

Digital Fashion

Subjects: Others

Contributor: Yanbo Zhang, Chuanlan Liu, Yanru Lyu

Digital fashion may instill transformative power into the fashion industry as it can simultaneously deliver fashionability and sustainability. Renowned for their innovativeness and creativity, luxury brands embrace digital fashion and achieve market success, indicating the future of digital fashion.

Keywords: digital fashion ; sustainability ; luxury fashion brands

1. Introduction

In the realm of textiles and apparel, the prevailing issues of overproduction and excessive consumption have substantively engendered environmental harm ^{[1][2]}. According to the Environmental Protection Agency's statistics report, in 2019, solid textile waste weighing approximately 15 million tons was sent to landfills in the United States, which is nearly nine times higher than the fashion waste generated in 1960. Undoubtedly, sustainability and digitalization stand as prominent overarching trends within the fashion industry. Scholars articulate two divergent perspectives regarding the interplay between these paramount trends ^[3]. Some argue for a conflictual relationship, positing that the extensive digitalization processes entail significant energy consumption, thereby contributing to unsustainable resource utilization ^[4]. In contrast, existing research underscores the transformative capacity of cutting-edge digital technologies, including 3D modeling, blockchain, Augmented Reality, and similar innovations, to significantly advance sustainability objectives ^{[5][6]}. For instance, it has been empirically proved that the utilization of 3D prototyping technology can offer an efficacious means of combatting unsustainable practices prevalent in the fashion sector ^[6]. It is worth noting that based on advanced technologies, digital fashion garments that people could use for dressing up their avatars or on-screen physical bodies in virtual environments might be an effective way to promote sustainability in the fashion industry due to the nature of dematerialization. Nonetheless, there exists a research gap in understanding how consumers perceive digital fashion and whether their sustainability awareness impacts their perceptions, attitudes, and adoption of digital fashion.

In recent years, fashion influencers have posted photos and videos on social media platforms, showcasing their on-screen physical bodies dressed up in various digital fashion attires ^[7]. A growing array of fashion brands, particularly luxury brands, have commenced collaborations with popular three-dimensional (3D) gaming platforms, such as Roblox and Fortnite, to launch digital fashion collections for players to experience the brands virtually ^{[8][9]}. Digital fashion emerges as capable of embellishing not only avatars but also real people's on-screen physical bodies in virtual spaces.

Digital fashion bears the prospect of instilling potent and transformative vigor into the fashion sphere as it can simultaneously deliver both fashionability and sustainability. Compared to physical fashion items, digital fashion products have the potential to be more creative, liberating, and imaginative since they are not bound by physical limitations, such as material requirements, social norms, gender constraints, or cultural expectations ^[10]. Advanced technologies, such as Style 3D design software (V6) and AI-powered image generators, enable digital fashion to provide a vast range of fashion possibilities that can be swiftly generated with novelty, stylishness, creativity, and charmingly appealing visual effects ^{[11][12]}. On the other hand, due to its innate dematerialized essence, digital fashion that only exists in cyberspaces can mitigate the negative environmental impacts caused by physical fashion manufacturing and consumption ^{[11][13]}. Fashion companies can also utilize digital fashion samples to reduce manufacturing waste by cutting off sample making and promoting make-to-order production, hence promoting sustainability ^[11]. In light of the considerable potential presented by digital fashion, it is imperative to deeply comprehend consumers' perceptions and receptivity toward digital fashion products. However, an evident scarcity of empirical research has been observed regarding digital fashion products through the lens of consumer perspectives.

Luxury fashion brands hold a prominent position as trendsetters, renowned for their innovativeness and creativity ^[14]. The degree to which luxury brands employ a digital fashion strategy and achieve market success in this domain is indicative of the digital fashion industry's future. To stay at the forefront of the fashion industry and cater to the evolving needs of consumers, luxury brands are embracing digital fashion. For instance, in 2021, Gucci experienced remarkable success by

unveiling its first digital sneakers known as the Gucci Virtual 25, which can be worn through Augmented Reality (AR) and/or Virtual Reality (VR) technologies ^[15]. Balenciaga partnered with the 3D gaming platform Fortnite to release exclusive digital fashion collections for players ^[15]. While there is a growing interest among consumers in digital fashion offerings by luxury brands, there is still much to be explored and understood regarding consumers' attitudes, preferences, and acceptance of these offerings. Notably, there is a salient research dearth concerning consumers' assessments of digital fashion offerings by luxury brands.

