

# Can the Metaverse support sustainable business models in the fashion industry? - A literature-based analysis

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**Abstract:** Fashion is one of the most polluting industries globally. It triggers environmental and social issues such as the exploitation of cheap and forced labor, as well as excessive resource utilization. The exploration of sustainable business models based on the “Triple Bottom Line” (TBL) should represent an essential endeavour for entrepreneurs and stakeholders in fashion companies. In recent years, as in many other industries, the Metaverse has rapidly penetrated the fashion industry. Currently, fashion incumbents like Gucci, Burberry, Nike, Adidas, and Ralph Lauren are experimenting with this new technology. From a sustainability perspective, the Metaverse enabled Gucci, for example, to introduce “Gucci Virtual 25” sneakers, exclusively existing in the virtual world, offering young consumers access to luxury-fashion at more affordable prices while meeting their shopping needs, without causing environmental pollution and waste associated with physical products. Due to the potential of the Metaverse in supporting sustainability in fashion, we propose to address three research questions. First, is virtual fashion able to effectively support sustainability within the real-world fashion industry? Second, as virtual fashion gains traction, how can the Metaverse support it? Third, what are the business models that fashion companies can leverage in the context of the Metaverse? In other words, how can fashion companies monetize their offerings in the Metaverse? Thus, through a literature-based analysis, the paper aims to investigate the potential of the Metaverse in creating business models that support sustainability in real-world fashion.

**Keywords:** Virtual Fashion; Metaverse; Fashion; Sustainability; Business Model

## 1. Introduction

Fashion is one of the most lucrative yet environmentally impactful industries characterized by resource exploitation, carbon emissions, and social challenges due to low-cost sourcing practices, all of them still unresolved (Niinimäki et al., 2020).

With the advent of Industry 5.0 and the development of artificial intelligence (AI), blockchain technology, Web 3.0, and other related technologies, we have observed a rising phenomenon of virtual fashion (Venturini & Columbano, 2024). For instance, Nike partnered with Roblox to create “Nikeland”, where users earn rewards for virtual products through gameplay and purchase virtual goods mirroring Nike’s real-life products in a digital exhibition hall (Mancuso et al., 2023). Gucci generated \$11.56 million in Non-Fungible Tokens (NFTs) revenue in 2021, and launched “Gucci Garden” on Roblox for virtual exhibitions connected to their physical headquarters, while also introducing the “Gucci Virtual 25 Sneaker” for around ten dollars to offer young consumers affordable luxury (Joy et al., 2022; Mancuso et al., 2023). Coincidentally, luxury and fashion houses such as Dior, Louis Vuitton, Dolce & Gabbana, Balenciaga, Burberry, Tommy Hilfiger, Adidas, Zara, and emerging digital-only fashion brands such as The Fabricant and RTFKT, among others, are actively venturing into the Metaverse with virtual fashion products (Joy et al., 2022; Casciani et al., 2022; Huggard & Särämäkari, 2023; Schauman et al., 2023; Mancuso et al., 2023; Biliakovych et al., 2024; Russo et al., 2024).

This research is motivated by observations of fashion companies entering the Metaverse for commercial activities. Our aim is to determine if virtual fashion can

support economically, environmentally, and socially sustainable business models in the real-world fashion industry through the Metaverse by addressing the following questions:

1. Can the virtual fashion activities support sustainability within the real-world fashion industry? If yes, how?
2. How can virtual fashion be supported by the Metaverse?
3. How can fashion companies leverage the Metaverse to monetize their offerings and introduce new revenue streams to virtual fashion?

These interconnected questions concern how the Metaverse can support virtual fashion, the methods of its value monetization related to business models, and whether the virtual fashion through the Metaverse can potentially support the sustainability of real-world fashion.

