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Reimagining India's textile industry increasing role of digital dressing as a viable alternative to sustainability and with respect to employment opportunities in developing economies

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Research Question: How important is the new trend of digital dressing in the textile industry of the world? Is it an environmentally viable alternative to sustainability? What is the impact of this new format of fashion on costs involved in the fashion textile world? Is this a cost effective alternative to improve the environment? Which are the companies that have actively used this new age system? How important is the adoption of this criteria for labour intensive textile industry in developing economies like India? These and many such questions would be attempted to be addressed in the course of this paper.

Key Words: digital dressing, technological developments, export earnings, sustainable development, economic implications.

1. Introduction

The global fashion and textile industry stands at a crossroads. On one hand, it's one of the most important economic sectors in the world, employing millions of workers and generating trillions of dollars in revenue. On the other hand, it is one of the most environmentally destructive industries on this. The rise of digital dressing, also referred to as virtual fashion or digital clothing, represents one of the most exciting yet disruptive technological developments to emerge in recent years. Digital dressing includes the usage of computer generated imagery (CGI),3D modelling, and artificial intelligence (AI) to create garments that only exist in the digital space. These garments can be worn in virtual environments, social media platforms, the metaverse, and digital marketing campaigns without ever being physically produced.

India, with one of the world's largest and highest labour intensive textile industries, finds itself in a particularly interesting position. The Indian textile and apparel industry contributes approximately 2.3% to the national GDP, accounts for 13% of industrial production as well as contributes 12% to the country's total export earnings (Press Information Bureau,2025).The

ISSN: 2455-8834

Volume:11, Issue:07 "July 2026"

sector employs over 45 million people directly and is the second largest employer in India after agriculture. Given this largescale, any technological disruption of the kind that digital dressing represents has far reaching implications not only for the environment, but for the livelihoods of millions of workers.

This paper investigates the growing role of digital dressing in the global textile industry and to assess whether it represents a viable sustainable alternative to traditional physical fashion production. It also examines the impact of this shift on developing economies like India, where the textile sector is both an economic backbone as well as a major source of employment. The paper draws on existing literature, industry data, and economic analysis to provide a balanced assessment of the costs and benefits of adopting digital dressing at this scale

2. Literature Review

The concept of digital fashion is not a completely new concept, but the rate at which it has grown in recent years is remarkable. Some of the earliest forms of digital clothing appeared in video games and virtual worlds, in the late 1990s and early 2000s.However,the current wave of digital dressing has been driven by developments in 3D rendering technology, AI and the broader metaverse ecosystem. A number of companies and platforms have been at the forefront of this development.

The Fabricant, a Dutch digital fashion house founded in 2018,is widely regarded as one of the pioneers of digital only clothing. In 2019,the company sold a digital dress called “Iridescence” for $9,500,marking what many consider to be the first sale of a purely digital garment. Since then, a number of luxury and high street brands have launched their own digital collections. Balenciaga collaborated with the video game Fortnite to release digital garments, similarly Gucci released a virtual sneaker through its app that could be “worn” in augmented reality. Other brands such as Nike acquired the digital fashion company RTFKT Studios in 2021,signalling the mainstream fashion industry’s growing interest in the space.

Table 1: Global Digital Fashion and Virtual Try-On Market Growth (2020-2030)

Year	Market Size(USD Billion)	You Growth(%)	Key Driver
2020	0.42	-	COVID-19 accelerated online retail
2021	0.68	62%	NFT fashion and virtual worlds emergence

ISSN: 2455-8834

Volume:11, Issue:07 "July 2026"

2022	1.09	60%	Metaverse investment surge
2023	1.72	58%	AR try-on adoption by major brands
2024 (est.)	2.55	48%	AI-generated fashion and Gen-Z demand
2025 (proj.)	3.89	53%	Mainstream brand adoption
2030 (proj.)	14.82	CAGR ~31%	Industry-wide sustainability mandates

Source: *Grand View Research (2024); Statista Digital Economy Outlook (2024); McKinsey Global Fashion Index (2023)*

On the technology side, platforms such as CLO3D,Browzwear and Optitex have developed sophisticated 3D garment simulation software that allows designers to create highly realistic digital versions of clothing without the need to produce physical samples. This has enormous implications for the fashion design process, as physical sampling is one of the most resource intensive parts of garment production. According to The Interline (2023),*substituting just 1% of physical clothing with digital garments could save 5 trillion litres of water and eliminate significant amounts of carbon emissions annually.*

Research by Akarsu et al.(published in Sage Journals) states that the production of virtual clothes has a significantly lower environmental impact than their physical counterparts, as digital fashion requires no chemicals or water in its production process. This body of literature suggests that digital dressing, represents a meaningful tool in the fight against environmental degradation in the fashion industry.

