

Application of Digital Tools and Digital Transformation in the Fashion Goods Industry

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DOI: <https://doi.org/10.51584/IJRIAS.2026.110400040>

Received: 01 April 2026; Accepted: 07 April 2026; Published: 01 May 2026

ABSTRACT

The research focuses on reassessing the global fashion goods industry across its value chain using digital literacy and digital transformation. It encompasses design, material sourcing to manufacturing, logistics, and retail. Illustrating five major categories of digital technologies—connectivity tools, transaction processing platforms, analytical and data visualization tools, security systems, and artificial intelligence. The study explores how digital capabilities enhance responsiveness, traceability, operational excellence, and customer experience. With a structured analysis of value chain functions, the study highlights utilization of digital tools in addressing persistent industry challenges like volatile demand, long lead times, sustainability compliance, counterfeiting and logistics complexity. The paper further examines use of digital tools in planning processes including forecasting, inventory optimization, production scheduling, and logistics execution. Emerging future readiness themes such as AI driven design, intelligent retailing, cybersecurity, resilience against geopolitical and climate disruptions are discussed to summarize the next stage of digital evolution. The study concludes that digital literacy is a technical competency along with a strategic capability that will define competitiveness, adaptability, and sustainable growth in the fashion goods industry.

Keywords: Fashion goods industry, Digital tools, AI, Digital transformation, Value chain

INTRODUCTION & LITERATURE

The fashion goods industry is one of the most dynamic and rapidly evolving sectors, encompassing apparel, leather goods and accessories. It operates at the intersection of creativity, craftsmanship, global supply networks, and digital technology. In 2023, the global fashion industry's estimated worth was \$1.7 trillion (Ariella, 2023). As per report published by BOF insights (Amed & D'auria, 2025), it is expected to grow globally 2-4 percent per year between 2025-2027. To support this growth efficiently the industry needs to look for newer and better tools in supply chain. Short product life cycles, volatile demand patterns, at the same time constant need for innovation create both opportunities and challenges. The luxury fashion industry is resource intensive and faces challenges such as overproduction, waste generation, and resource depletion (Bilancia, et al. 2025). Challenges specific to fast fashion apparel industry include product variety and very short product life cycles (Mehrhoj & Pasek, 2014). The industry also needs reverse logistics for product rework or destruction of unsold goods, the main reverse logistics supply chain configurations are: Fully local, Recycling waste hubs, Mass regeneration zones, and fully global (Burini, et al. 2025). The sustainability focus also pushes the industry to tailor Resource Orchestration mechanisms to different Sustainability Oriented Innovation initiatives (Ermini, et al. 2024). The supply chain needs to be agile to succeed in this environment. Agility plays an important role in mediating the effects of both the strategic and manufacturing flexibilities on firm performance. (Alan, et al. 2017). Both supply chain management practices, and Partnership Quality significantly affect Supply Chain Agility. (Jahed, et al. 2022).

Fashion companies use digital technology to accelerate product development, enhance coordination, optimize production, personalize customer experience, and improve end-to-end supply chain visibility. Digital

technologies enable smart working environments, enhancing Supply Chain Management processes and outcomes (Araújo, et al. 2026). Modern digital tools can be categorized into five major groups (**Table 1**):

- **Connectivity Tools:** Internet of Things (IoT) facilitates real time communication, location tracking, monitoring and data exchange across supply chains. Internet enabled platforms connect designers, manufacturers, retailers, improving collaboration.
- **Transaction Recording Systems:** Enterprise resource planning (ERP), Customer relationship management (CRM), Product Lifecycle Management (PLM), Warehouse management system (WMS) and Point of Sale (POS) systems automate and integrate key business processes.
- **Analytical and Data Visualization Tools:** Platforms viz. Power BI, Tableau, R and prescriptive analytics tool such as Advance Planner Optimizer (APO) enable data analysis and data visualization. These tools help with demand forecasting, distribution planning and inventory optimization by identifying patterns and trends. Recently developed logics of digital twins also help in analyzing the single point of failure in supply chains. There also exists a need for validation framework for the digital twin models (Gabellini, et al. 2025).
- **Security Tools:** Blockchain technology (Kouhizadeh & Sarkis, 2018) is particularly effective in detecting counterfeiting, tracing product origin, and ensuring compliance with regulations regarding conflict minerals and denied entities. Tools such as firewalls, antivirus software, encryption protocols help corporates in preventing malicious attacks.
- **AI Tools:** AI solutions, including conversational agents like ChatGPT, support process automation, predictive analytics, and enhanced customer interactions.

