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Article

Evaluating Public Opinion on Sustainable Fashion in the Metaverse: A New Frontier for Consumer Engagement and Environmental Advocacy

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Abstract: The limited understanding of how digital platforms, especially the Metaverse, influence public perception and attitude towards sustainable fashion in large scaled markets such as China highlights a critical gap. This study aims to examine the perspectives and perception of the Chinese public regarding sustainable fashion in the Metaverse. Through content analysis, this study evaluated 3,889 Weibo posts from Shanghai Fashion Week 2024 to identify key sentiments and discussions on sustainable and digital fashion. Results indicate that 76.08% of the conversations centered on sustainable fashion, reflecting strong public commitment to environmental issues. The findings highlight characteristics of public perception towards the utilization of immersive technologies and underscore the Metaverse's potential as a platform for fostering environmental consciousness in the fashion industry. This research provides crucial insights for fashion brands looking to integrate sustainability into their digital strategies, addressing a significant gap in current literature and offering practical guidance for leveraging digital platforms to promote sustainable consumption.

Keywords: Public Opinion; Sustainable Fashion; Metaverse

1. Introduction

In the dynamic landscape of fashion, the integration of sustainability and digital innovation emerges as a critical area for exploration, particularly within the Metaverse's framework. Existing research thoroughly investigates the impact of digital platforms like social media on consumer behaviors and sustainable fashion practices. Yet, as digital environments evolve, platforms such as the Metaverse are revolutionizing interactions between consumers and fashion brands. Previous studies have primarily concentrated on established digital platforms, often overlooking the burgeoning influence of the Metaverse, which merges virtual reality (VR) and augmented reality (AR) to create immersive commercial and social experiences. This gap is particularly significant given the rapid adoption of these technologies in markets such as China, which lead in both technological adoption and fashion consumption. Studies by Castro-López et al. (2021) and Kim & Na (2016) [1,2] highlight the changing landscape where digital engagement profoundly affects consumer perceptions and actions. Nevertheless, there is limited understanding of how these digital realms, especially the Metaverse, influence sustainable fashion consumption in Western markets. This deficiency emphasizes the critical need for focused research on consumer perceptions and behaviors regarding sustainable fashion within the Metaverse, particularly within the influential Chinese market.

This study aims to analyze the perspectives and perception of the Chinese public concerning the intersection of sustainable fashion and the Metaverse. It will explore vital issues in this under-researched area. What are Chinese consumers' perceptions of sustainable fashion within the Metaverse? What are the primary characteristics of their attitudes and opinions towards this digital environment? Additionally, the research will assess the influence of digital marketing strategies on

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shaping these perceptions and determine whether these strategies can effectively promote sustainable practices within the Metaverse. This investigation addresses a notable gap in scholarly discussions and aims to provide actionable insights for fashion businesses looking to leverage emerging technologies to foster sustainability.

The structure of this paper provides a comprehensive examination of the research topic. Following this introduction, the subsequent section reviews existing literature, outlining historical and current contexts, and identifying areas where this study contributes new insights. The third section details the methodology employed for data collection and analysis, explaining the choice of tools and procedures in relation to the research objectives. The fourth section presents and interprets the findings from the data analysis, contextualizing them within established theories and relevant prior research. The fifth section discusses these results, exploring their implications for both theory and practice, and suggests directions for future research. The paper concludes by succinctly summarizing the key insights gained from the study, their practical implications for the fashion industry, and the potential societal impacts of integrating sustainability within the Metaverse.

This research is significant in several ways. Academically, it extends the discourse on sustainable fashion into digital and virtual realms, offering a novel perspective on consumer behavior in non-traditional retail environments. Practically, the findings could provide fashion companies with crucial data for crafting effective digital marketing strategies that align with sustainability goals, tailored specifically for the Chinese market. This is particularly pertinent as the fashion industry faces increasing pressure to reduce its substantial environmental footprint, with consumer engagement in sustainability being key. By focusing on the Chinese market, this study deepens our understanding of global consumer behavior with insights applicable to other economies experiencing similar technological advancements. This research could influence policymaking by advocating for regulations that encourage sustainable practices in burgeoning digital spaces like the Metaverse, ensuring that innovation proceeds hand in hand with environmental and social responsibility.

