Textile & Leather Review

ISSN 2623-6281| www.tlr-journal.com | 10.31881/TLR

Intelligent Textile Technology–Driven Supply Chain Optimization in the Textile Industry

Qin Xu, Jinhong Wu

How to cite: Xu Q, Wu J. Intelligent Textile Technology–Driven Supply Chain Optimization in the Textile Industry. Textile & Leather Review. 2026; 9:925-943. https://doi.org/10.31881/TLR.2026.925

How to link: https://doi.org/10.31881/TLR.2026.925

Published: 17 April 2026

Intelligent Textile Technology–Driven Supply Chain Optimization in the Textile Industry

Qin Xu[1*], Jinhong Wu[2]
[1]Department of Economics and Management, Jianghai Polytechnic College, Yangzhou 225101, Jiangsu, China
[2]Business College, Yangzhou University, Yangzhou 225001, Jiangsu, China
*xq764012847@163.com

Article
https://doi.org/10.31881/TLR.2026.925
Received 30 May 2025; Accepted 9 July 2025; Published 17 April 2026

ABSTRACT

Intelligent textile technologies are increasingly transforming the textile industry supply chain. This study develops an intelligent supply chain model integrating AI forecasting, blockchain-based data sharing, and automated inventory management. A pilot study demonstrates significant improvements in inventory turnover, order fulfillment efficiency, cost control, and customer satisfaction. The results indicate that intelligent textile technologies can effectively enhance supply chain collaboration, transparency, and operational efficiency in the textile industry.

KEYWORDS

textile industry, intelligent textile technology, supply chain optimization, artificial intelligence, blockchain

INTRODUCTION

Against the backdrop of a rapidly expanding digital economy and significant shifts in global consumption patterns, the fashion industry is facing a profound transformation in supply chain models and market structures [1]. This digital surge is reshaping consumer behavior at present, with approximately 70% of fashion purchases being digitally influenced [2].

This evolving market landscape, frequently termed “consumption upgrading,” is characterized by nuanced consumer demands for increased personalization, value, and brand transparency [2,3]. Consumers are becoming increasingly price-sensitive, spurring growth in the value and resale markets [2]. Simultaneously, they expect greater corporate integrity and sustainability, demanding transparency across the supply chain

[3,4]. Consequently, traditional clothing companies, which mostly adopt the “order fair + long-cycle production” model [5], experience difficulty in effectively responding to these new demands for personalization, rapid trend changes, and the resulting inventory backlogs [6]. This limitation not only leads to waste of resources and rising costs but also weakens a company’s ability to respond quickly to the market. At present, the rapid integration of digital means, such as intelligent textile technology, artificial intelligence (AI), Internet of things (IoT), and blockchain technology, has brought new development opportunities to the fashion industry [7]. These emerging technologies enable the automation of fabric research and development and production processes [8]. In particular, intelligent spinning, weaving, dyeing, and finishing equipment have significantly improved production accuracy and response speed in the textile link. Simultaneously, the traceability of a blockchain and the predictive ability of AI are also reshaping the logic of supply chain management.

Although a large number of studies have focused on certain technical aspects of intelligent manufacturing and supply chain optimization, a systematic discussion on the overall market structure and supply chain coordination mechanism of the fashion industry is still lacking [9]. At present, research on how intelligent textile technologies can integrate AI/blockchain mechanisms remains insufficient. To systematically address the aforementioned challenges and compensate for the deficiencies in technological integration in existing research, this study sets the following clear and feasible research objectives: (1) Technology Validation: To verify the breathing and experimental effects of a new intelligent supply chain model that integrates AI, blockchain, and IoT. This research examines the practical application effect of this technology framework by constructing a model that includes an AI sales prediction system, a blockchain data traceability platform, and an automated inventory management module. (2) Efficiency Improvement: Through horizontal analysis, the specific improvement in operational efficiency of this intelligent supply chain model is evaluated compared with the traditional model. This study prioritizes and compares key performance indicators (KPIs), including, but not limited to, inventory turnover rate, order fulfillment cycle, total supply chain, and customer cost efficiency. (3) Market Effect: The profound influence of this technology-driven supply chain model on the market structure of the fashion industry is analyzed. The current study explores how this model enables enterprises to shift from the traditional “production based on production” approach to an agile “demand-based production” model. It then assesses the role of the latter in enhancing the differentiated competitive advantages of enterprises and the labor market landscape.

RELATED WORK

With the in-depth promotion of the concept of sustainable development around the world in recent years, supply chain management in the fashion industry has increasingly become the focus of academic and practical attention. Many scholars have conducted systematic research on blockchain applications, supply chain strategies, trend forecasting, and ethical governance. The specific results are presented below.