## 2. Methodology

The literature analysis was structured around three main pillars. First, a comprehensive search on the Scopus database was conducted to explore if the virtual fashion can enhance sustainability in the real-world fashion supply chain and the relationship between the virtual fashion and the Metaverse. Second, we examined cases related to how industry incumbents and practitioners leverage virtual fashion in the Metaverse, and the monetization strategies adopted by fashion companies using the Metaverse, while dedicating attention to economic and socio-environmental perspectives, and third, we synthesized the finding, discuss challenges and future opportunities associated with the virtual fashion through the Metaverse in fostering sustainable fashion practices. The study employed a

systematic literature search method and utilized a narrative review to analyze and synthesize the outcomes.

The first query aimed to assess the role of virtual fashion in enhancing real-world fashion sustainability. Criteria included searching for articles with the keywords “Digital fashion” OR “Virtual Fashion” AND “Sustainab\*” in the Title, Abstract, Keywords fields, covering the period from 2014 to 2024. We selected English-language papers of type “Article”, yielding 16 papers. After screening abstracts, we exclude those lacking substantive analysis, leading to 14 relevant papers. Further review of full texts focused on understanding the contributions of virtual and digital fashion to sustainability in the fashion supply chain, resulting in 12 papers within the scope.

The second query aimed to explore how fashion incumbents and practitioners utilize the Metaverse for virtual fashion activities. We applied the criteria: Title-Abs-Key “Digital Fashion” OR “Virtual Fashion” AND Title-Abs-Key “Metaverse”, with a time restriction from 2019 to 2024, as the most relevant discussions about the Metaverse have occurred after 2019. We included only articles in English, resulting in 15 relevant papers. After screening abstracts and retaining only those that deal with the interaction between virtual fashion and the Metaverse, 12 papers remained. After thoroughly reviewing these papers, only 6 papers have been selected for this review, as they are within the scope of the study.

The third query aimed to uncover how fashion incumbents monetize their value propositions in the Metaverse. The query criteria included Title-Abs-Key searches for “Metaverse” AND (“Business model” OR “Value capture” OR “Value proposition” OR “Monetize\*”) AND (“Fashion” OR “Luxury” OR “Digital”), limited to English articles published from 2019 to 2024 in the subject areas of “Business, Management and Accounting” and “Social Science”. This search yielded 22 articles. After reviewing the full texts, we identified 5 articles that explored the business models and methods through which fashion companies monetize their value propositions, while ensuring no overlap with the previous two queries.

The same articles found by different queries will not be counted twice; they will be classified under the first query

Cluster	Author	Support Environmental	Support Social Sustainability	Support Economic Sustainability	Support Culture Sustainability
Query1	Wagner & Kabalska, 2023	x		x	
Query1	Casciani et al., 2022	x	x	x	x
Query1	Choi, 2022	x	x		x
Query1	Schauman et al., 2023	x	x	x	x
Query1	Watanabe et al., 2021		x	x	
Query1	Venturini & Columbano, 2024		x	x	
Query1	Huyñh, 2022	x	x	x	
Query1	Zhang et al., 2023	x	x	x	
Query1	Bang & Su, 2022		x		
Query1	Fu & Liang, 2022		x	x	x
Query1	Biliakovych et al., 2024	x	x	x	
Query1	Hardabkhadze et al., 2023	x	x		
Query2	Kim & Chakraborty, 2024		x	x	
Query2	Donvito et al., 2024		x		
Query2	Chan et al., 2024			x	
Query2	Park et al., 2023		x	x	
Query2	Huggard & Särmäkari, 2023	x	x	x	
Query2	Joy et al., 2022	x	x	x	
Query3	Mancuso et al., 2023		x	x	
Query3	Queiroz et al., 2023		x	x	
Query3	Büchel & Spinler, 2024			x	
Query3	Zhang & Ye, 2023			x	
Query3	Russo et al., 2024			x	

Table 1: Literature Analysis

that found them. In all three queries, a total of 23 articles were within scope and included for full-text review. We have labelled these 23 articles according to the perspectives they cover. More details can be found in Table 1.

### 3.Results

This section explores how virtual fashion, particularly through the Metaverse, can support the sustainable development of the fashion supply chain. This includes addressing environmental, social, economic (TBL), and cultural sustainability (Abdelkafi et al., 2023; Casciani et al., 2022; Fu & Liang, 2022).

