

Personalizing Fashion in the Metaverse: The Role of NFTs in Transforming Digital Consumer Experiences

Jovana Miletić¹[ORCID 0009-0003-7476-533X], Zoran Anišić¹[ORCID 0000-0001-7030-0728]

University of Novi Sad, Faculty of Technical Sciences, Novi Sad, Republic of Serbia

Abstract: This paper explores how NFTs are revolutionizing personalization in digital fashion within the metaverse. By leveraging photorealistic 3D models, augmented reality (AR), and virtual try-on (VTO) technologies, brands can offer highly customizable and immersive fashion experiences. The study examines the benefits of these innovations for enhancing consumer engagement and reducing costs, while also highlighting the role of blockchain in ensuring secure ownership of digital assets. This analysis provides a concise overview of the impact and future potential of NFTs in transforming fashion personalization in the digital realm.

Key Words: *Personalization, NFT, Metaverse*

1. INTRODUCTION

The retail business is always changing because of new technologies, changes in customer behavior, and changes in the way the market works. The revolution of fashion and technology has reached new levels and heights, with the advent of the metaverse and non-fungible tokens (NFTs). This paper delves into rising impact of personalization within fashion, led by NFTs, within the metaverse. Since traditional retail shifts towards virtual environments, brands are leveraging NFTs to offer unique fashion experiences that are overcoming physical limitations. Photorealistic 3D models, interactive customization tools and AR are transforming how consumers engage with fashion brands, offering new levels of personalization and interaction.

By exploring these advancements, this paper aims to uncover how NFTs are reshaping the fashion industry, driving innovation, and meeting the evolving expectations of digital consumers.

1.1. Metaverse pillars

Metaverse is a compound word of transcendence meta and universe and refers to a three-dimensional virtual world where avatars engage in political, economic, social, and cultural activities. (S. M. Park, 2022.) As such term, it was first time introduced in Snow Crash Novel by Neil Stephenson. (Joshua, 2017.) Based on the study from 2021. (Lee, 2021.), there are two dimensions to consider when connecting physical and digital world: Technologies and Ecosystems. Out of them, we can extract 14 focus areas. Some of them are technology enablers, and others are ecosystem drivers,

that can with cooperation achieve final idea of the Metaverse concept.

Technology enablers are:

1) *Extended Reality*

Well explained in Fig.1., XR is consisted of 3 elements, VR, AR and MR. While VR uses a VR head set or a head-mouthed display (HMD) to immerse users in a digitally simulated environment (C. Anthes, 2016.), AR overlaps the real world with virtual objects. Mixed reality integrates the concepts of AR and VR. In MR, virtual and real-world objects interact in real-time. Some-times called hybrid reality, MR allows users to overlay digital objects such as videos, 3D models, etc., into the real world and interact with such objects as they would a physical one(HMD) to immerse users in a digitally simulated environment. (Lee M, 2021.)

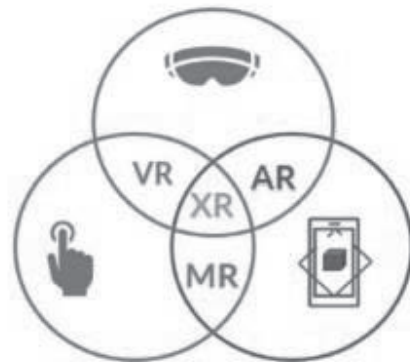


Fig. 1. A visual representation of how VR, AR and MR are conducted in XR (C. Anthes, 2016.)

2) *User Interactivity*

Refers to the ways in which users engage with a system or application. This includes elements such as the user interface, control options, feedback mechanisms, and any other interactions that allow users to actively participate and influence the operation of the system. (Sutcliffe, 2016.)

3) *Computer Vision*

Computer vision plays an important role in XR applications and lays the foundation for achieving the metaverse. Most XR systems capture visual information through an optical see-through or video see-through display. (Lee, 2021.)

4) Artificial Intelligence/Blockchain

Blockchain is a distributed database, in which data is stored in blocks, instead of structured tables. (Nofer, 2017), while Artificial intelligence (AI) refers to theories and technologies that enable machines to learn from experience and perform various kinds of tasks, similar to intelligent creatures.

5) Robotics/IoT

Virtual environments such as AR/VR/MR are good solution candidates for opening the communication channels between robots and virtual environments, due to their prominent feature of visualizing contents. (Chacko, 2019.)