Chen systematically reviewed the application of blockchain technology in promoting sustainable supply chains in the fashion industry and then combined it with coastal cases to explore its advantages in terms of traceability, security, and transparency. This previous study demonstrated that blockchain can help address the negative effect of the fashion industry on the environment, and it provided management suggestions and future research directions to improve the sustainable development level of the global fashion industry [10]. Bindi et al. explored the supply chain strategy (SCS) and its corresponding KPIs adopted under different competitive drivers (i.e., brand positioning, distribution channels, and product types) through a literature review and case studies of six luxury fashion companies [11]. Their study found that product line is the only factor that significantly affects the match between SCS and KPIs [11]. Koren and Shnaiderman proposed a multicolor clothing trend prediction model to improve the accuracy of fashion trend prediction. This model maximized profits and minimized errors by reducing overproduction and potential sales losses [12]. Schäfer et al. explored the relationship between supply chain transparency and pressure from nongovernmental organizations (NGOs) [13]. Based on a 5-year data analysis of 270 fashion companies, they found that companies with high transparency are more likely to be pressured by NGOs [8]. Abbate et al. systematically reviewed research on sustainable development in the textile, apparel, and fashion industries over the past 20 years and identified three major research areas: consumer behavior toward sustainable clothing, circular economy practices, and sustainable challenges in the supply chain [14]. Singh and Bansal pointed out that while the fashion industry is developing rapidly, it exerts significant effects on the environment and society, including carbon emissions, water shortages, pollution, and biodiversity loss [15]. Karaosman and Marshall found through multilevel field research that fast fashion brands use top-down governance tools in carbon reduction, leading to confusion in supply chain data and contradictory requirements and transferring pressure to workers, disregarding their physical and mental health and hindering a fair green transition [16]. Dobos and Éltető evaluated the sustainability policies and corporate practices of the fashion industry through literature analysis and case studies, revealing the problems of greenwashing and insufficient regulation in the industry [17]. They analyzed the difficulty in achieving balance between sustainability and expansion faced by high-growth companies, and they proposed policy recommendations, such as the establishment of a transnational regulatory agency to promote a transparent and environment-friendly means of operating in the industry [17]. Karadayi-Usta developed a novel neutrosophic logic stakeholder analysis method for evaluating the roles of members in the sustainable fashion supply chain and their contribution to sustainable goals [18]. Their study found that although manufacturers are the primary producers, their influence is actually limited [18]. Cuc analyzed the application of blockchain technology to smart contracts, payments, supply chain tracking, sustainable development, and customer interaction from 2017 to 2023 through case studies [19]. The results showed that an increasing number of companies are adopting blockchain technology to promote the transparent and efficient development of the industry [19]. Di Vaio et al. analyzed 114 articles from 1990 to 2021 through bibliometrics and systematic reviews, exploring the application of responsible innovation (RI) and ethical corporate behavior (ECB) in the fashion industry and its Asian supply chain [20]. Their study found that companies strive to promote RI and ECB, but the mismatch between corporate ethics and cultural values hinders the achievement of the United Nations 2030 Sustainable Development Goals [20]. Although existing research has achieved progress in multiple dimensions of sustainable supply chains in the fashion industry, bottlenecks, such as fragmented technology applications, insufficient data transparency, and imperfect governance mechanisms, still exist.

METHOD

Current Status and Challenges of the Supply Chain in Clothing Enterprises

Traditional clothing companies generally adopt the ordering meeting model, and products are typically produced half a year or even a year in advance. However, with the variability in fashion trends and market demands, this model has led to a large backlog of homogeneous products, resulting in inventory accumulation. An inventory will be repeatedly transferred among companies, sellers, and franchisees due to differences in popularity among different brands. If an inventory has not been effectively digested, then it will continue to affect a company's capital and operational efficiency. Improper inventory management will also aggravate the "bullwhip effect," leading to rising supply chain costs and limited overall operational vitality of a company. Against the backdrop of accelerated information dissemination and the rise of fast fashion consumption concepts, the traditional "production based on sales" model experiences difficulty in meeting the dynamic changes in market demand, and inventory risks still exist. Therefore, achieving efficient management and optimization of the supply chain has become the key to the fashion industry's response to market fluctuations. Supply chain management should start from the overall corporate strategy and build a collaborative system that covers logistics, information flow, organizational system, and value flow to cope with the fierce market competition, strong demand uncertainty, short product life cycle, and complex structure of the fashion industry. Supply chain management theory divides products into two categories: functional and innovative products. Functional products have a stable demand, long life cycle, and low profit margin. They are suitable for traditional stable supply chain management strategies. By contrast, innovative products have a high profit margin, unpredictable demand, and short life cycle. The fashion industry is composed mostly of innovative products, and its supply chain management must be more flexible and agile.

Application of Intelligent Technology to Textile Production

Intelligent textile technology introduces bionic intelligent materials and nanotechnology into fabric production, simulating biological characteristics in nature, such as the super-hydrophobic structure of lotus leaves, and achieving self-cleaning and anti-fouling properties of fabrics by constructing micro–nano structures on the fiber surface with low surface energy coatings. In addition, the study of the gene expression of spider silk protein provides a direction for the development of new high-strength and flexible fiber materials.