Virtual fashion as a subset of digital fashion, includes computer-generated garments and accessories for avatars and physical selves in cyberspaces (Zhang et al., 2023). It relies on 3-dimensional virtual and digital (3DVD) technologies, such as 3D modeling, Virtual Reality (VR) and Augmented Reality (AR), 2D and 3D scanning, and Digital Twinning (DT), providing immersive experiences for tech-savvy customers, mainly Gen Y and Gen Z (Zhang et al., 2023).

The Metaverse as a 3D mimic reality space, combines technologies like 6G, AI, VR, and Blockchain, enabling limitless interaction between humans and avatars (Mancuso et al., 2023). Together, virtual fashion and the Metaverse create and deliver value through these emerging technologies, as explained in the following paragraphs.

#### 3.1 How can virtual fashion potentially support the sustainability of the real-world Fashion?

##### 3.1.1 Environmental Perspective

In its 2021 winter collection, Italian startup Bacon Clothing collaborated with technology company TwinOne by utilizing DTs. They claimed that by minimizing physical paper and fabric usage, they saved approximately 2 kilograms of carbon dioxide, 40,000 liters of water, and three trees (Wagner & Kabalska, 2023). Furthermore, digitally co-designed and on-demand garments have increased emotional and functional value, fostering attachment between users and garments and potentially extending the product’s lifespan (Casciani et al., 2022). Life Cycle Assessment (LCA) shows that a digital T-shirt may eliminate 683 litres of water consumption, and reduce CO2 emissions from 7.8 kg to 0.26 kg (Huggard & Särmäkari, 2023).

Biliakovych et al. (2024) emphasize that virtual fashion employs machine learning, data analysis, and AI to enhance personalization for meeting consumer demands, while noting that zero-waste pattern cutting (ZWPC) technology reduces textile waste by 10%-30%, thereby minimizing environmental impact (Biliakovych et al., 2024). DTs can enhance production efficiency and accuracy while mitigating return risks due to mismatched customer expectations of fit (Wagner & Kabalska, 2023). Furthermore, digital and virtual fashion can contribute to sustainable development in the industry by offering innovative design tools, digital sales platforms, and integrating resources from environmental organizations

and scientific research institutions (Hardabkhadze et al., 2023).

However, taking a broader perspective, information and communication technology (ICT) itself contributes to 1.8-2.8% of global greenhouse gas emissions, and digital and virtual fashion products necessitate substantial 3D/VR infrastructure closely linked to ICT (Casciani et al., 2022). Due to the energy required for creating and storing digital files, digital and virtual fashion heavily triggers carbon footprint (Biliakovich et al., 2024). Therefore, evaluating the overall sustainability of digital and virtual fashion cannot solely focus on its direct environmental impact but must also be examined from a broader perspective (Casciani et al., 2022; Biliakovich et al., 2024).

### 3.1.2 Social Perspective

The Bacon Clothing - Twin One project, which occurred during the COVID-19 pandemic shows that remote collaboration enhances work efficiency. This eliminates the need for unnecessary physical samples and reduces production accidents or unsaleable items due to unpopular designs (Wagner & Kabalska, 2023). Thus, it supports, to some extent, not only the reduction of resource waste but also mitigates the dangers posed by the work environment (Wagner & Kabalska, 2023).

Bang & Su (2022) revealed that the sense of social responsibility and technological innovation conveyed by companies can stimulate consumer interest (Bang & Su, 2022). Zhang et al. (2023) found that consumers' willingness to purchase is not only related to virtual try-on technologies in virtual and real-world settings, but also influenced by their own social values and environmental engagement (Zhang et al., 2023). Therefore, the social and environmental values conveyed to consumers by brands and companies through digital or virtual fashion can serve as a medium for self-expression, self-presentation, and communication with others, just like physical fashion (Zhang et al., 2023).

