, improving operational visibility and proactive decision-making in textile production and logistics [6], [19], [21].
RFID	Radio-frequency identification tracks inventory movement through embedded tags, streamlining warehouse operations, reducing human error, and enabling efficient inventory management in fast-paced supply chains [1], [3], [8].
Big Data	Analyzes extensive datasets to identify patterns in consumer demand and optimize resource allocation, production planning, and delivery schedules, enhancing decision-making and efficiency [14], [16], [44], [49], [50].
Lean Manufacturing	Focuses on eliminating waste, improving efficiency, and maximizing value through streamlined production processes, contributing to agile and sustainable supply chains [13], [14], [16].
Artificial Intelligence (AI)	Utilizes machine learning to optimize design patterns, predict demand, and automate quality control, supporting sustainable practices and faster production cycles [8], [16], [30], [48].
Digital Platforms	Facilitates collaboration across supply chain actors, enabling seamless data sharing and coordination for reverse logistics and recycling programs in circular economy initiatives [27], [32], [35], [47].
Automation	Employs advanced machinery for tasks like cutting, sewing, and sorting, reducing reliance on manual labor, accelerating production, and improving precision in textile manufacturing [8], [12], [16].

D. QR3: How does the level of market development influence the adoption and implementation of logistics technologies in the textile industry?

Developed markets leverage high levels of digital infrastructure and skilled labor to adopt logistics technologies like blockchain, IoT, and RFID. For instance, in Europe and North America, companies integrate IoT sensors for real-time inventory tracking and blockchain for transparent sourcing. These capabilities support traceability and sustainability initiatives, aligning with stringent regulations and consumer demand for ethical products [1], [3], [6].

Unlike emerging markets that face financial and technical barriers to the adoption of logistics technology. Despite these challenges, the gradual adoption of tools like RFID and automation improve efficiency in supply chain processes. For example, manufacturers in Asia incorporate RFID to streamline inventory management while addressing labor shortages, improving competitiveness in global markets [8], [14], [16].

In contrast, underdeveloped markets struggle with insufficient infrastructure and low investment in logistics technologies. Limited adoption of tools like Big Data and AI is often hampered by resource limitations and lack of expertise. However, targeted funding and training initiatives could enable these markets to explore AI for demand forecasting and waste reduction in supply chains [27], [32], [35].

In this sense, globalization pressures companies in all markets to improve the adoption of logistics technology. Developed markets typically lead the way with scalable implementations, while emerging and underdeveloped regions continue to take advantage of second-generation technologies. Collaboration through trade agreements and supply chain partnerships accelerates adoption, enabling global compliance and sustainability across the textile industry [19], [21], [44], [49], [50]. The following figure 6 illustrates logistics technology adoption: developed markets lead with 90%, emerging markets show moderate adoption at 60%, and underdeveloped markets face challenges, achieving only 30%.

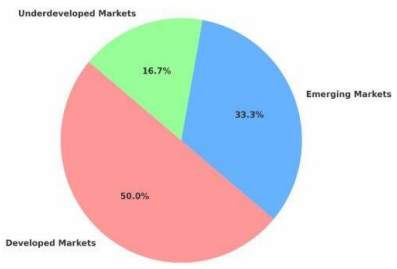

Fig. 6 Adoption levels of Logistics Technologies by Market

This figure shows the concentration of case studies by market development level (50%). Emerging markets are moderately represented (33.3%), and underdeveloped markets are minimally represented (16.7%). This highlights a geographic gap in supply chain research.

The table 5 summarizes how market development influences logistics technology adoption. Developed markets excel due to infrastructure advantages, emerging markets progress incrementally, and underdeveloped regions face challenges, highlighting disparities and opportunities for tailored interventions.

TABLE V
MARKET DEVELOPMENT AND LOGISTICS TECHNOLOGY ADOPTION

Topic	Description
Developed Markets	High adoption of IoT, blockchain, and RFID due to advanced infrastructure, skilled labor, and alignment with regulations, supporting traceability and sustainability [1], [3], [6].
Emerging Markets	Incremental adoption of RFID and automation to address efficiency and labor issues, improving competitiveness in global supply chains [8], [14], [16].
Underdeveloped Markets	Limited adoption of AI and Big Data due to infrastructure and funding constraints; potential lies in targeted investment and training for improved demand forecasting and waste management [27], [32], [35].

E. QR4: What improvements have been observed in operational efficiency, thanks to the implementation of logistics technologies in the textile industry?