In the production process of chemical fiber textiles, automated equipment and intelligent control systems have significantly improved production efficiency and product quality. Automated spinning machines can accurately adjust spinning speed and tension in accordance with preset parameters, reduce human errors, and ensure fiber uniformity. Intelligent weaving machines have built-in sensors to monitor fabric density and weaving status in real time, automatically adjust production parameters, and ensure fabric quality. The intelligent control system in the dyeing and finishing processes automatically adjusts dye concentration and dyeing time to achieve uniform dyeing and reduce waste. The overall intelligent process shortens the production cycle, improves product consistency and stability, and enhances market competitiveness.

Development Trend of Intelligent Production Equipment

As an important equipment for textile production, the ring spinning machine realizes digital control of drafting, twisting, and winding processes through intelligent upgrades. The stepper motor drive is used to realize the digital setting of the stretch ratio in the drafting area. The intelligent twisting system uses a digital analog display and a stepper motor to control the lifting and lowering of the steel collar plate to improve the forming accuracy of the bobbin yarn. The high-precision stepper motor drive improves the twist uniformity of the bobbin yarn, while optimizing energy saving and yarn quality. These technical improvements effectively improve the automation and accuracy of the production process and promote the development of textile equipment toward intelligence. To provide a more specific technical description, the dyeing equipment used in the present study can refer to the leading models in the current industry as examples. For instance, the Swiss Rieter K 48 spinning machine can be adopted during the spinning stage. During the weaving stage, the Belgian Picanol OmniPlus-i Connect jet loom can be introduced. During the dyeing and finishing stages, the German Thies iMaster content H2O dyeing machine can be applied. These devices generally integrate advanced sensors and data connection functions, serving as the physical foundation for realizing the dataization and intelligence of the production process. They can effectively support the intelligent supply chain model proposed in the current study.

Intelligent Services and Supply Chain Optimization

The combination of AI and blockchain technology has brought the possibility of safe intelligent services and personalized customization to the clothing industry. Companies can achieve real-time tracking of the entire life cycle of clothing products and obtain product usage and logistics information through the use of smart tags and sensors. The in-depth analysis of user data enables companies to accurately meet personalized needs and improve customer experience.

Blockchain technology provides technical support to the transparency and traceability of supply chain information, enhancing consumers' trust in products. With the support of blockchain technology, data sharing and collaboration in all the links of the supply chain can be efficiently connected, reducing communication costs and information islands. If an abnormality occurs in a certain link of the supply chain, then the blockchain can quickly locate the source of the problem, helping enterprises respond in time and reducing operational risks.

Combined with AI technology, the supply chain system can conduct data-driven dynamic analysis and prediction of raw material procurement, production planning, and inventory management, realizing the intelligent scheduling and optimization of the supply chain. The integration of the two technologies not only improves the transparency and collaborative efficiency of the supply chain but also effectively reduces operating costs and enhances the market competitiveness of enterprises.

Blockchain Implementation Framework and Deployment

To achieve the technical architecture of a blockchain, the current study adopts the “permissioned blockchain” architecture that is suitable for enterprise alliances, using the Hyperledger Fabric framework as the implementation basis.

Network Topology and Consensus: The pilot network consisted of three core validating nodes, representing the brand owner, the dedicated production factory, and the primary logistics partner. These nodes jointly verify transactions and maintain an immutable shared ledger, using a consensus mechanism designed for enterprise collaboration that does not require computational “mining.” This deployment ensures that critical business data (e.g., orders and logistics status) can only be recorded after being verified by multiple parties.

Smart Contract Logic: Key business logic was encoded in smart contracts to automate processes. For example, a smart contract will automatically update an order’s status to “shipped” upon verification of a transaction from the logistics partner or log a quality control check from the factory node for a specific product batch.

AI Forecasting Model Implementation

The AI-based sales forecasting system was built using a long short-term memory (LSTM) network, which is a type of recurrent neural network that is well-suited for time-series data.

Feature Engineering: The model was trained on a variety of input features to capture market dynamics, including stock-keeping unit (SKU)-level historical sales data, promotional periods, official e-commerce platform traffic, and sentiment analysis scores derived from major social media platforms.

Dataset and Training: The training dataset comprised 24 months of historical weekly data provided by a partner company.

Model Validation: Before deployment in the pilot study, the model was validated on a 3-month holdout dataset, where it achieved a mean absolute percentage error of 13.2%, demonstrating a high degree of predictive accuracy for this context.

Smart Textile Technology Reshapes the Supply Chain Structure of the Fashion Industry

The application of a smart textile technology promotes the transformation of the fashion industry from a traditional linear supply chain to an intelligent and flexible one. The automation and intelligent control of the production and manufacturing process shorten the product development and production cycle and increase the speed of responding to market changes. The research and development of smart materials and high-performance fibers enhance the added value and differentiated competitiveness of products, meeting the diverse and personalized market needs.