6) Edge/Cloud

The state-of-the-art Metaverse architectures rely on a cloud based approach for avatar physics emulation and graphics rendering computation.

7) Network

By design, a metaverse will rely on pervasive network access, whether to execute computation-heavy tasks remotely, access large databases, communicate between automated systems, or offer shared experiences between users. (Lee, 2021.)

8) Hardware Infrastructure

Hardware in Metaverse not only plays an important role in the immersive experience but also is a technically limiting barrier. In the Metaverse, hardware is quickly enhanced by the effects of technological advancement, but it still needs improvement compared to the experience of the real world. (S. M. Park, 2022.)

Ecosystem drivers are:

9) Social Acceptability

There are different design factors that are influencing the social acceptability of the metaverse. Some of them are related to the user addiction, cyberbullying, cross generational design and ser diversity.

10) Security and Privacy

Collections of user information are something that various digital devices do have access on. In the metaverse, users are the ones that share their personal information while creating avatars or other content.

11) Trust and Accountability

As the advancements in the Internet, Web technologies, and XR converge to make the idea of the metaverse technically feasible. And the eventual success would depend on how likely are users willing to adopt it, which further depends on the perceived trust and the accountability in the event of unintended consequences.(Lee, 2021)

12) Content Creation

There is a authoring tool that allow users to create and generate different content.

13) Virtual Economy

A new concept, that came along with the metaverse is metaverse commerce. It refers to a trading place inside of virtual worlds. It has multiple aspects, with its own currency (crypto) and special contracts that follow the transactions – smart contracts.

14) Avatar

It represents the virtual or digital representative of the human.

The Metaverse, NFTs, and Web 3.0 are transforming the way we interact, buy and sell products, and also the way we experience digital content. In other words, these technologies will create new lines of business and transform interactions between customers and companies. (Zakeke, 2023.)

2. METAVERSE PRODUCTS

A potentially critical success factor for metaverse retail relates to how products, especially real-life ones, will be presented in virtual spaces. Platform capabilities and user interfaces can play a major role in terms of how authentic and realistic product representations are and how they are perceived by customers. The simulated experience has been shown to relate to engagement, enjoyment, and satisfaction, and in turn purchase intention. (Papagiannidis, 2021.)

Virtual worlds could adopt existing methods like text, photos, and videos to describe products, but lacking 3D representations might feel like a missed opportunity. What sets metaverse retail apart from other online platforms that offer similar content more conveniently? Not fully utilizing the metaverse's capabilities could limit customers who want to experience a product before buying it. How will a simulated experience compare to real life? If it falls short, it could negatively impact satisfaction with the product, brand, retailer, and the metaverse itself. As Castronova (Castronova, 2005.) suggests, retailers and customers can be part of a dream in synthetic worlds, but a poor experience might kill that dream. Creating virtual product representations is challenging, especially given the vast number of products many retailers handle. Study shows how new way of retailing is all about experience, shown on Fig.2. (Papagiannidis, 2021.)



Fig. 2. The evolution from traditional to electronic and metaverse retailing

To be able to explain product or a service within Metaverse, let's decompose the facts and terms. It all starts with token, which is a digital representation of value, such as a stake, voting right, toll, currency, store of value, ownership rights, or multifunctional access within an ecosystem. Its value derives from the asset it represents, created through a process called tokenization. In economics, "fungibility" refers to an asset's ability to

be exchanged for another of the same type, facilitating trade by ensuring equal value between assets. (Popescu, 2021.)

A Non-Fungible Token (NFT) represents a *unique digital asset* that cannot be swapped for another NFT of the same type. Essentially, an NFT is a digital certificate of authenticity, stored on a blockchain, ensuring secure, immutable ownership records and allowing for only one owner at any time. NFTs are unique tokens with distinct properties, making them non-fungible and scarce. While all dollar bills or euro's hold the same value and are interchangeable, NFTs are valued for their individual uniqueness. (Ethereum, n.d.)

The first classification of NFT's comes from their type of digital object. By now, NFT's were presented as photos, videos, text and audio files,. This conclusion came up with observing several different platforms where NFT's can be purchased and traded. Naming couple of them OpenSea, Rarible, Nifty Gateway, Atomic Assets. Also, this classification has been confirmed by Nadini (Matthieu Nadini, 2021.)