2. Context

2.1. Sustainable Fashion in the Digital Age

Investigations into sustainable practices within the fashion industry reveal substantial research gaps at the intersection of digital transformation and sustainability. Existing literature forms a robust foundation for sustainable fashion, yet the swiftly evolving digital landscape, particularly the burgeoning Metaverse, necessitates further scholarly exploration.

Traditional research on sustainability in fashion predominantly addresses areas such as supply chain management and consumer attitudes towards eco-friendly products. Li et al. (2014) [3] explored the influence of corporate social responsibility on sustainability within the fast fashion supply chain, underscoring the critical role of robust governance and active stakeholder engagement. Shen (2014) [4] delved into sustainable supply chain practices within the textile industry, illuminating the complex decisions sourcing managers face in balancing economic and worker welfare considerations. Turker & Altuntas (2014) [5] employed Seuring and Muller's framework to analyze sustainability criteria in fast fashion supply chains, highlighting the importance of codes of conduct for suppliers, monitoring, and audits in enhancing supply chain efficacy. Furthermore, Khurana & Ricchetti (2016) [6] chronicled the evolution of sustainability perceptions and practices in the fashion industry over two decades, identifying pivotal shifts in corporate strategies towards sustainable supply chain management.

Despite these insights, there is a notable lack of research into the expansion of fashion into increasingly prevalent digital domains. Digital technologies present significant opportunities, and prior research demonstrates a positive correlation with consumer engagement. Castro-López et al. (2021) [1] identified an increasing consumer trend towards adopting slow fashion practices, facilitated by digital platforms that enhance transparency and engagement with brands' sustainability efforts. Similarly, Kim & Na (2016) [2] demonstrated that cause-related marketing can

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significantly influence consumer purchase intentions towards sustainable products, independent of the brands involved.

While digital technologies offer the potential to mitigate the direct environmental impacts of fashion production and consumption, their effective management is essential to prevent new environmental challenges. Claxton & Kent (2020) [7] emphasized the vital role of designers and strategists in addressing these challenges, advocating for an integrated approach to digital and sustainable strategies to achieve long-term environmental objectives. For instance, the Metaverse provides a platform for digital fashion shows and virtual garment showcases, potentially reducing the environmental footprint associated with traditional events and sample production. Moreover, C. H. Wu et al. (2023) [8] discussed how the integration of NFTs in fashion offers a unique opportunity to disrupt traditional consumption patterns by making fashion items collectible, thereby potentially reducing the need for physical garment production and its associated environmental impact. However, the significant energy requirements to support extensive digital environments, as highlighted by Vladuțescu & Stanescu (2023) [9], could negate these benefits if not sourced from renewable energies, underscoring the need for a balanced approach to digital fashion's evolution.

Additionally, although the influence of digital media on fashion is acknowledged, its integration with sustainable practices remains insufficiently explored. The studies by Kim & Na (2016) [2] and Haines et al. (2023) [10] investigate the impact of digital marketing strategies on consumer behavior but do not fully address how these strategies could be optimized to enhance sustainability in the fashion industry. Research by Na & Kang (2018) [11] demonstrates how mobile social networking services can spread sustainable fashion information, underscoring the potential of digital media to promote sustainable practices. Lee & Weder (2021) [12] explored the portrayal of slow fashion on social media in Australia, noting the significant impact digital platforms have on consumer perceptions of sustainable fashion. Additionally, Sailer et al. (2022) [13] examined how sustainable companies use Instagram to combat greenwashing and bluewashing, highlighting the profound role of digital media in transforming consumer perceptions. These studies underscore the growing importance and potential of digital media in promoting, elucidating, and advancing sustainable fashion practices.

2.2. The Role of Media in Shaping Sustainable Fashion

The convergence of media technology and digital platforms has profoundly transformed the sustainable fashion landscape, with social media emerging as a pivotal force in molding consumer behaviors and fashion trends towards sustainability. The comprehensive study by Busalim et al. (2022) [14] underscores the significant influence of social media on consumer behavior within sustainable fashion, advocating for further exploration through big data and qualitative research methodologies.

Social media's impact on sustainable fashion is multifaceted. Zhao et al. (2022) [15] explored how sustainable fashion brands utilize social media to align their sustainability goals with their brand messaging, effectively engaging a broader audience through expressive and directive communications. This dynamic plays a vital role in fostering deeper connections between consumers and sustainable practices. Furthermore, Shen (2023) [16] has shown that specific types of social media posts, particularly those focusing on sustainability and pricing, significantly boost user engagement, underscoring the critical role of content in shaping consumer perceptions.