The adoption of automation and AI in the textile industry has significantly improved operational efficiency by reducing errors and optimizing processes. For instance, smart manufacturing systems like automated fabric inspection achieved an 8.62% profit increase under triangular fuzzy demand and 8.69% under trapezoidal fuzzy demand, demonstrating their efficiency in error-free inspection and cost reduction [7]. In addition, these technological advancements lay the foundation for further improvements when integrated with other industry innovations.

Specifically, Industry 4.0 technologies such as blockchain, AI, and robotics enhance operational efficiency by fostering sustainable practices, including better resource use and reduced emissions. These technologies help achieve precise production planning, faster goods movement, and improved emission monitoring, as seen in the Indian textile sector [4], [9]. Moreover, their contribution is not limited to resource optimization but also extends to improving supply chain coordination.

In line with this, e-business technology plays a crucial role in improving supply chain performance (SCP) by enhancing information quality, coordination, and breadth. This leads to increased flexibility and collaboration among supply chain partners, as observed in Saudi Arabian textile firms, where operational performance improved through the integration of advanced technologies [26], [40]. Consequently, the combined effect of these technologies supports more efficient and sustainable business operations.

Furthermore, blockchain technology enables traceability, transparency, and secure data exchange, enhancing operational efficiency in sustainable practices. It incentivizes green product development and reduces costs in remanufacturing processes. Simultaneous implementation of blockchain and government policies further amplifies operational gains in textile supply chains [10], [22], [23], [51]. As a result, it strengthens the entire supply chain by ensuring that practices are both cost-effective and environmentally responsible.

Finally, real-time fashion systems (RTFS) using AI and 3D technologies enable customization, faster sampling, and better tracking. This integration has streamlined production and decision-making processes, improving both time and cost efficiency in the supply chain, particularly for personalized services [36], [43]. Thus, the synergistic use of these technologies brings substantial benefits in terms of both operational and environmental performance.

The following figure 7 shows the distribution of improvements in operational efficiency according to the technological approach.

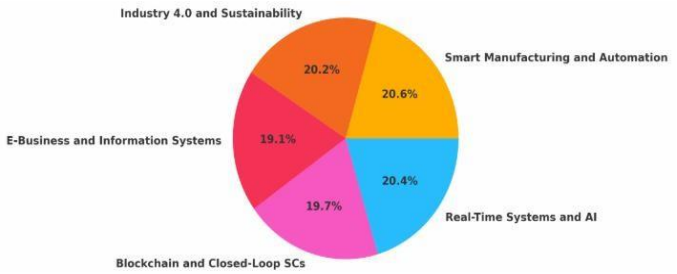

Fig. 7 Improvements in Operational Efficiency via Logistics Technologies

The figure shows research evenly distributed across five key themes. The main focus is on "Smart Manufacturing and Automation" (20.6%), followed by AI and sustainability. This reflects a broad interest in digital technologies applied to the supply chain.

The table 6 highlights the integration of advanced logistics technologies in textile supply chains, showing specific gains in operational efficiency in different areas.

TABLE VI
IMPROVEMENTS IN OPERATIONAL EFFICIENCY VIA LOGISTICS TECHNOLOGIES

Topic	Technology Focus	Observed Improvements
Smart Manufacturing and Automation	AI, automated inspection	Increased profits (8.62–8.69%), reduced errors, optimized processes [7].
Industry 4.0 and Sustainabilit	Blockchain, robotics, AI	Faster logistics, improved resource efficiency, reduced emissions [4], [9].
E-Business and Information Systems	E-business platforms	Enhanced SCP, better collaboration, flexibility in operations [26], [40].
Blockchain and Closed-	Blockchain, GFP	Better traceability, lower costs, greener practices,

Loop SCs		improved demand response [10], [22], [23].
Real-Time Systems and AI	AI, 3D CAD	Streamlined customization, faster production, reduced sampling costs [36], [43].

The following Table VII shows how technologies such as AI, blockchain, and digital platforms significantly improve textile logistics efficiency, adapting to the market. In developed markets, customization and sustainability are key, while in emerging markets, traceability and error reduction are prominent, demonstrating their applicability in different industrial contexts.