The second classification from the same study comes from the perspective of how NFT's are organized in the market, by collections. Collections are basically sets of NFT's that are typically somehow connected, sharing some features or color convention or similar. NFT collections by Nadini can be sorted in 6 most common ones

- Art

Art NFTs represent digital artwork that can be bought, sold, and owned on the blockchain. These can include paintings, illustrations, animations, and other forms of digital art. Artists can create unique pieces or limited editions, and NFTs ensure that each piece is verifiably original.

- Collectible

Collectible NFTs are digital assets that users can collect, often with a focus on rarity and uniqueness. These can include virtual trading cards, digital memorabilia, and other items that appeal to collectors. Each NFT in this category is typically part of a series or set, with varying degrees of rarity.

- Games

Games NFTs are used within blockchain-based games. They can represent in-game assets such as characters, weapons, land, or other items that players can buy, sell, or trade. These NFTs provide ownership and transferability, allowing players to truly own their in-game assets.

- Metaverse

Metaverse NFTs are assets used within virtual worlds or digital environments. These can include virtual land, property, avatars, and other items that users can own and interact with in the metaverse. These NFTs are essential for creating and experiencing the digital spaces of the future.

- Other

Other NFTs encompass any digital assets that do not fit neatly into the other categories. This can include domain names, virtual real estate, event tickets, and more. These

NFTs showcase the versatility and broad potential of the technology beyond more commonly recognized applications.

- Utility

Utility NFTs provide access to services, experiences, or benefits. These can include membership passes, exclusive content, or tickets to events. Utility NFTs often offer additional value beyond mere ownership, granting holders special privileges or access.

In explanation of areas of implementation, it is becoming clear which industries can benefit of entering virtual worlds. Areas of implementation that studies are showing are repeating, with significant number of them being confirmed and already proven, while some other areas of application are still emerging. (Mariapina Trunfio, 2022.)

1. Consumer goods
2. Healthcare
3. Hospitality
4. Education
5. Retail
6. Gaming
7. Other entertainment (art shows and concerts)

3. METAVERSE AND IT'S PRODUCTS IN THE FASHION INDUSTRY

1. Products in the fashion industry

Engaging with a fashion brand in a unique, immersive environment allows customers to experience the brand's narrative and set it apart from its competitors. This virtual space leverages the endless opportunities and benefits of the online realm, preserving the brand's aesthetic while making it accessible to a broader audience. The metaverse serves as a dynamic marketing platform, offering brands an interactive 3D digital space where users, represented by avatars resembling themselves, can gather and interact. (Svend Hollensen, 2023.) It allows customers to interact with an immersive retail experience by seamlessly navigating between virtual and physical environments, fostering a multi-channel approach for companies. (Dogadkina, 2022.) Unlike conventional websites and mobile apps, detailed, interactive 3D spaces encourage shoppers to linger longer when shopping in an immersive environment. (Thorsten Hennig-Thurau, 2022.) Consumer evaluation of products in a metaverse is more profitable for companies than in 2D environments. Companies have almost limitless options for designing virtual retail environments, thereby enhancing the consumer experience. Testing digital designs on avatars in virtual worlds before investing in production for physical shop sales; and developing the ability to co-create products with consumers. thus increasing the level of **personalization** of brands. (Anderson, 2022.)

As already mentioned, many retailers are trying to keep up the pace of fast developing industry – fashion in the metaverse. While everyone is thinking about the future and if metaverse would ever become “a thing”, others are trying to take a piece of cake and be pioneers.

The retailing business is very active in virtual worlds. For instance, during the first 10 years of Second Life existence, 2.1 million user-created virtual goods have been offered for sale, with resident-to-resident transactions amounting to over \$3.2 Billion USD (Lab, 2013). There are various methods and technologies to generate and create virtual products, that would become a part of the metaverse, and its experience. (Zakeke, 2023.)

- a) Virtual stores and showrooms
- b) 3D Product configurators
- c) Augmented Reality (AR) and Virtual Try-On
- d) NFTs (Non-Fungible Tokens)
- e) Collaborations with Metaverse Platforms
- f) Digital Fashion and Virtual Goods
- g) Interactive and Social Experiences