The effectiveness of social media in advancing sustainable fashion is also evident in targeted campaigns. Greco et al. (2023) [17] analyzed social media posts during Fashion Revolution Week, revealing that small businesses often position themselves as models of sustainable practices. Additionally, the impact of influencers on sustainable fashion narratives is substantial. Jacobson & Harrison (2022) [18] introduced the concept of 'content creation calibration,' where influencers balance their ethical commitments with their compensation strategies to effectively promote sustainable fashion.

Instagram, in particular, has proven to be a powerful platform for advocating sustainable fashion. Carfora & Catellani (2022) [19] demonstrated that Instagram advertisements focused on

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sustainability can significantly enhance user engagement in sustainable practices, boosting consumer involvement, systematic processing, and purchase intentions. Similarly, Marcella-Hood (2023) [20] analyzed sustainable fashion content on Instagram, identifying a community of content creators who actively disseminate messages about sustainable fashion solutions, emphasizing the platform's role in building community awareness and education about sustainable practices.

The fashion industry is also navigating a digital transformation with the advent of the metaverse and other emerging technologies, introducing new challenges and opportunities. Fu & Liang (2022) [21] proposed integrating traditional garments as game skins in video games, highlighting the metaverse's potential to promote cultural authenticity and sustainability by offering immersive and engaging experiences. Research by Choi & Ahn (2023) [22] indicated that consumer commitment to sustainable fashion brands could be significantly influenced by their perceived brand benefits, particularly economic advantages, illustrating the importance of well-crafted marketing messages in supporting sustainable fashion entities.

Additionally, studies on the impact of pandemic disruptions have illuminated the complexities involved in fostering sustainability in digital contexts. K. J. Wu et al. (2023) [23] developed a hybrid methodology to assess sustainability in the fashion industry, emphasizing the necessity for flexible strategies during crises. Bolesnikov et al. (2022) [24] investigated the role of AI in enhancing sustainable fashion practices, suggesting that technology can play a crucial role in setting industry standards and shaping consumer demands for sustainability.

2.3. Towards Audience Perception

The fashion industry has seen profound changes in the digital era, opening new avenues for influencing public opinion, particularly regarding sustainable fashion. Evans & Peirson-Smith (2018) [25] highlight how the vague use of 'green' terminology in marketing often leads to consumer confusion and dissatisfaction, which can undermine efforts to foster sustainable behaviors [25]. This complexity underscores the critical need for clearer communication and authentic engagement strategies to effectively shift consumer attitudes and promote sustainability.

Further research by Carfora & Catellani (2022) [19] demonstrates how targeted digital advertising can significantly enhance public engagement and intent to purchase by focusing on sustainability, showing that digital platforms can powerfully shape consumer behavior [19]. Clube & Tennant (2020) [26] explore the psychological barriers faced by consumers using online clothing rental services, such as concerns over contamination, which, despite the environmental benefits, can deter consumer participation. This situation highlights the delicate balance required to effectively communicate the benefits and address the concerns associated with sustainable practices.

Zhao et al. (2022) [15] discuss how sustainable fashion brands strategically use social media to align their sustainability goals with their branding strategies, a crucial element in broadening their audience and influencing public perceptions [15]. Marcella-Hood (2023) [20] notes that building a community around sustainable fashion on platforms like Instagram involves more than sharing information; it requires fostering an environment where sustainable practices are normalized and valued.

These insights underscore the necessity for developing sophisticated digital marketing strategies that can surmount barriers to consumer engagement and effectively communicate the benefits of sustainable fashion. Additionally, emerging platforms like the metaverse offer new opportunities for immersive consumer experiences that can significantly enhance public awareness of sustainable fashion. Studies by Lee & Weder (2021) [12] and Sailer et al. (2022) [13] indicate that social media and digital platforms play a significant role in shaping public views on slow fashion, strategically leveraging content to address issues like greenwashing and sustainability [12,13].

In the rapidly evolving digital landscape, it is crucial to consider the environmental impacts of digital advancements. Vlăduțescu & Stănescu (2023) [9] point out that the energy required to maintain extensive digital environments could negate the benefits of sustainability if not managed with renewable energy sources [9]. This highlights the importance of a balanced approach to digital sustainability that integrates technological innovations with environmental goals.