Furthermore, a digital-only fashion platform can offer marginalized groups like female, LGBTQIA+ (Lesbian, Gay, Bisexual, Transgender, Queer/Questioning, Intersex, Asexual, and other identities), BIPOC (Black, Indigenous, and People of Color) fashion creators an equal share of revenue, promoting more inclusivity (Huggard & Särämäkari, 2023). Digital fashion experiences can provide LGBTQIA+ with a private try-on environment, protecting more privacy and emotions (Bernat & Domoszlai-Lantner, 2023). This point helps a broader range of people achieve self-expression and recognize their own value, thereby enhancing social diversity and inclusivity.

### 3.1.3 Economic Perspective

According to professional statistics, the digital fashion market reached a value of US\$120 million in 2021 and is projected to grow at a compound annual growth rate of 187.6% over the next five years, potentially exceeding US\$50 billion by 2030 (Chan et al., 2024). The Metaverse, as a tool for digital fashion products, is emerging as a potent new commercial channel offering customers immersive and emotional experiences distinct from e-commerce and

offline commerce, with its size projected to rapidly grow to \$678.8 billion by 2030 (Büchel & Spinler, 2024; Venturini & Columbano, 2024). This will be discussed in more depth in Section 3.3.

### 3.1.4 Culture Perspective

Sustainable development is usually considered to include three pillars: ecological, economic, and social dimensions (Abdelkafi et al., 2023). However, more and more scholars believe that cultural sustainability should be seen as the fourth pillar of sustainable development (Soini & Birkeland, 2014).

3D/VR technologies can impact environmental, social, economic sustainability by shaping the organizational culture of companies and influencing the cultural systems of consumers through engagement across the entire fashion supply chain (Casciani et al., 2022). Digital substitutes can encourage consumers to adopt less resource-intensive consumption patterns, enhance their guilt-free enjoyment, and foster the development of a more sustainable consumption culture (Schauman et al., 2023). Research by Fu & Liang (2022) found that Chinese gamers buy game skins and digital clothing for their entertainment and cultural value (Fu & Liang, 2022). Authentic cultural elements in traditional clothing skins boost cultural pride and confidence among gamers, thus fostering cultural identity in both the real and virtual worlds (Fu & Liang, 2022). This helps Chinese youth develop proper cultural and national values, while advancing the sustainable development of traditional Chinese clothing culture (Fu & Liang, 2022). The virtual fashion has potential to support the cultural sustainability of fashion.

## 3.2 How can virtual fashion be supported by the Metaverse?

### 3.2.1 Metaverse Technologies

Companies are actively engaged in using 3D/VR technologies, to create virtual fashion activities, of which the Metaverse is one instrument (Choi, 2022; Biliakovich et al., 2024; Casciani et al., 2022). The Metaverse is built on five key technology clusters: interactive simulations like AR and VR, AI, creation platforms such as 3D engines and DTs, blockchain technologies including distributed ledgers and NFTs, and network and computing technologies like IoT and cloud computing (Russo et al., 2024).

Specifically, 3D modeling and printing can be used for producing real products, showcasing designs, or manufacturing products in virtual reality. Many fashion brands such as Adidas, H&M, Tommy Hilfiger, Balenciaga, and others utilize this technology for designing fashion collections (Biliakovich et al., 2024). Commonly used software programs include CLO 3D, Browzwear, Optitex, and Marvelous Designer, etc. (Biliakovich et al., 2024). Moreover, 3D modeling can also provide some effects that real-world fashion design cannot achieve, such as purely virtual flames and liquid silver clothing effects (Casciani et al., 2022).

DTs virtualize appearances, choices, and characteristics, enabling efficient fashion collection testing and optimizing

supply chains without material waste (Wagner & Kabalska, 2023). They enhance fashion’s economy, environmental friendliness, and positive outcomes (Wagner & Kabalska, 2023; Zhang & Ye, 2023). 3D design tools enable fashion designers to simulate garment materials, sizes, and effects, thereby reducing fabric waste and delivery time, while integrating body scanning technology enhances fit assessments, improves buyer data prediction, and provides personalized purchasing advice (Wagner & Kabalska, 2023).