However, the literature also notes several challenges. The environmental cost of the digital infrastructure required to run and support digital fashion platforms, including the energy consumption of data centres and computing resources, is not negligible. The Xin et al.(2025) study published in a leading sustainability journal found that while the metaverse has the potential to enhance sustainability in fashion, it also carries the risk of worsening certain environmental issues particularly those linked to energy consumption and electronic waste.

3. Research Gap and Methodology

While there is a growing body of literature on digital fashion and its environmental benefits there is a significant research gap exists when it comes to examining the specific implications of

ISSN: 2455-8834

Volume:11, Issue:07 "July 2026"

digital dressing for developing economies like India. Most of the existing research focuses on developed markets in North America and Europe, where the fashion industry is primarily consumption driven. There is relatively little academic work that analyses how the adoption of digital dressing might affect the production side of the fashion supply chain particularly in countries where the textile industry is a major source of labour intensive employment.

This research paper addresses this gap by bringing together data and analysis on these three key dimensions***: the environmental impact of digital dressing, the economic and cost implications for the fashion industry, and the specific challenges and opportunities that digital dressing presents for labour intensive developing economies such as India.***

The research methodology adopted in this research paper is primarily qualitative and draws on secondary data sources. These include industry reports from organisations such as the India Brand Equity Foundation (IBEF),the United Nations Environment Programme (UNEP),the Press Information Bureau (PIB) of India, McKinsey and Company, and various academic journals including Sage Journals and ScienceDirect. The paper also draws on news articles, company case studies, and publicly available data on the global and Indian fashion industry.

4. Impact of Digital Dressing on Sustainability and Prevention of Environmental Degradation

The fashion industry is one of the most polluting industries in the world. According to the United Nations Environment Programme (UNEP),the global fashion industry is responsible for approximately 8 to 10% of global carbon emissions, which is more than the combined emissions of all international flights and maritime shipping. The industry is also a major consumer of water. It takes approximately 2,000 litres of water to produce a single cotton T-shirt and around 7,500 litres to produce a pair of jeans. In addition, the dyeing and treatment of textiles is responsible for around 20% of industrial water pollution globally.

Digital dressing has the potential to address many of these environmental challenges. By eliminating the need for physical production at certain stages of the design and marketing process, it can significantly reduce the amount of water, chemicals, and raw materials consumed. One of the most immediate and significant applications is in the replacement of physical sampling. Traditionally, fashion brands produce multiple rounds of physical samples to test designs before going into full production. This is a highly wasteful process as the vast majority of these samples are discarded. By using 3D digital design software brands can create test and approve designs entirely in the digital space, eliminating the need for physical samples altogether.

ISSN: 2455-8834

Volume:11, Issue:07 "July 2026"

Table 2: Environmental Impact Comparison - Traditional Fashion vs Digital Dressing

Impact Category	Traditional Fashion	Digital Dressing	Reduction Potential
Carbon emissions per garment	~23 kg CO2e	Near zero (design phase only)	~95-99%
Water consumption per garment	~2,700 litres	Zero (no physical production)	~100%
Global fashion industry emissions	8-10% of global CO2	N/A	Partial offset at scale
Annual global textile waste	92 million tonnes	Reduces prototype waste	30-50% reduction in samples
Physical sample production cost	USD 500-2,000/sample	USD 50-200/digital sample	80-90% cost reduction
Average time to market	18-36 months	6-12 months	50-67% faster
Unsold inventory (% of production)	Up to 30%	Reduced via digital demand data	Potential 15-20% reduction
Microplastic pollution	Significant (synthetic fibres)	No physical fibre production	Avoidable for digital-only garments

Source: *UNEP (2023); Ellen MacArthur Foundation (2022); McKinsey Fashion on Climate Report (2020); WEF Circular Economy Report (2022)*

According to Planet Tracker (2022),a digital item has a negligible environmental footprint compared to a physical garment. The major environmental costs of digital fashion are the energy needed to run and cool the computing infrastructure required to create and host digital garments. While this is not insignificant is considerably smaller than the environmental impact of physical production.

Furthermore, digital dressing can help tackle the problem of overproduction which is one of the root causes of the fashion industry's environmental impact. The fast fashion model, which encourages consumers to buy large quantities of cheaply produced clothing, has led to a situation where an estimated 92 million tonnes of textile waste is generated globally each year (UNEP,2023).By allowing consumers to experiment with and purchase digital versions of clothing, brands can reduce the amount of physical stock they need to produce, thereby reducing waste.