Table 1: Major Categories of Digital Technologies

Technology Category	Purpose	Examples of tools
Connectivity	Real time data exchange, leading to system integration	Internet, IoT, Cloud, e-Mail
Transaction recording systems	Record business transactions, generate reports, maintain traceability	ERP, CRM, PLM, POS, WMS
Analytical and visualization technologies	Convert data into actionable insights	Tableau, Power BI, Python, R, APO, digital twin software
Security systems	Protect systems, data security	Firewalls, Encryption, Block chains
AI tools	Help gathering insights and automate decision making, help in creativity	ChatGPT, ML, Google Gemini.

We have explored use of various digital technologies to support the fashion goods value chain. There are studies proposing a cloud supply chain as a service model for the fashion retail industry to identify and analyze the implementation barriers (Haseli, 2026). There are mathematical models developed for methodical short-term procurement (Serel, 2016). A novel risk sharing quantity discount contract can be developed to support the continuously changing volumes which can be traced from analytics tools (Alom, et al. 2024). There are different barriers based on the upstream and downstream integration strategies of the companies. There also exist a mutual solution by building an e-Fashion global supply chain (Wang & Chan 2010). Block chain mechanisms are very effective for track and trace requirements (Qiao, et al. 2025). The success of a fashion business is determined not just by implementation of best strategies and tools but also by using them effectively. We must enhance information exchange between retailers and consumers to create uniform symmetry between fashion suppliers and retailers, implement sustainable practices and boost business performance effectively. (Hassaan, et al. 2024). This emphasizes that fostering collaboration, leveraging data analytics, and considering cultural contexts are crucial for maximizing the value of ERP systems in fashion (Correia & Baptista 2025).

The literature emphasizes the need for fashion goods industry to adopt new technologies to reduce risks and improve efficiency. Fashion firms must check the current adoption of digital technology in the industry, identify areas of missed opportunity and explore areas for future development. The objective of our study focused on identification of various members of the fashion goods value chain and its planning and execution processes, the challenges faced by them, the digital tools used for resolution of the challenges and the opportunities for further application.

METHODOLOGY

To explore the role of digital technology in transforming value chain of fashion goods industries, structured approach was adopted. The focus is to identify, classify and analyse digital tools and its application across supply chain processes. The data was primarily sourced from published peer reviewed indexed research papers in academic journals and trade reports from fashion and textile areas. The sampling period was predominantly from 2016 till date to encompass the current trends and development in digital technological advancements. A structured keyword-based search was conducted, and information was extracted through manual content review from related sections. The focus was the key initiatives in supply chain of fashion industry. Thus, the data sampled was based on adopted digital technology in demand forecasting, inventory optimization, planning, strategy and execution.

FINDINGS & DISCUSSION

Fashion Industry Value Chain And Digital Integration

The fashion industry value chain constitutes multiple members starting from fashion house identifying the current trends and designing the product, then sourcing the best quality materials across the globe, further treating them for assembly in the final product followed by distribution to point-of-sale locations. The value chain is spread across the globe, and each step has very high specialization, this adds complexity to the planning and control process.

Designing & Trend Forecasting

Design is the creative foundation of the fashion industry. Traditionally dependent on human intuition, historical trend and material knowledge, the specialized teams used by various brands for designing the products giving aesthetic look as per the trends and brands heritage. This process involves multiple iterations of designing, prototype making and approval or alteration.

The trend forecasting and designing is now increasingly powered by PLM software, AI-based trend forecasting, social media sentiment analysis, and 3D virtual sampling tools (Liu S & Liu C 2025). Brands use POS data to identify emerging consumer preferences, feeding this information to AI agents that propose new colour palettes, silhouettes, and style variations.

Material Suppliers

Material suppliers provide fabrics, leather, trims, zippers, and accessories. The challenge for suppliers is the variation in forecast leading to sudden changes in demand. Specific high-quality materials are required for each brand product combination, results in longer delivery lead times and sometimes limited availability. The companies have started asking for a complete traceability of the supplier's materials to avoid/detect counterfeiting, conflict minerals and relationship with denied entities.