Furthermore, AR overlays virtual digital layers onto the physical environment to achieve enhanced visual synthesis effects, widely utilized in physical stores and e-commerce platforms to elevate retail atmosphere and enhance customer experience (Periyasamy & Periyasami, 2023). Amazon has been using AR technology to support their fashion sales sphere since 2018 through their “AR Mirror” program (Watanabe et al., 2021). Snap also tested their “AR Mirror” with Nike at the Williamsburg store in New York, allowing clients to try on clothes virtually without physically putting them on (Snapchat, 2024). Virtual fitting room or virtual try-on technology allows customers to preview their appearance before purchase, thus enhancing the shopping experience and reducing unnecessary returns, costs, and waste (Wagner & Kabalska, 2023).

Unlike AR, VR technology leverages computer vision and machine learning algorithms, along with physical tools like VR headsets and touch controllers, enabling consumers to have a 360-degree immersive virtual experience of trying on and purchasing clothes in 3D virtual stores (Casciani et al., 2022).

### 3.2.2 Value Creation Support

Venturini & Columbano (2024) identified five values—utilitarianism, social identity, anthropomorphism, hedonism, and personal beliefs—that virtual fashion in the Metaverse provides, guiding technological innovations and experience upgrades aimed at enhancing consumer engagement (Venturini & Columbano, 2024).

The Metaverse’s most intuitive function for consumers involves the collaboration between virtual gaming platforms and haptic technology to enhance immersive experiences and utilize gamification to influence real-world behaviors (Park et al., 2023; Kim & Chakraborty, 2024). This method is widely adopted by many fashion incumbents, including Gucci, Nike, and Dior, who sell avatar skins on gaming platforms such as Minecraft, Roblox, and Animal Crossing (Venturini & Columbano, 2024). With advancements in 3D modeling and VR technology, virtual avatars are increasingly realistic, widely utilized in virtual try-on services and fashion shows, enhancing consumers’ intuitive experience of self-expression and communication in the virtual world (Park et al., 2023; Venturini & Columbano, 2024; Zhang et al., 2023). Digital fashion influencers and market experts in Metaverse play a crucial role in promoting digital fashion by guiding consumers to experience the authentic tactile sensation of digital fashion products, providing similar emotional value and interactive experiences as in the real world (Donvito et al., 2024; Kim & Chakraborty, 2024).

Furthermore, gamification in the Metaverse supports immersive customer experiences and benefits fashion companies, with Nike CEO John Donahoe emphasizing the use of branded NFTs for revenue by merging the Metaverse with traditional models, while platforms like Roblox aid in product testing, support omnichannel efforts, and help Nike reduce unsuccessful designs for sustainability (Mancuso et al., 2023).

At the same time, some experts have pointed out that while the Metaverse, as an instrument of virtual fashion, provides fun and communication convenience through “second life”, it also impacts the physical retail industry and leads to various social problems, including virtual riots, Ponzi schemes, and pseudo-strip clubs (Joy et al., 2022). The hidden dangers may also include mental health problems such as alienation and personality disorders, technology addiction, and issues related to privacy, data security, laws, and regulations (Donvito et al., 2024).

### 3.3 How can fashion companies leverage the Metaverse to monetize their offerings and introduce new revenue streams to virtual fashion?

The Metaverse is an immersive and emotional way that meets customer needs through additional channels beyond e-commerce and offline commerce (Büchel & Spinler, 2024). Fashion companies can use advanced technologies such as AI and natural language processing to create 3D immersive product experiences and virtually interact with customers, enhancing brand image, shopping experience, and overall competitiveness (Joy et al., 2022; Büchel & Spinler, 2024).

The Metaverse facilitates new value creation and capture mechanisms through two main business model concepts: internal processes and customer engagement (Mancuso et al., 2023). Internal processes involve enhancing the product portfolio, improving interaction methods through channels, and augmenting physical products in channels (Mancuso et al., 2023). On the customer side, the focus includes affirming virtual identities and building communities, among other strategies (Mancuso et al., 2023).