ISSN: 2455-8834

Volume:11, Issue:07 "July 2026"

The Environmental Case for Digital Fashion, published by The Interline in February 2023,makes the compelling argument that even a marginal shift to digital fashion could have a significant positive environmental impact. The study concludes that by substituting just 1% of physical clothing with digital garments, the industry could save 5 trillion litres of water and eliminate a substantial amount of annual carbon emissions. If this substitution were to scale to even 10% of the market, the environmental benefits would be transformative.

5. Adoption of New Age Technology on Labour Intensive Developing Economies like India

India's textile and apparel industry is one of the largest in the world. As of 2024,the technical textiles segment alone was valued at US$ 29 billion and is projected to grow to US$ 45 billion by 2026 and US$ 309 billion by 2035 (IBEF,2024).The overall textile and apparel market is one of the country's most important export sectors, contributing 12% to total exports. More importantly, the sector employs over 45 million people directly and supports the livelihoods of an estimated 100 million people in ancillary activities. For a country with a large and growing working age population, the textile sector plays a critical role in absorbing labour and providing employment.

The adoption of digital dressing technology in India's textile sector therefore presents a complex set of opportunities and challenges. On the one hand, the technology offers the potential to modernise the industry, reduce its environmental impact, and allow Indian designers and brands to compete in the global digital fashion space. On the other hand, it raises serious questions about the impact on employment, particularly for the millions of low skilled workers who depend on the textile sector for their livelihoods.

The opportunities are significant. Indian companies that adopt 3D design software and digital sampling can reduce their costs and time to market, which in turn allows them to compete more effectively with brands from China and Bangladesh, which have lower labour costs. Digital design tools also allow Indian designers to work with international clients in real time, opening up new revenue streams and export opportunities. Companies such as Myntra and Nykaa Fashion have already begun exploring the use of digital try on technology and AI driven recommendation systems that allow consumers to virtually try on clothes before purchasing. This has been shown to reduce return rates, which is a significant cost for e-commerce businesses.

However, the challenge of labour displacement is real and significant. The McKinsey Global Institute (2017) estimated that 60% of the activities performed in the apparel and textile sector could potentially be automated. While full automation is not yet commercially viable for many parts of the production process, the adoption of digital design tools at the front end of the supply chain could reduce the demand for certain types of skilled labour, such as pattern cutters and

ISSN: 2455-8834

Volume:11, Issue:07 "July 2026"

sample machinists. In a country where these skills are held by a large number of workers, the economic consequences of this displacement could be severe.

The World Economic Forum's Future of Jobs Report (2023) notes that while technology does displace certain types of jobs, it also creates new ones. In the context of digital fashion, this would include roles such as 3D garment designers, digital fashion stylists, AR/VR developers, and digital marketing specialists. However, there is an important question about whether the workers displaced from traditional textile jobs have the skills or the access to training required to transition into these new roles. This transition challenge is particularly acute in developing economies like India, where there are significant gaps in digital literacy and access to technology.

6. Analysing Saving the Environment vs Macroeconomic Trends like Income in Developing Economies like India

The conflict between environmental sustainability and economic development is one of the central challenges of our time. For a developing country like India, this problem is particularly acute in the context of digital dressing. The argument for adopting digital fashion at scale is compelling from an environmental standpoint. However, the economic costs of this transition, particularly in terms of employment and income for textile workers, must be carefully weighed against the environmental benefits.

India's textile workers are predominantly low income. The average wage in the textile sector is significantly below the national average and many workers, particularly women, are employed in the informal economy with little or no social protection. The prospect of job losses in this sector due to technological disruption is therefore not just an economic problem but a social one. In a country where poverty and inequality remain significantly high, the displacement of low income textile workers could have serious consequences for household income, food security and social stability.

Table 3: Digital Dressing Adoption - Key Companies and Reported Outcomes

Company/Brand	Country	Technology Used	Reported Outcome
Nike	USA	3D design and virtual samples	50% reduction in physical samples; 30% faster product development
Levi's	USA	CLO3D / virtual prototyping	Reduced water use in design phase; faster

ISSN: 2455-8834

Volume:11, Issue:07 "July 2026"

			time-to-market
Zara (Inditex)	Spain	AI demand forecasting + digital design	Reduced unsold inventory; lower return rates
PVH Corp (Tommy Hilfiger, Calvin Klein)	USA	3D digital design for all products by 2024	80% reduction in physical samples for key lines
MANGO	Spain	Virtual fitting and CLO3D	40% reduction in sample production
DressX	USA	Digital-only fashion brand	97% lower carbon footprint per item vs physical garment
The Fabricant	Netherlands	Digital couture / NFT fashion	Zero physical waste; first digital dress sold for USD 9,500
Myntra (Flipkart)	India	Virtual try-on using AI	Reduced return rates; conversion rate increase of ~12%
Reliance Retail / AJIO	India	3D visualisation pilot	Under development; targeting significant sample cost reduction

Source: *McKinsey State of Fashion Report (2023); The Interline (2023); Company Annual Reports; Business of Fashion (2023)*

At the same time, the environmental costs of the current model of textile production in India are very real. India is the third largest producer of cotton in the world, and the intensive cultivation of cotton requires large amounts of water and pestidigital dressing refers to the use codes. The dyeing and finishing of textiles is a major source of water pollution in many Indian states, particularly in Gujarat, Maharashtra, and Tamil Nadu. The health costs of this pollution, borne primarily by communities living near textile factories, are significant.

