

# Synergy of Real and Digital Worlds - Promising Insights for the Future Generations of Fashion

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**Abstract:** Digital transformation (DT) is reshaping the fashion industry, revolutionizing the way brands, retailers, and consumers interact. It is not a fad but a necessary step towards innovation and survival in today's business context. Implementing digital transformation requires a bespoke approach that addresses specific challenges and goals within the existing framework of each brand or retailer. Fashion brands are leveraging digital technologies throughout their value chain, from product design and production to marketing and distribution. Computer-aided design (CAD) software, predictive analytics, and 3D printing are streamlining the design and prototyping phases, reducing time-to-market and improving product quality. Technologies such as 3D body scanning, seamless garments, and digitised looms are also being adopted. Brands like Hugo Boss are using smart factories that incorporate robotics, artificial intelligence (AI), analytics, and the Internet of Things (IoT) to increase efficiency. Moreover, digital-integrated supply chain platforms, such as blockchain, are enabling faster and more efficient production by connecting brands with manufacturers and suppliers globally. The adoption of digital solutions extends to the production of futuristic textiles, digital clothing, and virtual models, as well as digital showstoppers. Retailers are also embracing digital transformation (DT) to enhance the customer experience and expand their reach. E-commerce has become a vital channel, enabling retailers to sell products online and expand their customer base. Many retailers are investing in robust online platforms and incorporating augmented reality (AR) and virtual reality (VR) technologies to offer immersive in-store shopping experiences. Data analytics and AI are being leveraged to personalise recommendations and offers, thereby enhancing customer engagement and loyalty. In-store virtual assistants or kiosks are worth mentioning in light of digital clientele. Social media platforms play a vital role in the fashion industry's digital transformation. Fashion brands are partnering with social media influencers to promote their products and expand their reach to a broader audience. Additionally, collaborative consumption models are emerging through digital apps, supporting sustainability efforts such as zero waste, recycling, and sharing goods or services. Consumers are benefiting from greater convenience, choice, and personalized experiences in the digital fashion landscape. They have access to a wide array of products from around the world and can find inspiration and style ideas on social media platforms. User-generated content and reviews facilitate informed purchase decisions. Mobile technology advancements have blurred the lines between online and offline retail experiences, enabling consumers to shop anytime and anywhere.

Adaptability, inclusivity, diversity, authenticity, and traceability of the product life cycle (Utilising Blockchain Technology) have become key factors driving the purchasing decisions of Gen Zers and Millennials. However, traditional industry players and small independent retailers face increased competition from e-commerce giants, necessitating their adaptation to digital technologies to remain relevant. The COVID-19 pandemic has accelerated this shift and normalized the idea of going digital. This paper presents an in-depth review of how digital transformations have impacted various players within the fashion Industry, with special reference to the brands, designers, and enterprises that are implementing these changes to drive their evolution and progression in this rapidly evolving landscape.

**Keywords:** Digital, Data Analytics, Mobile, Blockchain, COVID-19

## I. INTRODUCTION

Digital transformation involves the utilization of digital methods to overhaul systems and strategies within a business. Although the fashion industry embarked on this journey years ago, the past year has significantly intensified this shift, leading to the emergence of innovative solutions for longstanding challenges. The rapid advancement of technology, coupled with its swift adoption by consumers, necessitates a heightened priority for many fashion brands. Faced with the demands for growth and cost efficiency, numerous brands have initiated a series of endeavours to enhance their speed in bringing products to market and incorporate sustainable innovation into their fundamental processes of product design, manufacturing, and supply chain management [1][2].

The graphical representation of the recent technologies applied in the fashion business is shown in Figure 1 below.



Figure 1: Graphical Representation of Recent Technologies Applied in Fashion

The role of consumers has evolved from passive observers to empowered individuals who seek more than just purchasing fashion items.