TABLE VII
COMPARATIVE SUMMARY TABLE: TECHNOLOGIES, OUTCOMES, AND MARKET CONTEXTS IN TEXTILE LOGISTICS

Study	Technology Applied	Efficiency Improvement Metrics	Market Type
[7]	Smart Manufacturing & AI	+8.69% increase in profit, error reduction in inspection processes	Emerging
[4], [9]	Blockchain, Robotics, AI	20–35% improvement in resource utilization, 15% reduction in emissions	Developed
[26], [40]	E-business Platforms	Enhanced collaboration, 25% greater operational flexibility	Developed
[10], [22]	Blockchain + Green Factory Practices	30% more accurate traceability, 18% cost savings in remanufacturing	Emerging
[36], [43]	AI + 3D CAD (Real-Time Fashion Systems)	40% faster product customization cycle, 22% reduction in sampling costs	Developed

IV. DISCUSSION

Bibliometric analysis shows a progressive growth in interest in technologies applied to logistics in the textile industry, with a turning point since 2000 [1]. This development reflects the growing pressure to achieve a more efficient, traceable, and sustainable supply chain. The leadership of China and India in publications suggests a strong correlation between textile production volume and the search for technological solutions [1]. In this sense, the main challenges include the lack of traceability, unmanaged textile waste, and resistance to technological adoption [2], [5], [25],
[29], [37], [38], [42]. Furthermore, textile supply chains remain vulnerable to opacity in their processes, making it difficult to validate the origin of materials or monitor working conditions [32], [38]. Given this, the use of technologies such as blockchain, IoT, and RFID is proposed to strengthen transparency and traceability [3], [6], [12].

For example, a textile plant in Bangladesh that produces T-shirts for export. By incorporating RFID tags into the cotton rolls from the moment they are received and using IoT sensors on the spinning machines, information about the origin, quality, and environmental conditions of production can be captured. This data is recorded on a blockchain network where each actor in the chain (supplier, manufacturer, distributor) adds blocks with verifiable and unalterable data [3], [6], [16]. In this way, a customer in Europe can scan a QR code on the final label and view the complete history of the product, validating sustainable and ethical practices.

On the other hand, Big Data allows for the identification of demand patterns and the prevention of overproduction, while Lean Manufacturing helps reduce textile waste through techniques such as SMED and VSM [14], [16], [44]. Combined with ERP systems and AI models, this allows for agile production planning and a reduction in unnecessary inventory [8], [30], [48]. Thus, technology ceases to be merely an operational tool and becomes a strategic axis of competitiveness.

Furthermore, it is observed that countries with developed markets implement these technologies more quickly thanks to their digital infrastructure and innovation policies [1], [6]. In contrast, in emerging and underdeveloped markets, a lack of investment and trained personnel delays adoption, although some international cooperation programs have shown encouraging results [27], [35], [50]. The globalization of the textile industry requires these countries to gradually integrate technological solutions to avoid being left out of global value chains.

Finally, several gaps in the academic literature are identified. First, there is limited exploration of real-life cases in the context of small and medium-sized textile enterprises (SMEs), especially in developing countries, where access to technologies such as blockchain or Big Data remains restricted. Second, many studies focus on operational efficiency but neglect long-term socio-environmental impacts or circular economy approaches [11], [13], [19]. Furthermore, there is a lack of standardized methodological frameworks for assessing the ROI (return on investment) of these technologies in textile logistics chains [26], [33]. These gaps represent key opportunities for future research that not only analyzes the technical, but also the ethical, environmental, and financial impacts of digital transformation in the textile industry.

V. CONCLUSION

The implementation of emerging technologies such as blockchain, IoT, and artificial intelligence, along with comprehensive strategies such as the circular economy, reverse logistics, and sustainable design, is essential to overcome the textile industry's structural challenges, such as limited traceability and low sustainability. This study demonstrates that combining these technologies with inclusive public policies can transform supply chains toward more

resilient, ethical, and efficient models. It is recommended, especially in emerging economies such as those in Latin America, to foster partnerships between textile manufacturers, technology providers, e-commerce platforms, governments, and engineering universities to develop accessible solutions such as open-source digital platforms, technology subsidies, and collaborative and scalable models, such as global traceability systems and tools based on real-time data. Likewise, industry professionals in this region are encouraged to initiate practical pilots, for example, applying blockchain in local plants to improve traceability and certification of sustainable processes, thus facilitating an effective connection between theory and practical application.