#### 3.3.1 Target Customers

Tech-savvy and younger cohorts show a greater acceptance of virtual fashion (Joy et al., 2022). Millennials and Generation Z consumers, known for their high acceptance and use of technology, are expected to constitute the primary consumer base (Park et al., 2023; Zhang et al., 2023). According to Gucci’s Executive Vice President responsible for brand and customer interaction, Robert Triefus, these demographics are willing to pay premium prices for NFTs and digital collectibles, embracing a second life in the virtual universe (Joy et al., 2022).

#### 3.3.2 Types of Products

Chan et al. (2024) classified six different forms of digital fashion end products and their characteristics: Digital Skin for Gamified Environment, Digital Skin for Virtual Influencers, Superimposed Image Based, AR-filter Based, Fashion NFTs, and Digital Twins (Chan et al., 2024).

### 3.3.3 Monetization Methods

Incumbent companies in the Metaverse can be categorized into three types based on their goals and involvement. First, brands like PVH Group and Gucci use virtual fashion to enhance their traditional products’ production and marketing. Second, companies like Sunnei and Nike integrate virtual fashion to boost sales of physical products and create revenue from virtual items. Third, entities like The Fabricant focus exclusively on virtual fashion products, operating within the digital realm of the Metaverse (Casciani et al., 2022).

According to the value capture methods through which companies monetize the Metaverse, they can be roughly divided into four categories. First, companies utilize gaming platforms for selling avatar accessories and skins, such as Balenciaga’s virtual accessories in Roblox and Burberry’s virtual design series in Blankos Block Party (Schauman et al., 2023). The sales price for the 2022 Burberry Minny B series was US\$349.99 or 35,000 Blanko Bucks (a type of virtual currency), with the production cost ranging from \$50 to \$100 (Burberry, n.d.). Second, companies like The Fabricant and RTFKT specialize in directly selling virtual clothing and accessories designed to be worn by avatars or characters in virtual reality environments (RTFKT, n.d.; The Fabricant, n.d.). In May 2019, the only digital fashion company The Fabricant became the first fashion house to sell a digital-only outfit “the Iridescence dress” on blockchain for \$9500 in cryptocurrency (Huggard & Särämäkari, 2023). The RTFKT studio, now owned by Nike, continues to produce innovative NFT products for the Nikeland Metaverse (Huggard & Särämäkari, 2023). By selling digital products and analyzing sales data and popularity, they can better anticipate market demand and plan the production of similar physical designs (RTFKT, n.d.). Third, unique ownership facilitated by NFTs and blockchain protection enable the auctioning of virtual fashion art collections (Huggard & Särämäkari, 2023). For example, Dolce & Gabbana auctioned nine virtual clothing collections on the digital artwork platform UNXD in 2021, selling for 1885.73 ETH (approximately \$6 million), which also included five physical items alongside the purchase of nine NFTs (UNXD, n.d.). This Real-to-Virtual bundling strategy helps companies segment markets, differentiate between virtual and physical products, and expand markets in a complementary manner (Zhang & Ye, 2023). Fourth, the Metaverse can be seen as a supplementary marketing tool to boost sales of physical products, leveraging virtual community spaces such as Gucci’s “Gucci Garden” and Nike’s “Nikeland” to debut new products and brand narratives, thus facilitating product testing and enhancing brand perception (Mancuso et al., 2023).

### 4. Discussion and Conclusion

Through the analysis of existing literature, we find that virtual and digital fashion can serve as a significant driving force for the environmental, social, and economic sustainability of the fashion industry. The Metaverse, projected as a new channel alongside e-commerce and offline commerce, offers immersive emotional services and fundamentally differs from traditional methods. It can be

an effective instrument of virtual and digital fashion, supporting the real-world fashion industry towards sustainable transformation.

Existing journal articles emphasize how virtual fashion in the Metaverse leverages technologies like 3D modeling, 3D printing, VR, AR, 2D and 3D scanning, digital twins, blockchain, and NFTs to create digital fashion products, enriching real-world fashion through virtual displays. The Metaverse effectively showcases virtual fashion, providing emotional value through immersive experiences and community interaction. Consumers participate by purchasing digital products such as game avatars and clothing, trying on virtual items before buying real-world versions, and investing in virtual luxury fashion through NFT assets. Many fashion incumbents demonstrate the Metaverse’s ability to commercialize and monetize digital fashion products.