The extant literature related to digital fashion primarily includes research on 3D digital fashion design ^[16], digital fashion designers ^[11], historical clothing digitalization ^[17], virtual try-on technology ^[18], virtual fashion in 3D gaming worlds ^[19], and conceptual literature ^{[8][20]}. There is a notable research gap concerning the empirical examination of consumers' perceptions and assessments of digital fashion products. The digital fashion industry lacks comprehensive and evidence-based guidance for its practices.

2. Digital Fashion

The term "digital fashion" has been extensively employed by scholars; however, its definitions and manifestations vary due to different research focuses and scopes. For instance, Noris, Nobile ^[21] have presented a conceptual framework for digital fashion from a marketing and communication standpoint. Wearable smart clothing that can be achieved through the integration of electronic components into textile fabrics is occasionally denoted as digital fashion apparel ^[22]. Baek, Haines ^[20] employed a systematic literature review approach to identify six themes regarding digital fashion: design, consumer, virtual, body, printing, and supply. Based on the six themes, researchers proposed a unified working definition of digital fashion: "the virtual creation, production, and representation of one's identity via computer-generated design", involving three aspects of the value chain, fashion-design process, and consumer experiences ^[20].

Even though certain fashion brands and emerging digital fashion enterprises have commenced the offering of digital fashion garments to consumers within the past few years ^{[8][11]}, it is noteworthy that the lineage of digital fashion possesses a comparatively long history. As early as 2003, game players were already able to dress their avatars with a variety of digital items including clothes, shoes, hats, and other accessories in Second Life, a 3D game that underwent remarkable exponential expansion ^{[19][23]}. Avatars refer to virtual manifestations of physical users within diverse virtual realms, serving as representations of their digital selves ^[24]. In recent years, the popularity of using digital clothing and accessories to dress up avatars in games such as Animal Crossing, Overwatch, and Fortnite has increased considerably, becoming a significant source of revenue for the gaming industry ^[7]. The virtual gaming industry has laid the foundation for the growth of digital fashion. With the advancement of 3D modeling and VR technologies, avatars have undergone continuous refinement, becoming increasingly lifelike and finding extensive applications in virtual try-on services and virtual fashion shows ^{[9][25]}. Nevertheless, it should be acknowledged that avatars cannot entirely represent real individuals and attain photorealistic effects, thereby rendering discernable distinctions between avatars and real people ^[26].

Some fashion brands offering virtual try-on services have employed AR technology to overlay digital fashion garments onto the physical bodies of real individuals, such as virtual try-on mirrors within brick-and-mortar stores or dedicated AR try-on applications accessible on portable devices ^{[7][27]}. This enables consumers to share AR-enhanced virtual try-on photos or videos on social media platforms or with online friends, showcasing themselves adorned in digital fashion attire rather than physical fashion items ^[28]. Furthermore, AI-based image-generation systems have advanced to the degree of enabling the seamless mapping of digital fashion attire onto individuals' two-dimensional (2D) images ^[29]. To obtain heightened visual fidelity, some digital fashion companies like DressX provide a distinctive service of synthesizing consumers' purchased digital fashion apparel into their uploaded photographs ^[8]. Prior research has revealed that consumers, particularly the younger cohorts such as Generation Y (Gen Y) and Generation Z (Gen Z), exhibit a proclivity for regularly sharing fashion visual content, encompassing photographs or videos, wherein they showcase themselves adorned in fashion-forward outfits ^{[30][31][32]}. Unsurprisingly, the trend of dressing up on-screen physical bodies of real people has emerged and garnered significant attention and engagement in several recent years ^{[7][11]}.

Along with the development of digital fashion, its two fundamental functions could be highlighted: outfitting avatars and dressing up real people in virtual worlds. While the practice of embellishing avatars through the application of digital items lasts a relatively long time, the domain of digital fashion, capable of outfitting avatars and tangible individuals within virtual realms, remains in its early stages of development for most consumers. To offer visual references, scholars utilized an AI image generator, Midjourney, to generate a set of digital fashion images distinctively tailored for adorning avatars and real individuals, as visually depicted in **Figure 1** and **Figure 2**.



Figure 1. Examples of outfitting avatars.