With the help of big data, AI, and blockchain technology, supply chain management has achieved data-driven and transparent supervision of the entire process from raw material procurement to sales terminals, optimized inventory management, and reduced the volatility risk brought by the "bullwhip effect." The coordination ability of each node in the supply chain has been enhanced, and the elasticity and resilience of the supply chain have been improved, effectively responding to the rapidly changing fashion market.

In addition, intelligent services and personalized customization have become the core means of differentiated competition for fashion brands. Companies customize exclusive products and services through the accurate analysis of customer behavior and preferences to improve customer loyalty and brand added value. The deep integration of intelligent textile technology at the production end and the supply chain management end is reshaping the market structure of the fashion industry and promoting the development of the industrial chain toward intelligent drive, efficient collaboration, and green sustainability.

Technical Integration Architecture

To better illustrate the excellent relationship among AI, blockchain, and IoT, the current study has constructed a simplified three-layer technical architecture. This architecture clarifies how data are collected and processed, ultimately leading to the optimization decisions of the supply chain, as shown in Figure 1.

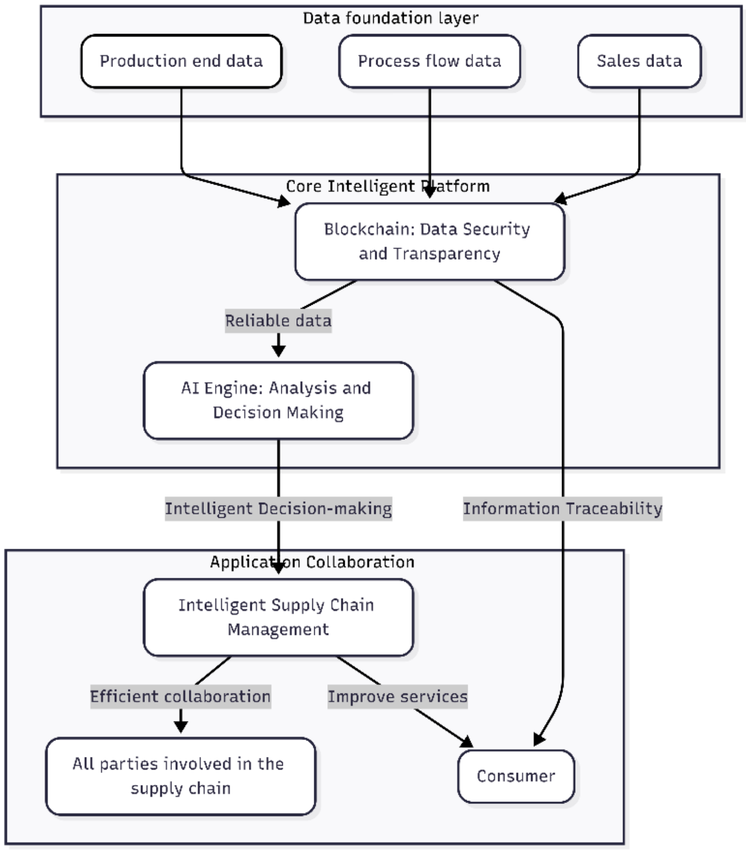

Figure 1. Core technical architecture of the fashion industry supply chain

Experimental Design and Implementation

Pilot Study Design and Scope

To validate the proposed intelligent supply chain model in a practical setting, a 6-month pilot study was conducted in collaboration with a partner fashion company. To ensure a manageable and controlled experimental environment, the study's scope was precisely defined as follows:

Product Scope: The study focused on a single, new seasonal product line (e.g., a summer collection that consisted of 25 SKUs), rather than on the company's entire portfolio. This scenario allowed for focused tracking and minimized interference within the company's core operations.

Channel Scope: The implementation was limited to the company's official e-commerce platform and 10 selected flagship retail stores located in major cities, serving as key indicators of market response.

Supply Chain Nodes: The system was deployed with one dedicated production factory and one primary logistics partner for this product line, enabling a closed-loop data tracking environment.

Experimental Groups and Data Collection

Control Group (Baseline): To establish a baseline for comparison, we conducted a retrospective analysis of a comparable product line from the previous year. These historical data, which cover the same 6-month sales period, represented the performance of the traditional supply chain model.

Experimental Group (Pilot Implementation): The new seasonal product line was managed entirely through the proposed intelligent supply chain system for the 6-month duration. An AI-based sales forecasting system (an LSTM network) was used for demand prediction. Blockchain technology (the Hyperledger Fabric framework) ensured data transparency across the selected nodes. An automated system managed inventory replenishment for the e-commerce and flagship store channels.

Data on inventory, logistics, costs, and customer satisfaction were collected weekly for the experimental group (in real time) and the control group (from historical records).