Traditionally the orders to the suppliers were placed by means of paper purchase orders and telephonic follow ups. Currently ERPs efficiently handle the material requirement planning process, communication and follow up with the suppliers, this streamlines the information flow while reducing the manual errors. Companies using internet technologies develop supplier portals which are integrated to ERPs, these portals help suppliers in terms of future demand visibility (to become more responsive) and payment status of the previous deliveries, some of the portals also work as repository of the latest specification for suppliers to refer, they can also

maintain supplier scorecard (quality, delivery etc.). Suppliers ethical audit helps in ensuring adherence to appropriate labour practices. IoT can be used to remotely monitor the supplier's quality. RFID and blockchain platforms ensure traceability and authenticity.

Manufacturing & Assembly

Manufacturing processes constitute cutting, assembly, finishing and packing. In cutting section, the raw materials are cut as per the products requirements. This process is greatly optimized by automation tools that maximize material usage. Assembly is one of the most important processes to project the quality image of the brand and needs to be handled by highly skilled workers. Once all steps on the assembly line are completed, the product becomes ready for finishing and packing. Some fashion houses use highly skilled artisans for manufacturing product where one person becomes responsible for completing one unit of the product. Challenges like demand shifts, high lead times, labour shortages, quality variability are often observed. Traceability, sustainability commitments and ethical regulations add further complexity in manufacturing.

Industry 4.0 technologies (Bertola & Teunisse, 2018) including robotic sewing, automated optimized cutting systems, IoT-enabled machinery, and predictive maintenance enable factories to operate as smart, connected systems. Computer vision tools detect defects in real time, reducing rework and improving efficiency.

Distribution & Logistics

Logistics networks must manage rapid replenishment for retail stores and e-commerce fulfilment. Unlike FMCG or industrial sectors, fashion logistics must accommodate short seasonal cycles, fragmented assortments, and rapid shifts in consumer demand. This makes transportation planning, order allocation, cross border shipping, and last mile delivery critical extensions of end-to-end supply chain planning. A hub and spoke network is commonly used, where centralized distribution centres receive goods from manufacturers and then dispatch them to various retail stores or regional spokes. This model supports product consolidation, inventory pooling, faster replenishment, but presents challenges such as balancing customer expectations for immediate availability, managing transit times, and controlling costs. Online stores require direct-to-consumer fulfilment which includes precise inventory tracking, fast order processing, and careful handling to minimize transit damages. Online operations also face difficulties in maintaining accurate inventory counts across multiple channels and locations. Reverse logistics demands robust processes for inspecting, restocking, or repairing returned goods, which can strain resources and impact profitability if mismanaged.

The fashion industry faces unique challenges like highly variable demand, Stock Keeping Unit (SKU) proliferation, regional seasonality, small batch replenishment. Lead time compression often from fast fashion competition puts pressure on distribution centre (DC) throughput and network flexibility. Warehouses struggle with balancing fast moving and long tail items while minimizing pick inefficiencies and storage costs. International shipments face delays from customs documentation and compliance, while last mile delivery is burdened by rising expectations for speed, sustainability, and delivery accuracy.

Retail (Physical & Online)

Fashion goods are sold in store at the dedicated brand retail shops and multi brand chains, and at outlet malls. They also are available online on the brand website and some of the multi brand sites. Customers prefer to feel the product before purchase and in store sale face a severe challenge when a customer visits to purchase a very specific SKU which is not available. For online shops, the customer purchases when the customer has already experienced the product or is aware of what to expect from the product, at the same time the customer also has a right to return the product. Accurate stock keeping and information about the stock availability is very important for the physical shops. Online shops have a built-in availability tracking to ensure that no zero-stock sale is executed.

POS systems capture real time sales data which informs inventory status, demand forecasting and production plans. AI recommendation, virtual try on systems and augmented reality engines assist in store and online customers with their purchases. The e-commerce platforms rely on cloud infrastructure to track online sale and protect customers and retailers from e-threats.

Planning And Execution In The Fashion Industry

Planning involves forecasting, assortment design, sourcing, production scheduling, inventory optimization, and allocation. Planning processes typically follow a well-established, long horizon Sales and Operations Planning (S&OP) framework. These processes integrate new product reviews, demand forecasts, production plans, and financial reconciliation into a management driven cohesive monthly cycle. Planning in the fashion industry operates on short life cycles with seasonal variations, trend driven demand and emphasis on flexibility over precision.