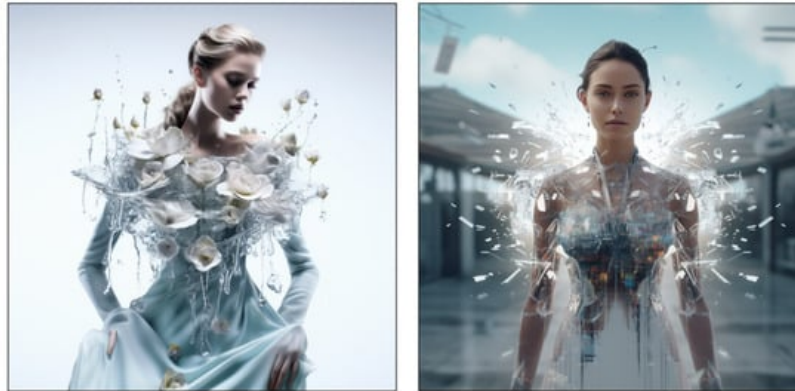


Figure 2. Examples of dressing real people in virtual spaces.

3. Luxury Brands and Digital Fashion

The adoption of digital fashion holds considerable advantages for luxury fashion brands. First and foremost, employing the digital fashion strategy could help luxury fashion brands uphold their leading positions as trendsetters and exhibit their creativity and innovativeness. Advanced technologies empower luxury fashion designers to craft digital collections with diverse effects, ranging from lifelike representations of physical clothing to fantastical visual outcomes unattainable through traditional means. For instance, garments can feature dynamic elements such as flowers blooming from pockets or boots seemingly aflame. Furthermore, without physical prototyping and manufacturing, designing and creating digital fashion products can be highly efficient ^{[10][11]}. A noteworthy instance is a collaboration between digital fashion designer Amber Jae Slooten and a software developer, resulting in an AI-based GAN model ^[10]. This model utilizes Paris Fashion Week photo datasets as the input to generate countless optimized photorealistic fashion design patterns including shapes, colors, and styles. Therefore, the potential of digital fashion to offer exclusively fashionable products can enhance luxury brands' capacity to wield creativity and innovation, further solidifying their status as trendsetters in the fashion kingdom.

Moreover, digital fashion offers luxury brands an opportunity to showcase their core values such as rarity, prestige, authenticity, and exclusivity while providing unique experiences for their consumers and enhancing their degree of engagement. One way for luxury brands to fully embrace exclusivity and authenticity is by launching digital fashion Nonfungible Tokens (NFTs) ^[8]. NFTs refer to indivisible and exclusive digital assets with verifiable ownership ^[33]. Based on blockchain technology, digital fashion NFTs can trace the origin and transaction history of the entire chain, providing sufficient protection of ownership to both luxury fashion brands and consumers while preventing counterfeiting ^[8]. This exclusive advantage of NFTs has been legitimized and validated in contemporary digital artworks through auctions and transactions held by well-known institutions such as Sotheby's ^[34]. The resale of luxury brands' digital fashion NFTs, similar to the collection and trading of digital artworks, may be quite attractive to consumers since the potential for financial gain from digital fashion NFTs is intrinsically linked to the psychological aspect regarding the appeal of scarcity ^[35]. Despite initial concerns surrounding the energy wastage associated with blockchain and NFT technology, the Ethereum blockchain is transitioning from energy-intensive to energy-efficient modes, anticipating over a 90% reduction in the energy requirement ^[34]. Overall, developing digital fashion NFTs provides luxury brands with a new way to exhibit exclusive luxury value and engage with consumers on a deeper level.

As digitalization continues to expand globally, there is a notable increase in the considerable time that consumers spend online, particularly observed among the young demographic with a keen interest in gaming and social media [15]. Specifically, Gen Y and Gen Z consumers display a willingness to regularly share fashion-related content, including fashion selfies, on social media platforms [30][36]. The remarkable purchasing power of luxury fashion products has been revealed among Gen Z consumers [32][37]. In light of this context, digital fashion, capable of dressing up both avatars and real people in virtual spaces, has captured young consumers' attention and interests and might see a substantial rise in consumption soon. Compared to conventional physical products, digital fashion is not restricted by physical requirements, such as size and gender, and can be produced without using any physical materials [9][15][20], thereby offering greater sustainability and inclusivity and appealing to young consumers concerned about environmental and social issues. Consequently, the development of digital fashion products emerges as a promising approach for luxury brands to cater to the preferences and requirements of young consumers within the Metaverse era.