2. NFT's as products in the fashion industry

NFT's or non-fungible tokens are there to allow consumers to acquire, possess and trade some unique virtual artefacts (R. Chohan, 2021.). Companies with the usage of it, can spread their product portfolios by adding it to the additional market and being able to increase the value of it. There are some examples where brands are selling products at really impressive amounts, all as unique virtual products based on NFT's. Companies like Nike, Gucci, Adidas and Coc-Cola already joined NFT marketplace. (Hofstetter, 2022.) Other fashion brands like Ralph Lauren, Gucci, Balenciaga are charging actual money for digital only apparel and accessories in the metaverse. (Debter, 2022.) Example of the avatar wearing some of the most popular brands in Fig 3. Ralph Lauren's newest storefronts debuted in the virtual world of Roblox. Roblox has 47 million daily active users, making it a more appealing site for Ralph Lauren than other large cities like Tokyo, New York or Milan. Stores that are available to anybody across the world, with virtual puffer jackets and checkered beanies for around 5 US dollars. Great example of NFT would be buying an authentic piece of art tokenized as a digital asset to customize a virtual house. The ground on which the house is built might be in position of the person. Right now, this is all possible withing the platform of Decentraland. (Realm, 2021.)



Fig. 3. Meta Avatar Store, featuring Balenciaga, Prada and Thom Browne (Bain, 2022.)

Fashion brands are entering the metaverse in order to create interactive and immersive virtual experiences, engaging users in 3D environments through digital fashion shows, pop-up shops, and virtual showrooms. By

venturing into the metaverse, these companies achieve several strategic objectives: promoting their products, establishing deeper connections with consumers, fostering brand trust, attracting new demographics, and providing highly personalized digital experiences. The metaverse allows users to become co-creators and co-producers of fashion content. This shift could democratize the fashion industry, empowering users with greater influence and control over their style and identity. It also has the potential to transform how fashion is conceived and consumed in the digital age. (Moates, 2024.)

Based on the studies, there are several key areas for fashion brands in virtual worlds. (Elena Alexandrova, 2023.): branding, goods, virtual fashion and digital skins, distribution channels and logistics, interaction with consumers and customer information. Brands are using metaverse to promote their products and at the same time connect with the consumers. They are doing this by creating product concepts in the virtual world. Benefits of the metaverse for the fashion industry include limitless online format for the product and brand concept development, reaching new customer groups. Current developments of fashion brands in existing virtual worlds (virtual fashion, games, NFT, digital skins, etc.) such as The Sandbox, Decentraland, Roblox, etc. suggest several key areas of company development in the meta worlds, presented in the Table 1.

N	Development sector	Features
1	Branding	Expanding real-world positioning, moving a brand into a new virtual environment that allows for a new appreciation of its benefits, interacting with potential and current customers, engaging consumers by providing virtual products, building brand equity through gamification, creating synergies between the virtual and real worlds.
2	Product	NFTs enable the acquisition, possession and trading of unique virtual artefacts that are identified using blockchain technology. NFTs expand brands' product portfolios with virtual offerings and increase interaction between the virtual and real worlds. NFTs as digital twins that store information about the history, authenticity and ownership of a physical or digital product, which is especially important for the luxury segment in the fight against counterfeits. NFTs as "loyalty tokens" offering additional benefits to consumers, such as access to new NFT releases and physical products.
3	Virtual fashion and digital skins	Generating sustainable revenues in the short term by changing the appearance of avatars in gaming and online platforms. In many countries (US, China), more than 70% of consumers show a high demand for creating and adapting online identities, acquiring virtual assets.
4	Distribution channels and logistics	Breaking down the boundaries between the physical and virtual worlds through NFT
5	Interaction with consumers	Interaction with artificial intelligence designed for learning through repeat customer interactions. Personalised customer interactions through virtual 3D agents of artificial intelligence in VR or a hologram in AR.
6	Customer information	Data availability - in terms of quality and quantity - on consumers. Extensive opportunities for experimentation in order to obtain information on consumer reactions to new product concepts or ideas.

Table 1. Key areas of fashion brand development in the metaverse (Y.K., 2022.)

Study of Holden and Houser (Houser, 2022.) show that NFTs are important to the clothing and fashion industry. They say that fashion industry validate the provenance and significance of goods or to produce collectibles. According to the study, NFT's can make it possible to sell physical wearables that unlock a premium online experience. Having an NFT might have a consumer of an apparel brand access to particular advantages, occasions, fashion shown or experience the business has produced offline and online. While another study demonstrates that collaboration between brands is significant using the metaverse platform. (Kemec, 2022.) Fashion labels can collaborate with well-known

organizations in the metaverse. It demonstrates the collaboration between the PlayStation and Dior Men as the example. The French Company staked its reputation on a skin that may appear in Gran Turismo 7 and eventually produced a premium vehicle. Technological development has made it possible for companies to collaborate through the metaverse. The nature of the virtual resources present in the metaverse, fashion brands, has enabled companies to collaborate while creating experiences with unlimited scalability. (Resty Nabukalu, 2023.)