Notes on Data Handling and Measurement

Ensuring that the product lines, sales channels, and market environments of the control and experimental groups are as consistent as possible is necessary to avoid external interference from affecting the experimental results. During the experiment, the basic supply chain process should be kept stable to prevent data anomalies caused by nonexperimental factors. Customer satisfaction surveys should be scientifically designed and include multidimensional questions to ensure accurate feedback. In particular, the current study employed a comprehensive questionnaire. The main body of the form utilized a 5-point Likert scale (1 = very dissatisfied, 5 = very satisfied), with its design referencing the standardized customer satisfaction index model. It focused on three key dimensions: (1) service quality, including order accuracy and process delivery timeliness; (2) overall experience evaluation, directly reflects customer satisfaction scores; and (3) customer loyalty, assessed through willingness to repurchase and the possibility of recommendation. Compared with the repurchase rate metric measured in the experiment, this method ensures the measurement accuracy and comparability of the data. Data security and privacy protection, particularly in the use of blockchain and customer data, must comply with relevant regulations and corporate requirements. To handle data outliers that can arise from external shocks (e.g., a sudden epidemic that temporarily affects logistics), a data screening process was established. We employed the interquartile range (IQR) method, where data points that fell outside 1.5 times the IQR from the first and third quartiles were flagged as potential outliers. Each flagged outlier was then qualitatively analyzed. If an outlier was determined to be a result of a systemic experimental error, then it was corrected. If it was a legitimate but rare external event, then it was documented and excluded from the calculation of aggregate performance indicators to prevent a skewed representation of the model's typical operational performance.

Limitations of the Experimental Design

Acknowledging the limitations inherent in the current study's quasi-experimental design is critical. Although the use of a retrospective control group is necessary due to practical constraints imposed by the partner firm, it introduces potential confounding variables. Factors, such as year-over-year shifts in fashion trends, different marketing campaigns, or macroeconomic conditions, can influence the results. Therefore, the findings should be interpreted as strong indicators of the model's potential effectiveness rather than a definitive proof of causality. The primary goal of this pilot was to validate the model's viability and directionality for improvement.

RESULTS AND DISCUSSION

Inventory Management

A primary objective of the pilot study was to improve inventory efficiency. As indicated in Table 1, the experimental group managed by the intelligent model demonstrated significant improvements across all key inventory metrics compared with the retrospective baseline.

Table 1. Comparison of Inventory Management Indicators from the Pilot Study

Indicator	Control Group (Traditional Supply Chain)	Experimental Group (Intelligent Supply Chain)	Percentage Improvement
Inventory Turnover Rate	3.2 times/year	5.6 times/year	+75.0%
Inventory Backlog Rate	18.40%	8.70%	−52.7%

Inventory Capital Occupation	1,200,000 CNY	720,000 CNY	−40.0%
Stockout Rate	6.50%	2.10%	−67.7%

The inventory turnover rate increased by a remarkable 75%, suggesting a considerably faster flow of goods for the piloted collection. This improvement is likely attributable to the more precise production and replenishment plans generated by the AI-driven forecasting. Consequently, the inventory backlog rate was more than halved, leading to a 40% reduction in inventory capital occupation for the product line. This reduction frees up significant financial resources and decreases the risk associated with obsolete stock.

Supply Chain Efficiency

The intelligent model also enhanced the overall speed and accuracy of the supply chain. Figure 2 visualizes the comparison of key efficiency indicators.