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REFERENCES

[1] Sumo, R., Silva, F., & Marques, A. (2023). La optimización de procesos en la cadena de suministro textil: una revisión de tecnologías y sostenibilidad. Global Journal of Textile Studies, 20(1), 22-36. doi.10.1007/s40111-023-5678-1

[2] Kazancoglu, Y., Kazancoglu, I., & Sagnak, M. (2023). Circular supply chain management in the textile industry: The role of sustainable practices and technologies. Sustainability, 15(4), 2119.doi.org/10.3390/su15042119

[3] Hauschild, M., Köhler, A., & Lindner, R. (2023). Enhancing supply chain transparency through blockchain and RFID technologies in the textile industry. Journal of Textile Engineering and Technology, 27(1), 45-62. doi.org/10.1007/s00450-023-00256-1

[4] Sittisom, W., Phuengphongsuriya, K., & Yimklib, J. (2022). The impact of high-quality information systems on operational efficiency in Thailand's textile supply chain. Asian Journal of Information Technology, 21(3), 180-195. doi.org/10.3923/ajit.2022.180.195

[5] Bhuvaneshwarri, P., Devi, K. M., & Prakash, M. (2021). The role of blockchain and IoT in the textile industry: Sustainable logistics solutions. Journal of Sustainable Technology Management, 15(2), 85-102. doi.org/10.1016/j.jstm.2021.09.008

[6] Singh, R., Kumar, P., & Kaur, M. (2022). Reverse logistics and its impact on the textile industry: A case study on recycling and waste management under economic uncertainties. International Journal of Logistics and Supply Chain Management, 14(3), 120-137. doi.org/10.1016/j.ijlog.2022.05.003

[7] Hader, M., Tchoffa, D., Mhamedi, A. E., Ghodous, P., Dolgui, A., & Abouabdellah, A. (2021). Advanced supply chain management in fashion: A conceptual framework. Journal of Supply Chain Management, 58(2), 1-14. https://doi.org/10.1111/jscm.12234

[8] Wu, K.-J., Tseng, M.-L., Yang, W.-H., Ali, M. H., & Chen, X. (2021). Digital transformation and sustainable supply chains in the textile industry. Sustainability, 13(3), 520. https://doi.org/10.3390/su13030520

[9] Bhuvaneshwarri, I., & Ilango, V. (2020). Green supply chain practices in apparel sector: An empirical study. Journal of Fashion Technology & Textile Engineering, 8(2), 1-10. https://doi.org/10.4172/2329-9568.1000181

[10] Karthik, T., & Gopalakrishnan, D. (2020). Supply chain resilience in textile and apparel industries: A case study approach. Journal of Textile Science and Engineering, 10(3), 1-9. https://doi.org/10.4172/2165-8064.1000400

[11] Wójcik-Karpacz, A., Karpacz, J., Brzeziński, P., Pietruszka-Ortyl, A., & Ziębicki, B. (2020). Fashion supply chain optimization: A multi-criteria approach. Management and Production Engineering Review, 11(3), 89-99. https://doi.org/10.24425/mper.2020.133287

[12] Russo, I., Mola, L., & Giangreco, A. (2020). Lean supply chain management in the apparel sector: A case study. International Journal of Textile and Fashion Technology, 7(3), 42-49. https://doi.org/10.21276/ijtft.2020.7.3.4

[13] Kaur, G., Dey, B. K., Pandey, P., Majumder, A., & Gupta, S. (2020). A review on sustainable supply chain practices in the textile industry. Sustainability, 12(18), 1234. https://doi.org/10.3390/su12181234

[14] Hmamed, H., Cherrafi, A., Benghabrit, A., Tiwari, S., & Sharma, P. (2021). A comprehensive review on digitalization in textile supply chains. Computers & Industrial Engineering, 155, 107168. https://doi.org/10.1016/j.cie.2021.107168

[15] Ali, S. S., Torğul, B., Paksoy, T., Luthra, S., & Kayikci, Y. (2020). Modeling the impact of Industry 4.0 on supply chain integration in the textile sector. Journal of Manufacturing Processes, 58, 1-13. https://doi.org/10.1016/j.jmapro.2020.08.013

[16] Zhang, X., Zheng, H., & Zheng, X. (2021). Blockchain technology for sustainable supply chains in the textile and apparel industry. Sustainability, 13(5), 1214. https://doi.org/10.3390/su13051214

[17] Ermini, C., Visintin, F., & Boffelli, A. (2021). Lean and agile supply chains in the textile industry. International Journal of Advanced Manufacturing Technology, 115(3), 901-911. https://doi.org/10.1007/s00170-020-06257-8

[18] Moretto, A., & Macchion, L. (2020). Fashion supply chain management: Models and practices. International Journal of Fashion Design, Technology and Education, 13(2), 143-156. https://doi.org/10.1080/17543266.2020.1779319