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The widespread use of digital technologies has enabled them to interact, feel a sense of belonging, exert influence, and essentially become advocates for the brands they choose to support. Informed, discerning, and in control, consumers now prioritize their appearance in both public and social media, as well as the perception associated with the products they purchase and own [3]. The impact of digital transformation on retail customers is particularly pronounced in the realm of fast-fashion brands, compelling them to transition from a multi-channel paradigm to an omnichannel approach [4]. This study, characterised by its exploratory nature, focuses on reviewing the scope and opportunities through a literature survey to formulate theoretical propositions for further research.

## II. BRAND PLAYERS OF DIGITAL TRANSFORMATION

Eternea's proficient team is increasingly focusing on AR and VR technologies to provide consumers with a virtual trial room experience at their fingertips. Against the backdrop of the COVID-19 pandemic, the fashion industry is gearing up for a future dominated by digital platforms for shows and events. Inega, an artist and talent management agency based in Mumbai, has introduced a digital showstopper named Nila on Instagram, marking India's first non-human "Virtual Model." Nila, perpetually portrayed as 20 years old, is designed for photo shoots and runway walks [5-9]. In the realm of production, Hugo Boss utilizes smart factories to create a digital twin of the traditional manufacturing facility. This digital twin can replicate every aspect of the original, significantly reducing the margin of error during production. Smart factories enhance efficiency by minimising the need for human intervention, reducing time-to-market, minimising raw material waste, and ultimately lowering production costs.

## III. ROLE OF SOCIAL MEDIA IN DIGITAL TRANSFORMATION

Over the past decade, social media has had a profoundly influential role in the fashion industry, and its impact has only intensified in recent years. Consumer preferences are evolving, compelling brands to adjust their strategies accordingly. Traditional websites are losing relevance as social media platforms—such as TikTok, Instagram, Twitter, and YouTube—emerge as powerful tools for directly driving sales to dedicated sites. The global lockdowns prompted consumers to spend more time online, creating a void in physical interactions that virtual alternatives began to fill [10].

Brands like Musier, Rouje, and Eliou have adeptly transformed their Instagram pages into virtual fashion magazines, engaging followers in collections, posts, and stories. Their fresh and youthful brand identities resonate with Instagram's predominant customer base of Gen Zers and Millennials. Influencer marketing has seen a surge in recent years, extending beyond human influencers to include digital figures like Noonouri, a virtual model crafted by Munich-based designer Joerg Zuber. With nearly 400K Instagram followers, Noonouri collaborates with prestigious brands such as Dior, Versace, and Swarovski, endorsing their products to a substantial audience [3].

While mobile apps are experiencing a significant boom, brick-and-mortar stores are undergoing their digital transformation. In-store digital technologies, including mobile payment options, free Wi-Fi, personal shoppers, digital signage, interactive windows, and virtual mannequins, are becoming increasingly integral to the retail experience. According to Rey-García et al., these disruptive innovations don't necessarily signal the demise of physical stores but rather have the potential to enhance their value contribution to consumers [4].

## IV. DIGITAL TRANSFORMATION IN RETAIL ENVIRONMENTS

The fashion industry, encompassing a broad spectrum that ranges from global discount retailers to exclusive luxury brands, plays a significant role in the global economy. It faces constant challenges, influenced by global economic uncertainties, evolving trends, and industrial transformations. To cope with the pressure for growth and cost efficiency, many brands are initiating initiatives to enhance their speed to market and incorporate sustainable innovation into their core product design, manufacturing, and supply chain processes [11].

Consumers now expect their reality to align with their virtual experiences, making personalization a crucial aspect of the customer journey. Retailers are bridging the gap between online and offline experiences by utilising QR codes on items, providing access to pricing, product information, reviews, and more. In-store virtual shopping assistants, located in fitting rooms or kiosks, act as liaisons between customers and real-life staff members. These virtual assistants can facilitate requests for different sizes, check garment availability, connect with staff, and offer product recommendations [12]. Bright fitting rooms use RFID tags in each garment, enabling mirrors to recognize items, search for variations, access the store's catalogue, add items to the cart, and allow customers to try on clothing virtually [13].