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2.4. Metaverse Sustainable Fashion Debate

Public enthusiasm for the potential benefits of digital fashion is tempered by pragmatic assessments of its environmental impact, underscoring the intricate yet critical nature of this field's development within the metaverse. Online communities praise digital fashion as a sustainable alternative capable of significantly reducing the environmental impact traditionally associated with the fashion industry.

Proponents argue that digital fashion offers a viable solution to the environmental problems posed by one of the world's most polluting industries, by reducing the need for physical materials and the resultant waste [27,28]. The adoption of digital platforms in the fashion sector is seen as beneficial due to its revolutionary potential in mitigating the environmental implications of apparel consumption.

Advocates like Balakrishnan (2019) [29] and Lee (2021) [30] emphasize the importance of incorporating renewable energy sources and enhancing the energy efficiency of digital platforms. These strategies aim to ensure that technological advancements in the metaverse do not compromise ecological health, aligning digital growth with broader environmental sustainability goals.

Conversely, critics express significant concerns about the environmental footprint of the technologies underpinning digital fashion. Fletcher (2018) [31] and Park (2022) [32] caution that the substantial energy consumption required to maintain digital infrastructures, such as data centers and network systems, might negate the purported environmental benefits of digital fashion. Watson (2021) [33] and Hartman (2023) [34] echo this critical viewpoint, highlighting that the considerable energy needed to operate and expand metaverse infrastructure may offset the environmental gains achieved by reducing the production of physical goods.

The uncertainty surrounding the true long-term viability of digital fashion, given its technological impact, is a central topic of debate. Researchers like Periyasamy and Periyasami (2023) [35] argue that the sustainability of digital fashion remains questionable until it significantly reduces its reliance on non-renewable energy sources. This paradox underscores a broader issue within the metaverse concerning the balance between technological advancement and environmental responsibility.

Adding complexity to the discourse, D'Amico et al. (2021) [36] assert that the genuine sustainability of digital fashion depends not only on minimizing material waste but also on managing the lifecycle of digital assets and the obsolescence of the technology used in their creation. Padilla-Rivera et al. (2023) [37] stress the importance of conducting comprehensive lifecycle assessments that include the energy consumption associated with the ongoing maintenance of digital assets, rather than focusing solely on their initial production.

Zhang et al. (2023) [38] argue for the more aggressive implementation of green computing practices within the metaverse to address these issues. They suggest that advancements in software and hardware efficiency could effectively mitigate these concerns. Meanwhile, environmental researchers like Singh et al. (2022) [39] advocate for stricter regulations on the energy consumption of data centers powering the metaverse. They propose that such measures could accelerate the shift to renewable energy sources.

These diverse perspectives illustrate the dynamic and complex interplay between technological progress and environmental sustainability. The debate highlights the need for ongoing research and innovation in sustainable technology to support the growth of eco-friendly digital fashion. Furthermore, it underscores the importance of a holistic approach that integrates technological advancements and regulatory frameworks to fully harness the potential of the metaverse as a sustainable fashion platform.

In conclusion, the existing gaps in the literature concerning sustainable fashion, particularly in the context of digital transformation and the Metaverse, can be summarized across four dimensions. First, while there is substantial discussion on the role of traditional digital platforms like social media in promoting sustainable fashion, there is a noticeable lack of in-depth research into newer digital spaces like the Metaverse. These emerging platforms offer unique opportunities and challenges for sustainable fashion practices that are not yet well understood. Second, much of the existing research

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focuses on Western markets, with less attention given to how sustainable fashion is perceived and engaged with in other significant markets, particularly in China. This gap is notable given China's influence as a major global market and its rapid technological advancements, which could offer different insights into consumer behavior and digital adoption. Third, existing studies often touch on consumer perceptions of sustainability in fashion but do not delve deeply into how these perceptions influence behavior in digital environments. There is a need for more detailed exploration of how digital marketing and communication strategies impact consumer attitudes towards sustainability, especially in the Metaverse. Finally, there is a scarcity of empirical research specifically addressing public opinion on sustainable fashion within digital contexts like the Metaverse. More empirical data is needed to better understand how consumers interpret and respond to sustainable fashion initiatives in these novel environments. Overall, the literature reveals a need for more comprehensive studies that integrate sustainability with new digital technologies, focus on diverse markets (especially non-Western ones), and provide empirical insights into consumer behaviors and perceptions in these evolving contexts.