A few studies and industry reports have shed light on the current implementation and accomplishments of digital fashion by luxury brands. For instance, in 2021, Dolce & Gabbana's digital fashion collection sold out for approximately USD 6 million, with "The Doge Crown", the most expensive item, fetching about USD 1.3 million [7][8]. Renowned luxury fashion retailer FARFETCH has also utilized digital samplings of physical garments to dress their brand ambassadors to promote new launches [28]. To commemorate its 200th anniversary, Louis Vuitton introduced a video game that incorporated NFTs [35]. Ralph Lauren collaborated with the South Korean social network app Zepeto, resulting in the development of a digital fashion collection that enables users to adorn their avatars with distinctive digital fashion merchandise [35]. Overall, these examples have highlighted the significant potential and opportunities for luxury brands to extend into the digital fashion market.

References

1. Ozdamar Ertekin, Z.; Atik, D. Sustainable markets: Motivating factors, barriers, and remedies for mobilization of slow fashion. *J. Macromark.* 2015, 35, 53–69.
2. Henninger, C.E.; Alevizou, P.J.; Oates, C.J. What is sustainable fashion? *J. Fash. Mark. Manag. Int. J.* 2016, 20, 400–416.
3. Joerß, T.; Hoffmann, S.; Mai, R.; Akbar, P. Digitalization as solution to environmental problems? When users rely on augmented reality-recommendation agents. *J. Bus. Res.* 2021, 128, 510–523.
4. Krause, M.J.; Tolaymat, T. Quantification of energy and carbon costs for mining cryptocurrencies. *Nat. Sustain.* 2018, 1, 711–718.
5. Bang, H.; Su, J. Who Uses Virtual Wardrobes? Investigating the Role of Consumer Traits in the Intention to Adopt Virtual Wardrobes. *Sustainability* 2022, 14, 1209.
6. Papahristou, E.; Bilalis, N. Should the fashion industry confront the sustainability challenge with 3D prototyping technology. *Int. J. Sustain. Eng.* 2017, 10, 207–214.
7. Palumbo, J. Digital Dress Codes: What Will We Wear in the Metaverse? Available online: <https://www.cnn.com/style/article/metaverse-digital-fashion/index.html> (accessed on 1 May 2022).
8. Joy, A.; Zhu, Y.; Peña, C.; Brouard, M. Digital future of luxury brands: Metaverse, digital fashion, and non-fungible tokens. *Strateg. Chang.* 2022, 31, 337–343.
9. Park, H.; Lim, R.E. Fashion and the metaverse: Clarifying the domain and establishing a research agenda. *J. Retail. Consum. Serv.* 2023, 74, 103413.
10. Särmäkari, N.; Vänskä, A. 'Just hit a button!'—fashion 4.0 designers as cyborgs, experimenting and designing with generative algorithms. *Int. J. Fash. Des. Technol. Educ.* 2022, 15, 211–220.
11. Särmäkari, N. Digital 3D Fashion Designers: Cases of Atacac and The Fabricant. *Fash. Theory* 2023, 27, 85–114.
12. Sayem, A.S.M. Digital fashion innovations for the real world and metaverse. *Int. J. Fash. Des. Technol. Educ.* 2022, 15, 139–141.
13. Hoekstra, C. Digital fashion for sustainable change: A strategy for digital fashion at Tommy Hilfiger. Master's Thesis, Delft University of Technology, Delft, The Netherlands, 2021.
14. Lawry, C.A. Futurizing luxury: An activity-centric model of phygital luxury experiences. *J. Fash. Mark. Manag. Int. J.* 2022, 27, 397–417.