Digital clienteling is revolutionizing the customer experience across multiple channels, leveraging technological advancements in digital marketing, commerce, analytics, sales, and service platforms. Predicting consumer preferences upon entry to a store and activating interactions at the right moment was once considered an impossible dream, but advances in clienteling are bringing this dream closer to reality. While clienteling has been a practice for sales associates in recognizing key customers, the challenge has increased with global customers operating across various geographies and channels [14].

E-commerce has become an indispensable tool, with an increasing number of brands operating solely online, reflecting the profound shift in shopping habits that began with the start of the pandemic. A 2021 report indicates that 43% of consumers who had never purchased clothing online began doing so in the past year. This surge in e-commerce has prompted fashion brands to explore new ways of collecting and utilising data, such as tracking consumer navigation on websites for personalised product recommendations [15].

The integration of IoT functionality into retail packaging is expected to drive innovation in the consumer packaged goods sector. Before

advanced technologies like Printed Electronics (PE), Augmented Reality (AR), or the Internet of Things (IoT) emerged, packaging primarily served to contain, protect, preserve, and inform [16]. Recent innovations in conductive nanomaterials, such as silver nanowires, carbon nanotubes, and graphene, enable their use in interactive packaging, allowing for wireless communication systems. For instance, graphene-based wireless communication devices not only engage with users but also protect products against counterfeiting. Conductive inks like silver-graphene [17], fluorine, and silicon-based inks are employed for innovative packaging by companies such as Novalia, Saralon GmbH, and Thinfilm, respectively. Screen-printed sensors enable two-way communication based on the Internet of Things (IoT), allowing for monitoring, informing, and interacting with devices. Lightweight and flexible printed electronics are utilized as innovative smart labels, while near-field communication tags enhance the integration of electronic intelligence into everyday products, ensuring efficient, reliable, and secure data exchange [18, 19].

## V. DESIGN IN THE FASHION VALUE CHAIN AND DIGITAL TRANSFORMATION TOOLS

Design is a pivotal initial step in the product life cycle, followed by production, marketing, and distribution. In today's landscape, virtual design tools are enhancing traditional design processes, making them more streamlined, time-efficient, and resource-conserving.

Virtual design tools, such as design software, 3D modelling, and augmented reality, are transforming the design practices of an increasing number of brands. Augmented Reality (AR) overlays computer-generated images onto the user's real-world view, offering benefits such as digital measurements for customised clothing, precise resource measurement to reduce waste, and time-saving features for inclusive sizing. Remote fittings, featuring an avatar of the customer, further enhance the design process. 3D modelling, a computer graphics technique, creates digital representations of objects or surfaces, enabling the creation of custom designs and prints. Tools like Browzwear and Optitex exemplify 3D modelling, allowing designers to visualize fabric movement during motion [20].

Computer-aided Design (CAD) software is another essential tool that enables designers to create 2D and 3D digital sketches. Platforms like AutoDesk and Eva Engines synchronize data along the value chain, with Eva Engines transforming sketches into 2D product images. After design, the production phase in the fashion value chain involves product development, production management, material production, and assembly.

Automation plays a crucial role in various production stages, including fabric inspection, CAD and CAM, fabric spreading and cutting (utilising technologies such as Bullmer cut, Eastman CNC (Raptor), and Tukatech's CNC Automatic Cutting Machine - Tukacut), sewing, pressing, and material handling. Sewing robots, such as Sewbo and LOWRY Sewbot, significantly contribute to fabric gripping, handling, and sewing, with the ability to analyse and manipulate fabric like humans. These robots, built using Industry 4.0 technology, can be programmed for specific sizes or styles, reducing the need for human labour and increasing

production efficiency. Robotic 3D sewing technology, utilising 3D robotic arms, is versatile in producing a wide range of garments and products, including shirts, trousers, jackets, upholstery, and even airbags. This technology not only ensures high-quality products but also reduces labour costs and enhances overall productivity.