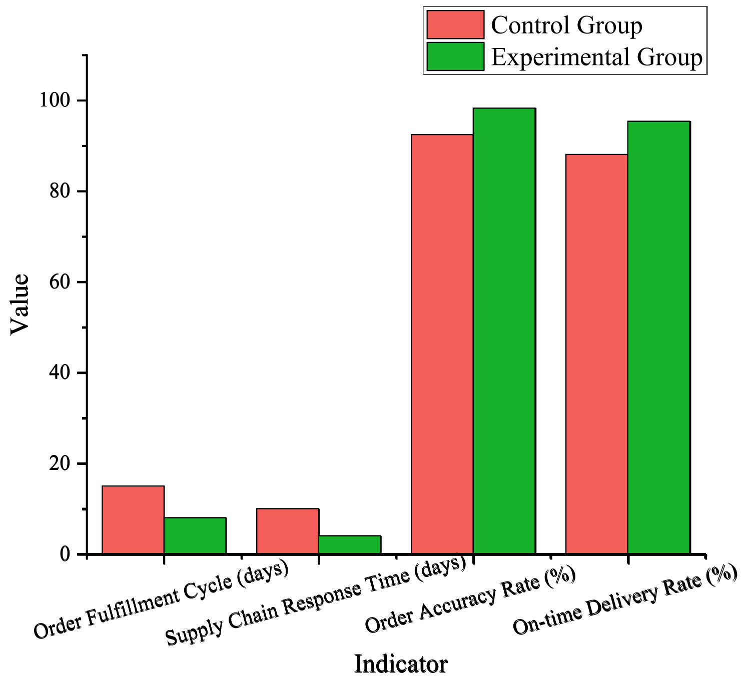

Figure 2. Comparison of supply chain efficiency indicators

The order fulfillment cycle of the control group is 15 days, which is significantly longer than the 8 days of the experimental group, indicating that the traditional supply chain has a large bottleneck in order processing and delivery efficiency. In terms of supply chain response time, the traditional model takes 10 days to complete a response, while the intelligent supply chain only takes 4 days. In addition, the response speed is more than doubled, effectively enhancing the agility and market adaptability of the supply chain. The order accuracy rate of the control group is 92.5%, while that of the experimental group increases to 98.3%, indicating that the intelligent supply chain exhibits evident advantages in order management and information transmission accuracy, reducing errors and rework. In terms of logistics delivery on-time rate, the traditional supply chain is 88.1%, while the experimental group increases to 95.4%, i.e., an increase of 7.3 percentage points, which enhances customer experience and satisfaction. Overall, the intelligent supply chain has significantly improved order processing efficiency and logistics delivery quality. It has also enhanced the stability of the overall operation of the supply chain and customer service level.

Cost Control

Operational efficiency translated directly into substantial cost savings for the piloted product line. The breakdown of cost reductions is detailed in Figure 3.

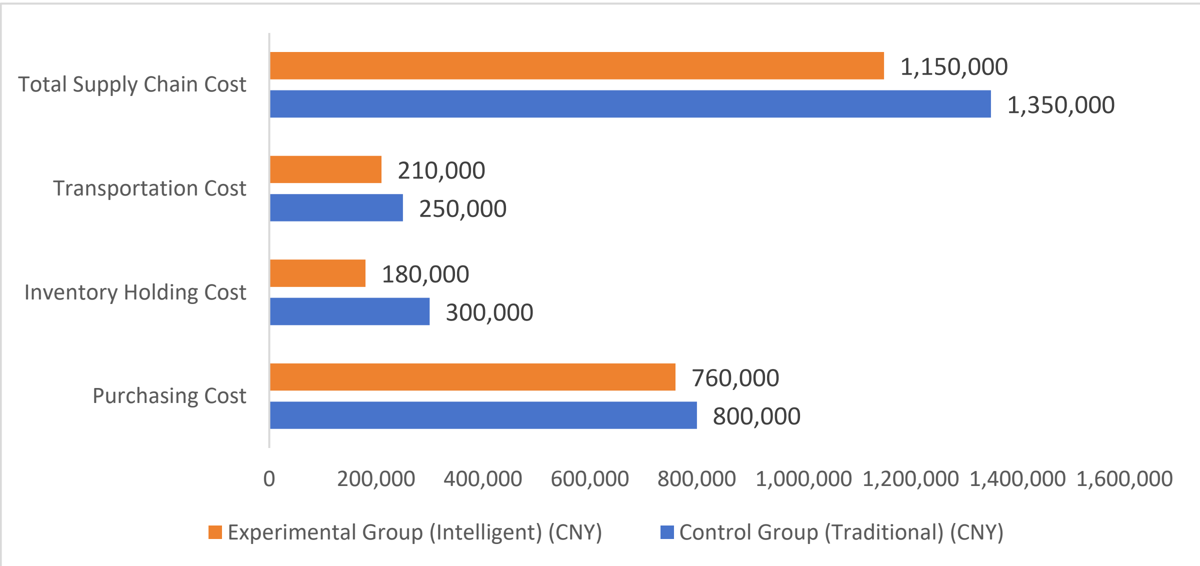

Figure 3. Comparison of cost control indicators

The total supply chain cost for the product line decreased by 14.8%, i.e., from 1,350,000 CNY to 1,150,000 CNY. The most significant savings came from inventory holding costs (a 40% reduction), which is directly linked to the lower backlog rates shown in Figure 3. However, a comprehensive evaluation of the model's business case must also consider the significant investment required for its implementation. These costs include software development for the AI and blockchain modules, cloud infrastructure deployment, and specialized personnel training. Although a formal return on investment (ROI) analysis was outside the scope of this pilot study, it is a critical next step for any firm that is considering full-scale adoption. The promising cost reductions reported here provide a strong justification for undertaking such an analysis.

Customer Satisfaction

Ultimately, the supply chain improvements exerted a strong positive effect on the end consumer. As shown in Figure 4, every metric related to customer satisfaction demonstrated a marked improvement.