Execution in the fashion goods industry involves supplier management, manufacturing, warehousing, logistics, and retail operations. The fashion industry expects the supply chain to be responsive (Kanyalkar, 2026), digital tools increase responsiveness by enabling real time visibility, advanced analytical capability and smart decision making.

Demand Forecasting

The purpose of forecasting in make to stock (MTS) companies is to predict sales so that the right products can be made available at the right store for the customer to purchase. Forecasts can never be 100 % accurate due to internal and external uncertainties. However, increase in forecast accuracy increases the efficiency and effectiveness of the supply chain. Sales in the fashion goods industry depend on current social trends, climate and branding strategies, making forecast accuracy a crucial step to a company's success.

Firms can use Machine learning to develop forecasting models that incorporate sales history, seasonality, promotions, weather, and social-media trends. Companies such as Zara use daily sale data to refine assortment decisions weekly.

Inventory Optimization

Inventory optimization aims to ensure the right products are available at the right locations at the right times to meet customer demand while minimizing cost and reducing markdowns. The process involves setting optimal safety stock levels, managing reorder points, and coordinating inter store transfers to increase service level. Demand volatility and forecast inaccuracy is the primary challenge in this process.

Production Planning

Production planning involves coordinating and scheduling of manufacturing activities to drive alignment between demand forecasts, product launches, promotional events and inventory strategy. Demand forecasting and assortment planning typically kicks off the planning process, followed by raw material procurement, capacity planning and scheduling of production runs. Due to short product lifecycles and rapidly changing trends, agility is paramount to avoid excess inventory and stockouts. High lead times, raw material sourcing issues, supply disruptions and high demand volatility are primary challenges observed in fashion goods production planning. Close collaboration between design, sourcing, and manufacturing teams is essential to deliver the right products on time.

Digital twins simulate production schedules and capacity loading, helping planners avoid bottlenecks. ERP-Manufacturing Execution System (MES) integration provides real time updates on machine status, improving productivity. Advanced Planner Optimizer (APO) tools assist in assembly line scheduling while the Material requirement planning (MRP) module of ERP helps to plan the materials accurately as per the optimizer output.

Logistics Execution

Logistics planning and execution involves orchestrating the movement of products from manufacturing sites to retail stores and online customers. The biggest challenge in logistics planning is to satisfy rapid shifts in consumer preferences and ensure product availability. Additionally, fashion goods are vulnerable to theft,

counterfeiting and transit damage. The process of disposal of damaged product also needs to be controlled. Overall, effective logistics planning and execution of fashion goods requires technology integration and process optimization to navigate complexities and deliver seamless customer experience.

Effective digital literacy in this domain means understanding how goods move and how data inventory visibility, transit times, and capacity constraints drives these movements. Artificial intelligence, AMRs (autonomous mobile robots) (Karabegović, 2025), blockchain, and IoT technology improve speed, transparency, and accuracy in distribution. Blockchain secured documentation simplifies customs clearance and improves transparency across global freight lanes. AI driven route optimization platforms reduce transit time by dynamically adjusting delivery sequences based on traffic, weather, carrier capacity, and delivery windows. Automated warehousing, powered by warehouse management systems (WMS), AMRs, computer vision enabled picking, and robotic sorting, enable faster order processing and reduce human error. IoT sensors and telematics enable real time fleet monitoring, providing predictive insights into delays or disruptions.

IoT sensors and RFID technology also help track shipments and warehouse conditions. Fashion goods industries have started near shoring practices for reducing lead times during peak seasons.

Benefits Of Digital Technology And Digital Literacy In The Fashion Goods Industry

Digital adoption and digital literacy are fundamental for any fashion goods company to remain competitive, responsive, and resilient. As supply chains grow more complex and consumer demands shift rapidly, leveraging digital technologies enables businesses to streamline operations, enhance transparency, and respond proactively to emerging challenges.

Role In Supply Chain Management

Each category of digital tool plays a vital role in controlling and managing supply chain flows. Connectivity tools enable seamless coordination among suppliers, manufacturers, and retailers. Transaction recording systems integrate procurement, production, and distribution, ensuring accurate and timely resource allocation. Analytics tools provide visibility into performance, highlighting inefficiencies and opportunities for improvement. Security solutions protect transaction data integrity, while AI tools drive automation and scalability.