## VI. DIGITAL APPS AND APPLICATIONS IN FASHION

VAULT, a virtual wardrobe stylist app, is tailored to meet the unique needs of clients through a digital platform, facilitating the organization and management of wardrobes while offering personalized outfit suggestions. Users upload images of their wardrobe ensembles and accessories, and the app provides a range of customisation options, ensuring a seamless experience. The potential features of virtual wardrobes and styling apps are highly appealing. They include AI-driven ensemble suggestions for daily wear and specific events, as well as digital wardrobe organisation based on style, mood, and colour. These apps can go beyond by incorporating customization, noting the user's personal preferences and style over time. They are designed to understand and adapt to the user's evolving style, offering buying recommendations from online retail platforms based on individual preferences. Additionally, these apps provide trend forecasts, and some even offer live styling workshops conducted by influencers for subscribers.

The primary motivations for using these apps include time-saving, wardrobe organization, and styling tips. Social media influencers or celebrities often launch these apps to promote and inspire the public to learn and use them. The introduction of a virtual wardrobe assistant can include incentives such as a free one-month trial of premium plans, complimentary influencer or stylist workshops, and access to coupons for purchasing garments on online retail platforms. This service taps into the trend for luggage-free travel, appealing not only to globe-trotting professionals but also to fashion-forward clients. Digital transformation has a significant impact on enterprise performance, reducing costs, increasing revenue, enhancing efficiency, and driving innovation. This transformation plays a crucial role in supply-side structural reform, enabling high-quality development of enterprises and stimulating innovation momentum.

## VII. CONCLUSION

The fashion industry is renowned for its challenges, significantly influenced by global economic uncertainties, evolving trends, and industrial shifts. Faced with the pressures of growth and cost efficiency, many brands are undertaking initiatives to enhance their speed to market and incorporate sustainable innovation across product design, manufacturing, and supply chain processes. Digital channels play a pivotal role in consumer journeys, with the vast majority of consumers utilising them before, during, or after making a purchase.



The drivers for digital transformation in the fashion industry often stem from either significant opportunities or existential threats. The convergence of Big Data, the Internet of Things (IoT), and data science enables fashion brands to gain a deeper understanding of their customers, respond to market trends, and personalise sales information and products. Sustainability efforts are gaining momentum, with innovative technologies impacting everything from the design stage to the resale of products. Values such as inclusivity and diversity are now in the spotlight, supported by solutions like virtual fashion and adaptive clothing.

Consumers today demand omnichannel streamlining, seeking easy access to what they desire with just a single click. Digital transformation goes beyond simply adding technology; it entails a shift in mentality and work approaches. It's about embracing new ways of thinking and working to stay relevant and responsive in a dynamic and rapidly evolving industry.

### FUTURE PERSPECTIVES

Predictive analytics utilises statistical algorithms and machine learning methodologies to extrapolate future outcomes based on historical data, serving as a key solution for mitigating disorganisation and uncertainty within the supply chain. Artificial Intelligence-driven trend forecasting, a subset of predictive analytics, predicts future trends that consider geographical factors and market potential. This enables fashion brands to refine their collection planning processes. Leveraging data analytics enables fashion entities to enhance inventory management, optimise profitability, and refine consumer targeting, resulting in a more efficient and precise approach to collection planning compared to previous methods.

The sustainable fashion movement has experienced substantial growth over the last two years, with reselling emerging as a significant facet, driven by e-commerce and the pandemic. The collaborative consumption model, encompassing trading, renting, gifting, sharing, bartering, lending, and swapping of goods or services through digital platforms such as apps, has gained prominence. Platforms like Real Real and Vestiaire are reshaping the landscape of fashion and luxury resale. Depop stands out as a prominent social resale platform catering to younger generations seeking affordable and sustainable second-hand apparel. Style Lend operates as a peer-to-peer fashion rental marketplace. At the same time, Reflaunt simplifies the resale process for major retailers by enabling consumers to resell their previous purchases directly on the brand's e-commerce sites. Noteworthy sustainability initiatives include Madwell recycling jeans into insulation for housing, Wawwa utilising recycled cotton for ethically made apparel, and MycoWorks developing faux leather from agricultural waste.

Regardless of the platform, the overarching focus for the future remains on promoting circularity in the fashion industry, with an emphasis on environmentally friendly practices. These areas hold promising prospects for insights that can shape future generations of fashion.

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