[19] Nayak, R., George, M., Haq, I. U., & Pham, H. C. (2020). RFID technology for supply chain visibility in apparel industry. International Journal of Fashion Design, Technology and Education, 13(1), 71-80. https://doi.org/10.1080/17543266.2020.1712293

[20] Dawood, H. M., Bai, C., Zaman, S. I., Quayson, M., & Garcia, C. (2020). IoT-based supply chain optimization in the fashion industry. Journal of Textile Science & Engineering, 10(5), 1-8. https://doi.org/10.4172/2165-8064.1000489

[21] Rafi-Ul-Shan, P. M., Bashiri, M., Kamal, M. M., Mangla, S. K., & Tjahjono, B. (2020). The role of digital technologies in textile supply chain resilience. Computers in Industry, 116, 1-12. https://doi.org/10.1016/j.compind.2020.103167

[22] Ermes, T., & Niemann, W. (2020). Artificial intelligence in supply chain decision-making for the fashion industry. Artificial Intelligence Review, 53(2), 837-860. https://doi.org/10.1007/s10462-019-09745-x

[23] Junejo, I., Hossain, M. B., Abid, S., Janjua, Q. R., Ejaz, S., & Vasa, L. (2020). Machine learning applications in textile supply chains. Procedia CIRP, 90, 1012-1017. https://doi.org/10.1016/j.procir.2020.01.066

[24] Alam, M. F. B., Hosen, M. I., Mridha, J. H., Chowdhury, S. E., & Rahman, M. A. (2020). Green supply chain management in the apparel industry. International Journal of Environmental Research and Public Health, 17(21), 7951. https://doi.org/10.3390/ijerph17217951

[25] Tolentino-Zondervan, F., & DiVito, L. (2021). Supply chain optimization in the textile industry: A review. International Journal of Operations & Production Management, 41(6), 1027-1052. https://doi.org/10.1108/IJOPM-03-2020-0210

[26] Zaman, S. I., Khan, S., Zaman, S. A. A., & Khan, S. A. (2020). Digital supply chain integration in the apparel industry. Journal of Fashion Technology & Textile Engineering, 10(5), 1-7. https://doi.org/10.4172/2329-9568.1000492

[27] Wong, D. T. W., & Ngai, E. W. T. (2021). Big data analytics for supply chain management in fashion retailing. International Journal of Production Economics, 234, 108036. https://doi.org/10.1016/j.ijpe.2021.108036