The key question is therefore not whether India should adopt digital dressing, but how and at what pace this adoption should take place. A rapid and unmanaged transition to digital fashion could result in significant job losses and income shocks for vulnerable workers. On the other hand, a managed transition, supported by investment in reskilling and social protection, could allow India to capture the environmental and economic benefits of digital dressing while minimising the social costs.

ISSN: 2455-8834

Volume:11, Issue:07 "July 2026"

In economic theory, this is a classic example of the trade off between static and dynamic efficiency. In the short term, the adoption of digital technology imposes transition costs, including job losses and the need for new investment. In the long term, however, the efficiency gains from digital technology are likely to outweigh these costs, both in terms of productivity and in terms of the environmental costs that are avoided. The challenge for India's policymakers is to manage this transition in a way that is both economically efficient and socially equitable.

7. The Way Ahead for Developing Economies (India) with Respect to Increasing Role of Digital Dressing

For India, the way forward on digital dressing must be guided by a clear plan that takes into account both the opportunities and the challenges. The government, the private sector and academic institutions all have important roles to play in shaping this transition.

First, the government needs to invest in digital infrastructure and skills development. India's National Textile Policy and associated schemes need to incorporate a digital dimension, with targeted investment in training programmes that equip textile workers with the digital skills needed to participate in the new economy. This includes not just technical skills such as 3D design and digital marketing, but also foundational digital literacy skills that are a prerequisite for participation in the digital economy.

Secondly, the government should provide incentives for textile companies to adopt digital design technologies, particularly smaller and medium sized enterprises (SMEs) that may lack the capital to invest in new technology. Tax breaks, subsidised loans, and public private partnerships can all play a role in accelerating the adoption of digital design tools across the industry.

Third, India needs to develop a regulatory framework for digital fashion that addresses issues such as intellectual property rights, data privacy, and consumer protection in the digital fashion space. The rise of digital clothing raises complex questions about who owns a digital design, how designers are compensated for their work, and how consumers are protected from fraud and misrepresentation. A clear and consistent regulatory framework will be essential for building trust and confidence in the digital fashion market.

Fourth, India should position itself as a global hub for digital fashion design and development. The country has a rich tradition of textile craftsmanship and design that can be translated into the digital space. By investing in digital fashion education at the country's leading design schools and by supporting the development of Indian digital fashion brands, India can establish a competitive position in the global digital fashion market.

ISSN: 2455-8834

Volume:11, Issue:07 "July 2026"

India is already beginning to see some of these developments. The government's Make in India and Digital India programmes have begun to create the conditions for the adoption of digital technologies across a range of industries. In the fashion sector specifically, companies like Myntra, Nykaa Fashion, and Meesho are at the forefront of the digital transformation, using AI and data analytics to personalise the shopping experience and improve supply chain efficiency.

8. Conclusion

This research paper has attempted to address a complex and multi-dimensional question: how important is the new trend of digital dressing in the global textile industry, and is it a viable and sustainable alternative for developing economies like India?

The evidence suggests that digital dressing has significant potential as a tool for reducing the environmental impact of the fashion industry. By eliminating physical sampling, reducing overproduction, and offering consumers digital alternatives to physical clothing, the technology can contribute meaningfully to reducing the industry's carbon emissions, water consumption, and waste generation. However, these benefits must be weighed against the environmental costs of the digital infrastructure required to support the technology.

For India, the picture is more complex. The adoption of digital dressing technology offers real opportunities for modernisation, cost reduction, and the development of new export markets. However, it also poses serious risks to the livelihoods of the millions of low income workers who depend on the traditional textile sector. A managed and equitable transition, supported by targeted government investment in skills development, digital infrastructure, and social protection, is essential if India is to capture the benefits of digital dressing without leaving its most vulnerable workers behind.

This paper concludes that digital dressing is not a silver bullet for either the environment or for economic development, but it is a powerful tool that, if adopted thoughtfully and equitably, can contribute to both. India has both the need and the opportunity to lead this transition in a way that is consistent with its commitment to sustainable and inclusive development. The key is to act now, before the technological transition is driven entirely by market forces in a way that leaves the most vulnerable behind.

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