3. Method

3.1. Research Design

This study employs content analysis to examine public perceptions of sustainable and digital fashion trends by analyzing social media interactions. The primary dataset comprises 3,889 Weibo posts collected during Shanghai Fashion Week 2024, from March 25th to April 1st. This period is pivotal due to the event's prominence in the fashion calendar, offering rich insights into consumer perspectives through the analysis of social media posts, thereby capturing the prevailing sentiments and discussions within the fashion community.

3.2. Sampling Rationale and Criteria

Data collection spanned the entire week-long event, with the sample meticulously selected to provide a comprehensive view of the conversations occurring during a peak period of fashion discourse in China. The choice of Weibo as the platform for this study stems from its widespread use and its role as a key forum for public sentiment. The dataset includes posts specifically selected for their relevance to terms such as "sustainable fashion," "digital fashion," "virtual fashion," and references to metaverse platforms associated with notable metaverse fashion brands like Nikeland and Gucci Garden. This targeted approach ensures that the data encompasses a broad array of topics crucial for understanding the intersections of fashion, technology, and sustainability.

3.3. Ethical Considerations

The research adhered to stringent ethical guidelines, employing rigorous methods to ensure the anonymity and confidentiality of the individuals whose posts were analyzed. Personal identifiers were carefully anonymized or masked, ensuring that the data could not be traced back to specific individuals. Additionally, robust data security protocols were implemented to prevent unauthorized access, reflecting a commitment to responsible data management. The research was conducted with full transparency, with all methodologies and objectives clearly outlined in the accompanying disclosures and publications.

3.4. Analytical Process

The analytical approach was meticulously structured to ensure precision and comprehensiveness. Initially, each Weibo post was thoroughly examined to identify specific elements and detect patterns, utilizing a flexible and iterative coding process that allowed for the continual refinement of categories. This method ensured the reliability and consistency of the coding framework, involving multiple rounds of coding and verification by independent analysts to minimize potential biases. Advanced statistical tools were employed to manage the large volume of

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data, facilitating the identification of key themes and the intensity of discussions around digital fashion and sustainability.

Thematic analysis was utilized to extract overarching themes from the narratives in the posts. The coding process commenced with the application of a preliminary set of codes derived from the analyst's initial observations. These codes were assigned to specific segments of the data to facilitate organization and accessibility [40]. The coding was continually refined based on insights from prior studies on public opinion themes, adapting existing codes to better fit the specific context of this research [41–45]. The coding scheme was evaluated and refined through a rigorous process involving independent coder assessments and a pilot test, which achieved an inter-coder reliability of at least 0.80 [46]. After this process, the study conducted a qualitative analysis of 200 randomly selected posts to examine the narratives more closely. This qualitative analysis was documented in an appendix A for detailed discussion, with each post assigned a unique ID number. This additional qualitative step provided deeper insights into the themes and patterns identified in the broader quantitative analysis. The results are detailed in the following sections.

4. Results

From March 25 to April 1, 2024, a comprehensive analysis of Weibo posts revealed significant interest and engagement in discussions related to sustainable fashion. The majority, accounting for 76.08% of the total 3,889 posts (equivalent to 2,965 posts), focused on the topic of sustainable fashion ("kechixushishang"). This indicates substantial public interest in sustainability within the fashion industry, particularly during Shanghai Fashion Week, reflecting a widespread acceptance of eco-conscious fashion within the metaverse.

Conversations on Weibo extended beyond traditional sustainability topics to include innovative fashion technology. Notably, virtual fashion, or "Xunishishang," was the subject of 780 posts, representing 20.02% of the discussions. Digital fashion, referred to as "shuzishishang," was mentioned in 150 posts, constituting 3.85% of the overall conversation. These figures illustrate a dynamic discourse on the intersection of technology and sustainability in fashion, highlighting a growing interest in the potential of fashion technology within virtual reality environments.

An analysis of brand-specific conversations within the metaverse revealed a significant disparity between major fashion initiatives and digital consumer engagement. Among the topics discussed, Gucci Garden was mentioned in only 2 posts, making up a mere 0.05% of the overall conversation. No mentions were recorded for other prominent brands such as Nikeland, Vans World, Forever 21 Shop City, and Balenciaga in Fortnite. This suggests a notable lack of brand awareness or ineffective digital strategies in engaging the metaverse audience.

The discussions were predominantly concentrated in major urban areas, particularly in Beijing and Shanghai, which together accounted for 26 out of the 39 location-specific posts, representing 66.67% of all such discussions. In stark contrast, the regions of Hebei, Guangdong, and Anhui collectively contributed only 7 posts. This urban-centric focus underscores the pivotal role of metropolitan areas in discussions about sustainable fashion within the virtual world.