Addressing Industry Challenges

Digital technologies directly address key challenges in the fashion goods industry. Sustainability goals are supported through improved traceability and resource optimization, while resilience is enhanced by real time monitoring and predictive analytics. AI and Machine Learning help improve forecast accuracy while blockchain and IoT tools combat counterfeiting and facilitate compliance with regulations. Resource management systems improve overall scalability of business while reducing complexity while advanced analytics tools reduce the risk of overproduction, minimizing waste and improving supply chain transparency.

Opportunities For Digital Technology

The fashion goods industry stands at a pivotal inflection point as digitization becomes foundational rather than optional. Emerging digital technologies are not only solving today's industry problems but actively redefining what the next generation of product, planning, and customer engagement will look like. The industry's future will be shaped by an integrated ecosystem of AI, machine learning, intelligent robotics, advanced analytics, blockchains and immersive digital interfaces, each pushing fashion brands toward greater speed, personalization, sustainability, and resilience.

Future Challenges And Digital Opportunities

Sustainability & Traceability

Consumers and regulators have started demanding product lifecycle transparency. Customers see carbon footprints as an indicator of a company's environmental awareness. Technologies like Blockchain and IoT can

provide end-to-end material traceability, enabling carbon footprint visibility. The future success of fashion goods brands will depend on their commitment to sustainability.

Geopolitical & Climate Disruptions

Increasing Geopolitical tensions and climate disruptions impacts the fashion goods industry drastically by causing material shortages and cost fluctuations. By leveraging digital technologies, fashion brands can mitigate risk, maintain continuity, and uphold sustainability commitments while ensuring rapid response to shifting global conditions. Advanced forecasting systems and real time monitoring platforms allow companies to anticipate supply chain interruptions and scenario planning tools empower firms to adapt to these challenges proactively.

Cybersecurity

Due to increasingly digitized fashion goods industry, cybersecurity becomes a topic of concern. Fashion companies can face cyberattacks on sensitive data like customer information, proprietary designs and secret launch dates. Robust cybersecurity measures across value chain partners including secure data storage, periodic vulnerability assessments, and employee training are essential to safeguard digital assets and ensure business continuity. Fashion brands need zero-trust architectures, data encryption, AI-driven threat monitoring and regular auditing to help maintain trust with consumers and partners.

AI-Driven Design

AI is transforming the fashion design domain by learning from current trends, brand image, and advertising, to design future collections that resonate with consumers. Through advanced analytics and machine learning, AI can identify emerging styles, assess the ecological footprint of materials, and gauge brand perception across digital channels.

Future Responsive Supply Chains

AI powered predictive demand planning, autonomous logistics optimization, real time risk assessment that anticipate disruptions and improve efficiency.

Intelligent Retailing

Intelligent retailing aims to deliver personalized shopping experiences by considering multiple factors like customer preferences, order history and real time store data. Online and in store virtual tryout solutions allow shoppers to visualize products before committing to a purchase. Additionally, data analytics tools can track complaints enabling targeted after sales support and improving customer experience.

CONCLUSION

Digital technology has transformed the fashion goods industry, reshaping how products are designed, sourced, manufactured, distributed, and sold. The study demonstrates that adopting digital tools and building the literacy required to use them effectively, consistently, and strategically is a key differentiator in the fashion industry. Connectivity systems improve end-to-end visibility; transaction platforms integrate operational workflows; analytics and AI enhance responsiveness in decision making; and security technologies safeguard brand equity and supply chain integrity. Together, these capabilities address long standing challenges such as demand volatility, supply uncertainty, sustainability pressures, counterfeiting, and the growing complexity of global logistics.

As the industry moves into a future shaped by environmental concerns, geopolitical instability, unpredictable trends cycles, and accelerated use of AI, digital literacy will determine how quickly organizations can adapt their business models to meet market need. Companies that invest in building digital capability across design, planning, procurement, manufacturing and logistics will be better positioned to achieve resilience, operational excellence, and customer delight. The fashion goods industry is entering a period where digital competence is

no longer optional; it is foundational to sustaining competitiveness, ensuring transparency, and unlocking the next wave of creativity and growth.

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