The most important thing for a retail business to focus on when it comes to customer happiness is the customer experience. When it comes to shopping, customers have better experiences when products can be found, purchased, and delivered quickly. (Akram, 2021.) Recognising the benefits of a metaverse for brand development, companies in the fashion industry are now actively investing in virtual worlds, creating and developing them. For example, luxury brands are inviting shoppers to explore and play in innovative virtual spaces.

For the fashion brands themselves, the metaworld can be profitable. For example, Gucci promoted a virtual handbag on the popular and well-established Roblox gaming platform and sold it for US\$4,100, well above its physical price. (Bloomberg, 2021.) Other fashion brands - Louis Vuitton, Dior - also go along the way of developing their own virtual games, virtual shops, etc., thus expanding their presence in the meta universe.

The fashion industry's increased focus on metaverse technologies (NFT, blockchain, Web 3, etc.) is due to the fact that they are exclusive and scarce in addition to their functional characteristics, thus matching the nature of fashion brands. Blockchain provides a more secure and transparent record of transactions, which reduces the risk of fraud and provides greater visibility and sub-accountability in the premium buying process. Balmain announced in 2022 the creation of the Non-Fungible Thread, a fashion ecosystem supported by NFT, catering to Balmain clothing owners. (Decrypt, 2022.)

4. PERSONALIZATION IN METaverse

Unique experience is for sure what metaverse provides to the consumers. From choosing between color preferences and personalizing their avatars, to purchasing land and parcels they like. Avatars can be different and personalized, based on age, social networks, interests, gender etc. With this type of configuration, customers are allowed to present themselves how they want. On the other hand, brands can use customer preferences to develop a customer centric approach. (Rao, 2022.)

Highly personalized customer experience should be on the strategic roadmap for all fashion brands nowadays. Companies like Netflix, Spotify and Amazon made a huge impact on consumers expectations. Now, fashion brands have to chase the same level of options to provide. (Co., 2022.) In the same report it is being mentioned how consumers now are expecting that their product choices and experiences are tailored to their individual preferences. Historically, personalization in fashion was something only luxury shoppers were able to

provide to themselves. Now, personalization is becoming a priority and key factor for success. Past purchases of consumers are being tracked, and now with new technologies data can become the most powerful tool. (Co., 2022.) Cloud based technologies are using AI or machine learning algorithms to speed up the process of analyzing Big Data on customer behavior like past purchases etc. What companies who deal with e-commerce can do is to convert results of these analysis into one-to-one, personalized experiences. In the report of McKinsey is mentioned hyper-personalization, to mark the relevance or size this type of personal approach can grow.

Not all the companies are ready to step into Web3.0 worlds and Metaverse and to be able to digitally transform by themselves. This transformation is very much driven by information technology, and companies are facing challenges in deciding which elements of information technology to keep in-house, and which of them is easier and more applicable to outsource. (David Rueckel, 2020.)

With the need of it, some of the IT companies shifted their focus into digital transformation and Web 3.0 technologies. One example is company Zakeke. In their portfolio, this company offer companies looking to create, personalize, and configure their NFT collections. Here's how they assist companies in these areas:

4.1. Personalizing fashion product with Zakeke

Zakeke assists companies in creating, personalizing, and configuring their NFT collections through a comprehensive suite of tools and services. They provide advanced design tools for creating unique NFTs, including 3D modeling and customizable templates. For personalization, Zakeke offers interactive customization features, allowing users to modify colors, patterns, and add custom elements in real-time. They also support augmented reality previews to enhance the personalization experience. Zakeke ensures seamless integration with various blockchain platforms for secure minting and storage, and they help configure smart contracts to manage ownership, royalties, and transfer rules. Additionally, Zakeke assists in listing NFTs on popular marketplaces and integrating sales into existing e-commerce platforms. They provide analytics tools for tracking performance and customer engagement, and they offer robust security measures and compliance support to protect digital assets and ensure regulatory adherence. (Zakeke, Zakeke Solutions, n.d.)

Zakeke provides a range of tools and services specifically tailored to help companies personalize their NFT fashion collections. The way how they do it is based on various steps to take in order to get to the desired state.