The data also identified distinct peaks in online activity, with the highest number of posts recorded on March 30, totaling 1,466 posts, followed by a secondary peak on March 28 with 1,014 posts. These spikes likely correspond to specific events or announcements during Shanghai Fashion Week, which generated substantial public attention and engagement, particularly around themes of sustainability and fashion technology in the metaverse.

This study provides insights into public attitudes and the challenges of implementing sustainable and ethical standards in the digital fashion industry, focusing on three primary conversation groups. Firstly, it is widely acknowledged by participants that virtual items are viewed as viable alternatives to traditional fashion (see ID6; ID10; ID103; ID169). The prevailing sentiment is that digital fashion can significantly mitigate the environmental impact by reducing the need for physical production, thereby decreasing waste and resource consumption associated with the textile industry. However, there is considerable concern regarding the energy consumption required for the infrastructure of the metaverse, despite its potential benefits (see ID110; ID31). The substantial energy

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demands of servers and data centers needed to support vast virtual worlds could offset the environmental advantages of transitioning from physical to digital formats. Furthermore, discussions on digital fashion also delve into the potential for enhanced transparency and ethical practices facilitated by digital technologies such as blockchain. Participants appreciate the opportunity for greater supply chain transparency and emphasize the importance of ethical standards in the digital creation and distribution process (see ID48; ID56; ID92; ID136; ID196). These findings reflect the optimistic yet cautious perspectives of individuals considering the evolution of fashion within the metaverse. The results highlight significant interest in the potential benefits for sustainability and the ethical implications of digital fashion, underscoring the need to address the integration of technology with environmental and social responsibility in a complex but essential manner.

5. Discussion

5.1. Dominance of Sustainability in Metaverse Fashion Discourse: Brand Engagement, Sentiments, and Geographic Distribution

An analysis of online discussions reveals that a significant 76.08% of the conversations center around sustainable fashion, indicating a robust public commitment to environmental concerns within the virtual world. This high level of engagement suggests that sustainability is a dominant theme, rather than just a niche issue, in the discourse on digital fashion.

The increased public focus on sustainable practices aligns with broader consumer trends and academic insights, signaling a shift towards environmentally conscious purchasing behaviors. Research by Jung and Jin (2016) [47] highlights a growing consumer demand for sustainable products, which is increasingly reflected in scholarly discussions. Further studies support that consumers are actively seeking brands that demonstrate a strong commitment to environmental responsibility.

This strong inclination towards sustainability presents a significant opportunity for businesses, especially in urban areas where discussions are most vibrant. By adopting sustainable practices, companies can enhance their appeal to a consumer base that values environmental ethics. According to research by Fung et al. (2021) [48], embracing sustainable practices is crucial for businesses to remain competitive and relevant, particularly during high-profile events like fashion weeks. This underscores the importance of sustainability in shaping brand strategies within the metaverse.

Bhandari et al. (2022) [49] highlight the importance of distinguishing between virtual and digital fashion to ensure effective implementation in digital environments. However, initiatives like Gucci Garden have received minimal attention, indicating visibility issues and a lack of meaningful engagement with the target audience.

The lack of engagement suggests that marketing strategies may not be adequately aligned with the interests or expectations of a tech-savvy and environmentally conscious consumer base. Blut et al. (2023) [50] suggest that this misalignment could stem from brands failing to integrate their digital initiatives with the values demanded by consumers. This highlights the urgent need for brands to revamp their marketing approaches within the metaverse. Developing engaging, relevant, and value-driven narratives could bridge this gap, emphasizing sustainable practices and aligning metaverse initiatives with broader environmental goals.

The predominantly neutral online sentiments about sustainable fashion in the metaverse suggest that the public might be in an observational phase, cautiously exploring what the metaverse offers in terms of sustainability before committing to stronger sentiments or loyalty. This period of neutrality, likely a reflection of consumers' careful evaluation of brand promises regarding sustainability, aligns with theories by Yuvraj Singh et al. (2024) [51], suggesting that new technological environments like the metaverse require a period of adjustment for consumers to assess brand credibility.

During this phase, brands have the opportunity to positively influence public perception by demonstrating genuine commitment and measurable impacts in their sustainability efforts. This could potentially shift public sentiment from neutral to positive.