15. Rolland, M.L. From NFTs to Body Doubles: Why Virtual Fashion is Becoming Big Business. Available online: <https://www.euromonitor.com/article/from-nfts-to-body-doubles-why-virtual-fashion-is-becoming-big-business> (accessed on 1 May 2023).
16. Volino, P.; Cordier, F.; Magnenat-Thalmann, N. From early virtual garment simulation to interactive fashion design. *Comput.-Aided Des.* 2005, 37, 593–608.
17. Meier, C.; Berriel, I.S.; Nava, F.P. Creation of a Virtual Museum for the Dissemination of 3D Models of Historical Clothing. *Sustainability* 2021, 13, 12581.
18. Lee, H.; Xu, Y. Classification of virtual fitting room technologies in the fashion industry: From the perspective of consumer experience. *Int. J. Fash. Des. Technol. Educ.* 2020, 13, 1–10.
19. Liao, C. Virtual fashion play as embodied identity re/assembling: Second Life fashion bloggers and their avatar bodies. In *Reinventing Ourselves: Contemporary Concepts of Identity in Virtual Worlds*; Peachey, A., Childs, M., Eds.; Springer: London, UK, 2011; pp. 101–127.
20. Baek, E.; Haines, S.; Fares, O.H.; Huang, Z.; Hong, Y.; Lee, S.H.M. Defining digital fashion: Reshaping the field via a systematic review. *Comput. Hum. Behav.* 2022, 107407.
21. Noris, A.; Nobile, T.H.; Kalbaska, N.; Cantoni, L. Digital fashion: A systematic literature review. A perspective on marketing and communication. *J. Glob. Fash. Mark.* 2021, 12, 32–46.
22. Koo, S.; Chae, Y. Wearable Technology in Fashion. In *Leading Edge Technologies in Fashion Innovation*. Palgrave Studies in Practice: Global Fashion Brand Management; Lee, Y.A., Ed.; Palgrave Macmillan: Cham, Switzerland, 2022; pp. 35–57.
23. Koles, B.; Nagy, P. Virtual customers behind avatars: The relationship between virtual identity and virtual consumption in second life. *J. Theor. Appl. Electron. Commer. Res.* 2012, 7, 87–105.
24. Barrera, K.G.; Shah, D. Marketing in the Metaverse: Conceptual understanding, framework, and research agenda. *J. Bus. Res.* 2023, 155, 113420.
25. Liu, K.; Wang, J.; Zhu, C.; Kamalha, E.; Hong, Y.; Zhang, J.; Dong, M. A mixed human body modeling method based on 3D body scanning for clothing industry. *Int. J. Cloth. Sci. Technol.* 2017, 29, 673–685.
26. Silva, E.S.; Bonetti, F. Digital humans in fashion: Will consumers interact? *J. Retail. Consum. Serv.* 2021, 60, 102430.
27. Hsu, S.H.-Y.; Tsou, H.-T.; Chen, J.-S. “Yes, we do. Why not use augmented reality?” customer responses to experiential presentations of AR-based applications. *J. Retail. Consum. Serv.* 2021, 62, 102649.
28. McDowell, M. Influencers are Wearing Digital Versions of Physical Clothes Now. Available online: <https://www.voguebusiness.com/technology/influencers-are-wearing-digital-versions-of-physical-clothes-now> (accessed on 3 May 2022).
29. Luce, L. Artificial Intelligence for Fashion: How AI Is Revolutionizing the Fashion Industry; Apress: Berkeley, CA, USA, 2019; pp. 127–128.
30. Reilly, A.; Hawley, J. Attention deficit fashion. *Fash. Style Pop. Cult.* 2019, 6, 85–98.
31. Solomon, M.R. Consumer Behavior: Buying, Having, and Being; Pearson: Boston, MA, USA, 2018; pp. 186–187.
32. Mondalek, A. The Complete Guide to Influencer Marketing. Available online: <https://www.businessoffashion.com/case-studies/marketing-pr/fashion-beauty-brand-influencer-marketing-strategy-guide/> (accessed on 11 November 2022).
33. Banerjee, A.; Byrne, R.; Bode, I.D.; Higginson, M. Web3 beyond the Hype. Available online: <https://www.mckinsey.com/industries/financial-services/our-insights/web3-beyond-the-hype> (accessed on 12 November 2022).
34. Treiblmaier, H. Beyond blockchain: How tokens trigger the internet of value and what marketing researchers need to know about them. *J. Mark. Commun.* 2023, 29, 238–250.
35. Balchandani, A.; Berg, A.; Hedrich, S.; Jensen, J.E.; Merle, L.L.; Rölkens, F. How the Fashion Industry Can Get into a Metaverse Mindset. Available online: <https://www.mckinsey.com/industries/retail/our-insights/how-the-fashion-industry-can-get-into-a-metaverse-mindset> (accessed on 3 March 2023).
36. Zhang, Y.; Liu, C.; Lyu, Y. Profiling Consumers: Examination of Chinese Gen Z Consumers' Sustainable Fashion Consumption. *Sustainability* 2023, 15, 8447.
37. Sun, Y.; Wang, R.; Cao, D.; Lee, R. Who are social media influencers for luxury fashion consumption of the Chinese Gen Z? Categorisation and empirical examination. *J. Fash. Mark. Manag. Int. J.* 2022, 26, 603–621.