The Metaverse facilitates value transmission by minimizing material and labor waste and providing varied interaction spaces for real-world fashion, showing potential to foster sustainability. However, there are some negative concerns:

#### Environmental Concerns

Using the Metaverse necessitates substantial energy for operation, which is a process linked to significant environmental costs and pollution (De Giovanni, 2023; Vlăduțescu & Stănescu, 2023; Profumo et al., 2024). Additionally, the environmental impact of VR technology encompasses the consumption of scarce raw materials and substantial annual electronic waste, which poses pollution challenges due to non-biodegradable components like plastics (Vlăduțescu & Stănescu, 2023; De Giovanni, 2023). However, we expect significant advancements in Metaverse sustainability as large tech firms like Google, Microsoft, and Meta commit to achieving carbon neutrality by 2030, including net-zero goals for infrastructure and VR/AR technologies (Google Sustainability, n.d.; Metaverse, n.d.; Smith, 2020).

#### Social Concerns

The Second Life in the virtual world warrants discussion. The Metaverse presents opportunities for hackers to commit crimes, and users may face security threats such as exposure to shocking photos, child pornography, blackmail, cyberbullying, cybercrime, online harassment, and other forms of abuse, potentially leading to mental trauma or even life-threatening situations (Wang et al., 2023). Social issues, such as social exclusion, income inequality, discrimination, and others, may also be exacerbated by the Metaverse (De Giovanni, 2023). Additionally, prolonged exposure to virtual environments can induce motion sickness and dizziness physiologically, while socially, it may lead to addiction, social isolation, and a decline in interpersonal skills (Wang et al., 2023).

The Metaverse primarily caters to millennials, Generation Z and Alpha, proficient in technology, while older generations, who are less tech-savvy or economically restricted from accessing it, may be limited in experiencing the same consumption and emotional value in virtual

fashion as they do in real-world fashion due to this digital divide (LinkedIn, 2023).

### Data Security and Regularity Concerns

The implementation of the Metaverse requires careful consideration of issues such as standardization, regulation, privacy, security, data protection, data sharing, sensitive data, digital assets, universal access and inclusion, and ethical concerns (Queiroz et al., 2023). Ethical challenges, particularly concerning intellectual property protection, are pressing due to the ease of copying and distributing digital goods, necessitating effective regulatory measures (Biliakovich et al., 2024). The Metaverse offers emotional consumption through immersive experiences (Venturini & Columbano, 2024), yet raises privacy issues related to sensor data, eye tracking, and room mapping of Metaverse users (Büchel & Spinler, 2024). Since most users agree to network agreements without thorough review, laws like GDPR and related network regulations cannot fully protect customer privacy, allowing many technology companies to influence Metaverse algorithms to benefit specific groups, which is not conducive to sustainable social development (Bojic, 2022).

Experts recommend that oversight entities like Meta and Google should prioritize security and data management in the future, focusing on data collection methods that emphasize wallet and transaction tracking over customer privacy concerns (Büchel & Spinler, 2024). Authorities and regulators should enact strict laws and public policies to safeguard user privacy and promote healthy virtual social interactions on Metaverse platforms (Al-Ghaili et al., 2022). Robust security, data management, and identity protection are essential for meeting evolving customer behavior standards and fostering customer loyalty (Büchel & Spinler, 2024). Governments can bolster the Metaverse industry by enhancing digital copyright verification and establishing clear regulatory frameworks, which can mitigate unfair competition, dismantle data monopolies, ensure sustainable development, and promote coordinated growth between digital and real economies (Zhang & Ye, 2023).

In conclusion, given the early stage of peer-reviewed research, our literature analysis is a first attempt toward understanding whether the Metaverse could have positive effects on sustainability in the fashion industry. While we focus on the positive, we also acknowledge challenges such as the disparity between virtual garments and physical ones, consumer acceptance issues, environmental impacts of Metaverse technologies, and unresolved concerns about data security, privacy, and regulatory frameworks, all of which warrant further study in the future.

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