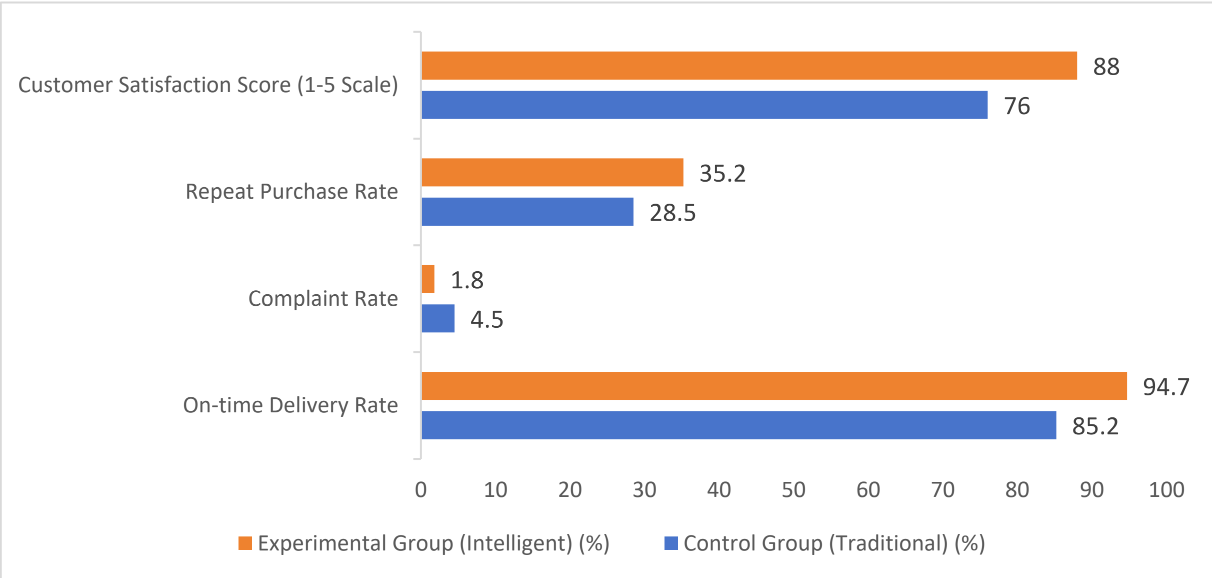

Figure 4. Comparison of customer satisfaction indexes

The increase in customer satisfaction score from 3.8 to 4.4 (i.e., an improvement of 15.8%) was driven by tangible benefits: customers received their orders more reliably and encountered fewer issues. This superior experience directly translated into higher customer loyalty, as evidenced by a 23.5% increase in the repeat purchase rate for the new collection compared with the previous year's baseline.

System Performance and Synergistic Effects

The underlying blockchain system was benchmarked to ensure its technical feasibility for a potential full-scale rollout. The test results are shown in Table 2.

Table 2. Test Results of Blockchain System Performance

Performance Indicator	Result
Average Transaction Throughput (TPS)	~350 TPS
Average Transaction Finality Time	~3–5 s

The pilot study strongly validated the synergistic effect between the AI and blockchain modules. The AI forecasts provided the intelligence for what items to produce, while the blockchain-enabled transparency ensured that this intelligence was implemented swiftly and accurately. This synergy was the fundamental driver behind the simultaneous improvements in inventory, cost, and customer satisfaction observed in this pilot project.

CONCLUSIONS

This work conducts a systematic study on the reconstruction of the fashion industry supply chain driven by an intelligent management system. It constructs a theoretical framework and validates it through a pilot study that compares a traditional model (via a retrospective baseline) with an intelligent supply chain model that integrates AI and blockchain technology. Empirical data suggest that with the support of this system, inventory turnover was significantly improved, backlog and out-of-stock rates were considerably reduced, supply chain response time and order fulfillment cycles were shortened, and multiple operational costs were decreased. Concurrently, customer satisfaction and repeat purchase rates demonstrated positive changes. This series of results strongly indicates that the intelligent supply chain system not only improves operational efficiency and market responsiveness but also provides powerful support for meeting personalized consumer demand.

However, challenges related to data standardization, privacy protection, and system coordination in the process of intelligent technology integration still require further exploration. Future research should build upon the findings and limitations of the current study.

Methodological Refinement: To establish causality more definitively, future research should prioritize an experimental design by using a parallel control group rather than a retrospective one.

Component-Specific Analysis: To precisely quantify the individual and synergistic contributions of each technology, design ablation experiments that separately test the effects of the AI and blockchain components are recommended.

Economic Analysis: A comprehensive ROI analysis is a critical next step to fully assess the business case for industry-wide adoption.

Functional Expansion: A key direction is to specify the technical route for a “carbon footprint tracking mechanism” by deeply integrating the technologies discussed. This direction can be achieved by using IoT sensors to collect real-time energy and material consumption data, recording it on blockchains, and using AI to analyze these trusted data to identify carbon hotspots and suggest optimizations, ultimately leading to a verifiable, product-specific carbon label for consumers.

To accelerate the intelligent transformation of the fashion industry, policy measures should provide precise support. Key recommendations include the following: establishing special funds or tax incentives to subsidize investments in digital systems; leading the establishment of unified data technology standards to solve “information island” problems; and supporting cooperation among academia, industry, and research to cultivate interdisciplinary talents.