The focus of discussions in major urban centers like Beijing and Shanghai underscores the significant role these cities play in the digital fashion dialogue, reflecting their advanced digital

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infrastructure and tech-savvy consumer base. Gupta et al. (2019) [52] propose that targeting these urban centers during key event periods could significantly enhance marketing strategy effectiveness. By synchronizing sustainability initiatives with major events, brands can capitalize on heightened attention and engagement, driving more focused discussions on sustainable practices within the metaverse.

5.2. Metaverse Fashion Debate as a Sustainable Option

An analysis of online discussions indicates that a significant majority, specifically 76.08%, of conversations revolve around sustainable fashion in the metaverse. This finding reflects a notable public commitment to environmental issues. The high level of engagement suggests that sustainability is a central theme in digital fashion discussions, aligning with the broader consumer trend toward eco-friendly shopping habits. Research by Guo et al. (2023) [53] supports the increasing demand for environmentally-friendly products, which is also reflected in academic discourse. Furthermore, Choi et al. (2021) [54] emphasize the importance of brands adopting sustainable practices to remain competitive, especially during major events like fashion weeks, which amplify the role of sustainability in shaping brand strategies within the metaverse.

Despite these potential benefits, significant concerns exist regarding the energy consumption required for the metaverse's infrastructure. The high energy demands of servers and data centers necessary to sustain large virtual worlds could negate the environmental benefits of transitioning from physical to digital media.

Criticism from ID31 and ID110, for example, saying that "isn't the metaverse just shifting the environmental cost from physical to digital?"(ID110), and "the real cost of digital fashion might be higher than we think, considering all the servers." (ID31) questions whether the metaverse merely shifts environmental costs from the physical to the digital realm rather than eliminating them. These discussions reflect a pragmatic assessment of environmental costs, presenting a multifaceted yet essential area of development. Online communities perceive digital fashion as a practical solution with the potential to significantly reduce the environmental impact of conventional fashion practices by lowering the need for physical materials and subsequent waste.

This study provides empirical evidence supporting theories that digital fashion positively impacts material consumption reduction. This is consistent with the findings and arguments of scholars like Gam (2019) and Niinimäki, (2020) [27,28], who suggest digital fashion as a viable solution to mitigate the environmental impacts of the fashion industry. Additionally, the proposal to integrate renewable energy, advocated by Balakrishnan (2019) [29] and Lee (2021) [30], is supported by public optimism and concern for sustainable technological advancements.

The environmental implications of digital fashion technologies are rigorously examined, aligning with the critical evaluations of Fletcher (2018) [31] and Park (2022) [32], who question the sustainability of these advancements. Ismail et al. (2024) [55] analyze the reliance on non-renewable energy sources in digital infrastructure and advocate for a shift toward more environmentally friendly options. This discussion also includes perspectives from Safari et al. (2015) [56], who explore the environmental effects of digital assets throughout their lifecycle, emphasizing the need for robust sustainability metrics.

The findings underscore the importance of a comprehensive approach that considers both technological advancements and regulatory frameworks. This strategy should prioritize the development of environmentally sustainable computing infrastructures while addressing regulatory gaps related to digital sustainability standards. Additionally, it should explore strategies to engage consumers in fostering a culture of sustainability in the digital realm. This comprehensive discussion integrates insights from various academic disciplines to analyze the complex relationship between digital progress and sustainability. It outlines potential pathways for future research and policy development to ensure that the growth of digital fashion aligns with global sustainability objectives.

5.3. Digital Supply Chains, Ethical Concerns, and Fairness in Fashion

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The increasing recognition of blockchain technology as a powerful tool in the digital fashion industry is notable for its ability to provide an immutable record of transactions and processes, thereby enhancing transparency and ethical standards in both digital and physical facets of the sector. Hughes (2017) [57] and Jensen (2020) [58] have conducted groundbreaking research that suggests blockchain technology has the potential to bring about substantial change in the fashion industry. This technology could lead to greater transparency and accountability, thereby empowering consumers to make well-informed decisions based on reliable data.

The discourse on digital fashion frequently emphasizes the potential for improved transparency and ethical practices facilitated by technologies like blockchain. Participants in discussions about the metaverse express enthusiasm about the enhanced visibility of supply chains and stress the importance of maintaining ethical standards in the production and distribution of digital fashion. Community testimonials, such as "The supply chain in the metaverse is visible, which is groundbreaking," (ID 48) and "Blockchain has the potential to revolutionize how we trace the source of our garments," (ID 196) underscore the transformative potential of these technologies in addressing current ethical concerns in the fashion industry.