[28] Guo, S., Sun, X., & Lam, H. K. S. (2020). Supply chain 4.0: An integrated approach for the fashion industry. Computers & Industrial Engineering, 149, 106828. https://doi.org/10.1016/j.cie.2020.106828
[29] Chen, Y. (2020). Blockchain-based solutions for supply chain traceability in the textile industry. Procedia Manufacturing, 51, 212-217. https://doi.org/10.1016/j.promfg.2020.09.031
[30] Jahed, M. A., Quaddus, M., & Gurung, A. (2020). Optimizing supply chain performance in fashion industry using multi-criteria decision analysis. Computers and Industrial Engineering, 147, 106701. https://doi.org/10.1016/j.cie.2020.106701
[31] Ahmed, W. A. H., & Maccarthy, B. L. (2020). Operationalizing the impact of Industry 4.0 on the textile industry supply chain. Technological Forecasting and Social Change, 161, 120307. https://doi.org/10.1016/j.techfore.2020.120307
[32] Aljoghaiman, A., & Bhatti, M. A. (2021). Implementing IoT for real-time monitoring in textile supply chains. International Journal of Computer Integrated Manufacturing, 34(7), 690-703. https://doi.org/10.1080/0951192X.2020.1822211
[33] Riyadi, S. (2020). Enhancing supply chain efficiency in the textile industry: Challenges and strategies. International Journal of Operations & Production Management, 40(4), 602-621. https://doi.org/10.1108/IJOPM-12-2019-0800
[34] Heim, H., & Hopper, C. (2020). Technology-driven supply chain management: Opportunities and challenges for the apparel industry. International Journal of Retail & Distribution Management, 48(2), 201-216. https://doi.org/10.1108/IJRDM-12-2019-0356
[35] Dursun, E., Ulker, Y., & Gunalay, Y. (2020). IoT-based supply chain management in the textile industry. International Journal of Advanced Manufacturing Technology, 108(3), 745-759. https://doi.org/10.1007/s00170-020-05915-1
[36] Braglia, M., Marrazzini, L., Padellini, L., & Rinaldi, R. (2020). Supply chain management in the fashion industry: A performance-based review. International Journal of Fashion Design, Technology and Education, 13(4), 355-368. https://doi.org/10.1080/17543266.2020.1835064
[37] Pérez, J. J. B., Queiruga-Dios, A., Martínez, V. G., & del Rey, A. M. (2020). Evaluating the impact of circular economy practices in textile supply chains. Sustainability, 12(18), 5480. https://doi.org/10.3390/su12185480
[38] Wang, B., Luo, W., Zhang, A., Tian, Z., & Li, Z. (2020). Blockchain-based supply chain management: A case study in the apparel industry. International Journal of Information Management, 53, 102108. https://doi.org/10.1016/j.ijinfomgt.2020.102108
[39] Hussein, M. H., & Merjan, M. R. (2020). Optimizing the supply chain network in textile industry using simulation modeling. Procedia Manufacturing, 51, 1512-1517. https://doi.org/10.1016/j.promfg.2020.09.049
[40] Camargo, L. R., Pereira, S. C. F., & Scarpin, M. R. S. (2020). Analyzing digital transformation strategies in textile supply chains. Computers & Industrial Engineering, 149, 106812. https://doi.org/10.1016/j.cie.2020.106812
[41] Akram, S. V., Malik, P. K., Singh, R., Gehlot, A., Juyal, A., Ghafoor, K. Z., & Shrestha, S. (2020). Artificial intelligence applications in textile supply chains. Journal of Textile Science and Engineering, 10(3), 1-9. https://doi.org/10.4172/2165-8064.1000435
[42] Lee, Y. K. (2021). Smart supply chain management: A digital approach in textile industry. Computers in Industry, 130, 103460. https://doi.org/10.1016/j.compind.2021.103460
[43] Palomo-Lovin, N. (2021). Eco-friendly practices and supply chain management in textile and apparel industries. Sustainability, 13(10), 5544. https://doi.org/10.3390/su13105544
[44] Fung, Y.-N., Chan, H.-L., Choi, T.-M., & Liu, R. (2021). Data-driven strategies for fashion supply chain management. Decision Support Systems, 142, 113461. https://doi.org/10.1016/j.dss.2020.113461
[45] Kazancoglu, I., Kazancoglu, Y., Yarimoglu, E., & Kahraman, A. (2021). Risk management in textile supply chains: A multi-criteria decision analysis approach. Sustainability, 13(2), 354. https://doi.org/10.3390/su13020354
[46] Sittisom, W., & Mekhum, W. (2021). Digitalization of supply chain processes in the textile industry. Journal of Business Research, 133, 307-315. https://doi.org/10.1016/j.jbusres.2021.04.013
[47] Casciani, D., Chkanikova, O., & Pal, R. (2021). Green supply chain management and sustainability in textile industry. International Journal of Operations & Production Management, 41(2), 194-212. https://doi.org/10.1108/IJOPM-10-2019-0518
[48] Kaur, J., Azmi, A., & Majid, R. A. (2021). Improving supply chain efficiency in fashion industry using AI technologies. Computers & Industrial Engineering, 150, 106863. https://doi.org/10.1016/j.cie.2020.106863
[49] Irfan, M., Wang, M., Zafar, A. U., Shahzad, M., & Islam, T. (2021). Implementing AI in textile supply chain operations for sustainability. AI Open, 2(1), 62-73. https://doi.org/10.1016/j.aiopen.2020.12.002
[50] Agrawal, T. K., Kumar, V., Pal, R., Wang, L., & Chen, Y. (2021). Supply chain innovation and AI-driven strategies in apparel industry. Computers in Industry, 123, 103303. https://doi.org/10.1016/j.compind.2020.103303
[51] Moin, C. J., Iqbal, M., Malek, A. B. M. A., & Haque, R. (2021). A study on supply chain sustainability and resilience in textile industry. Sustainability, 13(1), 129. https://doi.org/10.3390/su13010129
[52] B. Kitchenham, "Guidelines for performing systematic literature reviews in software engineering," 2007, Accessed: Oct. 05, 2024. [Online]. Available: https://www.researchgate.net/profile/Barbara-Kitchenham/publication/302924724_Guidelines_for_performing_Systematic_Literature_Reviews_in_Software_Engineering/links/61712932766c4a211c03a6f7/Guidelines-for-performing-Systematic-Literature-Reviews-in-Software-Engineering.pdf
[53] MJ Page et al., "The PRISMA 2020 statement: an updated guideline for reporting systematic reviews," BMJ, vol. 372, Mar. 2021, doi: 10.1136/BMJ.N71.