Author Contributions

Qin Xu and Jinhong Wu designed the study; all authors conducted the study; Qin Xu and Jinhong Wu collected and analyzed the data. Jinhong Wu and Qin Xu participated in drafting the manuscript, and all authors contributed to critical revision of the manuscript for important intellectual content. All authors gave final approval of the version to be published. All authors participated fully in the work, took public responsibility for appropriate portions of the content, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or completeness of any part of the work were appropriately investigated and resolved.

Funding

Not applicable.

Conflict of Interest

The authors declare no conflict of interest.

Availability of Data and Materials

The datasets used and/or analysed during the current study were available from the corresponding author on reasonable request.

Acknowledgements

Not applicable.

REFERENCES

[1] Ye Y, Hung Lau K, Teo L. Transforming supply chains for a new competitive market alignment–A case study of Chinese fashion apparel companies. International Journal of Logistics Research and Applications. 2023; 26(3):365-397.

[2] McKinsey & Company. The state of fashion: trends that matter in 2025. New York: McKinsey & Company; 20 Jun 2025. Available from: https://www.mckinsey.com/industries/retail/our-insights/the-state-of-fashion-2025.

[3] Innova Market Insights. Global consumer trends 2025. Arnhem, The Netherlands: Innova Market Insights; 20 Jun 2025. Available from: https://www.innovamarketinsights.com/trends/top-10-trends-2025.

[4] United Nations Conference on Trade and Development. Digital Economy Report 2024: Shaping an environmentally sustainable and inclusive digital future. Geneva: United Nations; 20 Jun 2025. Available from: https://unctad.org/publication/digital-economy-report-2024.

[5] Lamarca KP, de Mello AM, Alvarez FJSM, de Souza Nascimento PT. Traditional collection development: Lessons from fast fashion. In Proceedings of PICMET'14 Conference: Portland International Center for Management of Engineering and Technology; Infrastructure and Service Integration; 27-31 July 2014; Kanazawa, Japan. New

York: IEEE; 2014. pp. 2082-2091.

[6] Kang Y, Albey E, Hwang S, Uzsoy R. The impact of lot-sizing in multiple product environments with congestion. Journal of Manufacturing Systems. 2014; 33(3):436-444.

[7] Pal K. Internet of things and blockchain technology in apparel manufacturing supply chain data management. Procedia Computer Science. 2020; 170:450-457.

[8] Nayak R, Padhye R, editors. Automation in garment manufacturing. Cambridge, UK: Woodhead Publishing; 2017).

[9] Zhou L, Jiang Z, Geng N, Niu Y, Cui F, Liu K, Qi N. Production and operations management for intelligent manufacturing: A systematic literature review. International Journal of Production Research. 2022; 60(2):808-846.

[10] Chen Y. How blockchain adoption affects supply chain sustainability in the fashion industry: A systematic review and case studies. International Transactions in Operational Research. 2024; 31(6):3592-3620.

[11] Bindi B, Bandinelli R, Fani V, Pero MEP. Supply chain strategy in the luxury fashion industry: Impacts on performance indicators. International Journal of Productivity and Performance Management. 2023; 72(5):1338-1367.

[12] Koren M, Shnaiderman M. Forecasting in the fashion industry: A model for minimising supply-chain costs. International Journal of Fashion Design, Technology and Education. 2023; 16(3):308-318.

[13] Schäfer N, Petersen L, Hörisch J. The interplay between supply chain transparency and NGO pressure: A quantitative analysis in the fashion industry context. Journal of Business Ethics. 2024; 192(4):713-727.

[14] Abbate S, Centobelli P, Cerchione R, Riccio E. Sustainability trends and gaps in the textile, apparel and fashion industries. Environment, Development and Sustainability. 2024; 26(2):2837-2864.

[15] Singh J, Bansal S. The impact of the fashion industry on the climate and ecology. World Journal of Advanced Research and Reviews. 2024; 21(1):210-215.

[16] Karaosman H, Marshall D. Impact pathways: Just transition in fashion operations and supply chain management. International Journal of Operations & Production Management. 2023; 43(13):226-237.

[17] Dobos E, Éltető A. Regulation of the fashion supply chains and the sustainability–growth balance. Sustainability Accounting, Management and Policy Journal. 2023; 14(1):101-129.

[18] Karadayi-Usta S. A novel neutrosophical approach in stakeholder analysis for sustainable fashion supply chains.

Journal of Fashion Marketing and Management: An International Journal. 2023; 27(2):370-394.

[19] Cuc S. Unlocking the potential of blockchain technology in the textile and fashion industry. FinTech. 2023; 2(2):311-326.

[20] Di Vaio A, Hassan R, D'Amore G, Tiscini R. Responsible innovation and ethical corporate behavior in the Asian fashion industry: A systematic literature review and avenues ahead. Asia Pacific Journal of Management. 2024; 41(3):1129-1173.