However, the extent to which blockchain can enhance transparency depends on the effectiveness of its implementation and the legal frameworks in place. Kosyukova (2022) [59] and Marini (2023) [60] highlight the importance of effective implementation and robust legal structures to ensure that digital supply chains adhere to stringent ethical standards. These components are critical for blockchain to effectively foster transparency and trust in the fashion industry, addressing issues such as fraud, greenwashing, and other unethical practices.

Moreover, it is essential to balance the optimism for blockchain's potential with a realistic assessment of the practical challenges that need to be addressed for its widespread adoption. This includes overcoming technological and logistical hurdles, as well as the need for comprehensive regulatory oversight to ensure the ethical and effective use of the technology. The broader conversation on leveraging new technologies to genuinely advance sustainability and ethical standards is a crucial aspect of the discourse surrounding blockchain.

The digital fashion sector also requires robust ethical frameworks to address complex issues such as labor rights, intellectual property, and cultural appropriation effectively. Bainbridge (2020) [61] and Kim (2022) [62] advocate for the development of comprehensive frameworks to tackle these unique challenges, ensuring that the digital transformation of the fashion industry progresses ethically and responsibly.

Additionally, establishing fair compensation and equitable profit-sharing models in the digital fashion industry is vital to ensure that creators and stakeholders are justly rewarded for their contributions. Thomas (2019) [63] and Clarke (2021) [64] argue that ethical fashion extends beyond environmental sustainability to include supporting sustainable livelihoods through fair business practices.

As the fashion industry increasingly integrates digital platforms, it must also consider the broader societal implications of its actions. The ethical creation and fair distribution of digital fashion products should align with societal values of equity and justice, addressing potential inequalities and exploitations exacerbated by technological advancements.

Furthermore, the integration of digital and physical elements in the fashion industry presents a significant opportunity to enhance sustainability across the sector. Anderson (2021) [65] and Brown (2022) [66] highlight the potential of hybrid models to reduce environmental impact by minimizing waste and extending the lifespan of garments through digital customization options that complement physical production.

While the concept of hybrid fashion models is promising, it faces practical challenges such as managing manufacturing processes, integrating advanced digital technologies with traditional production methods, and understanding consumer behavior in response to these innovations. To implement hybrid fashion models effectively, it is crucial to prioritize the seamless integration of digital and physical elements strategically. This requires not only technological innovation but also

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adapting business practices to accommodate evolving consumer preferences and production techniques.

6. Conclusions

This study has explored the perceptions and attitudes of the Chinese public concerning sustainable fashion within the Metaverse. The findings indicate a significant enthusiasm and positive reception towards sustainable practices in digital fashion settings, highlighting the Metaverse's potential as a platform to enhance environmental awareness and sustainability in the fashion industry. Consumers showed a marked preference for digital initiatives that merge sustainability with innovative user experiences, underpinning the demand for authenticity in brand communications and the application of immersive technologies to enrich the virtual shopping experience.

However, this research presents notable limitations. Focusing predominantly on urban and technologically savvy consumers may not provide a comprehensive reflection of the broader Chinese population, which includes rural or less digitally literate segments. Additionally, the fast-paced evolution of technology and consumer preferences within the Metaverse necessitates continual updates to maintain the relevance of findings. Future studies should expand the demographic scope to include a more diverse array of participants and explore the long-term impacts of digital sustainable fashion initiatives. Investigating the effectiveness of specific marketing strategies in the Metaverse and their applicability across different cultural contexts could provide deeper insights into global sustainable fashion trends.

Nonetheless, the significance of this research in enhancing our understanding of digital consumer behavior in relation to sustainability is apparent. The study offers critical insights into the use of digital platforms, particularly the Metaverse, to foster sustainable consumption behaviors among a key demographic in one of the world's largest markets. This research not only fills a crucial gap in existing literature but provides actionable recommendations for fashion companies looking to integrate sustainable innovations in digital spaces. By delivering a thorough understanding of consumer attitudes and behaviors towards sustainable fashion in the Metaverse, this study lays a robust foundation for industry stakeholders to devise more effective strategies, ensuring that sustainability is deeply embedded in the future of digital fashion.

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Appendix A

Appendix A includes 200 original posts and links from the Chinese social media platform Weibo that were used for analysis in this study.

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