- *Design and Creation Tools*

3D Modeling: Zakeke offers advanced 3D modeling tools that enable companies to create detailed and realistic digital fashion items. This includes clothing, accessories, and other fashion-related items. In Fig 4. Is shown how company offer of 3D Modeling look like. The potential is huge, and the impact on the customer is

guaranteed. This type of photorealistic 3D Models can enhance e-collection with lifelike 3D models. They offer showcasing numerous 3D variations, reducing sampling expenses. The engagement is increased through customization, 3D, AR, and virtual try-ons. Its possible to effortlessly manage a dynamic 3D catalog and to keep up with trends in Metaverse market.

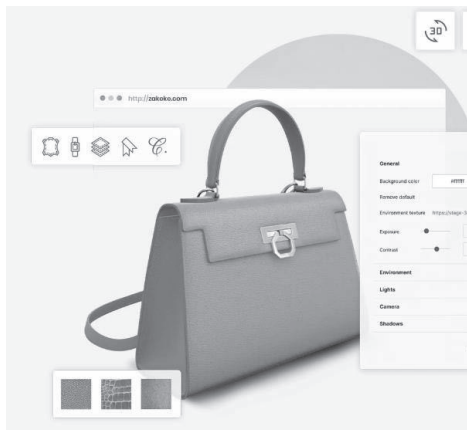


Fig 4. 3D model of a purse from Zakeke 3D modeling tool. (Zakeke, Zakeke Solutions, n.d.)

Templates and Customization: Companies can start with pre-designed templates and then customize these templates to match their brand’s style and aesthetic. This allows for faster creation while still offering unique designs.

- Personalization Features

Interactive Customization: Customers can interact with the fashion items in real-time, personalizing elements such as color, pattern, texture, and even adding custom logos or text. This interactivity ensures each NFT is unique and personalized according to the buyer’s preferences.

Augmented Reality (AR) Preview: Zakeke provides AR tools that allow users to preview how their personalized fashion items will look in a real-world context. This enhances the shopping experience by giving a realistic view of the final product.

- Blockchain and Minting

Blockchain Integration: Zakeke supports integration with various blockchain platforms, facilitating the minting process. This ensures that personalized fashion NFTs are securely and transparently recorded on the blockchain.

Smart Contracts: They help set up smart contracts tailored for fashion NFTs. These contracts can include rules for ownership, royalties, and transferability, ensuring that creators are properly compensated and that the items remain unique.

- Marketplace Integration

Seamless Listing: Zakeke assists companies in listing their personalized fashion NFTs on popular NFT marketplaces. This makes it easier for companies to reach a broader audience and sell their customized fashion items.

E-commerce Integration: They also provide tools for integrating NFT sales into existing e-commerce platforms, allowing companies to sell NFTs directly through their own websites.

- Analytics and Customer Engagement

Analytics Tools: Companies can track the performance of their NFT fashion collections using Zakeke’s analytics tools. This includes data on sales, customer preferences, and engagement metrics.

Customer Feedback and Iteration: Zakeke enables companies to gather feedback from customers, allowing for continuous improvement and iteration of the fashion items. This ensures that future collections meet customer expectations and preferences.

- Security and Compliance

Security Measures: Zakeke implements robust security measures to protect digital assets and personal data, ensuring the integrity and safety of the NFT transactions.

Compliance Support: They offer guidance on legal and regulatory compliance, helping companies navigate the complexities of selling digital fashion items as NFTs.

By providing these comprehensive tools and services, Zakeke helps fashion brands create, personalize, and sell unique NFT fashion collections, enhancing both the creative process and the customer experience.

5. CONCLUSION

In conclusion, the exploration of personalization in fashion products within the metaverse, facilitated by NFTs, reveals a transformative potential for the fashion industry. The integration of photorealistic 3D models and interactive customization tools not only enhances the consumer experience but also drives deeper engagement and loyalty. By leveraging augmented reality (AR) and virtual try-on (VTO) technologies, brands can offer immersive and personalized shopping experiences that align with the digital-first preferences of modern consumers. Furthermore, the blockchain infrastructure ensures secure ownership and transferability of these unique fashion items, fostering a new era of digital asset management.

As the fashion industry continues to evolve, embracing NFTs and the metaverse will be crucial for brands seeking to stay competitive, reduce costs, and innovate in a rapidly changing digital landscape. This shift not only meets current market demands but also sets the stage for future advancements in digital fashion personalization.

6. REFERENCES

- Akram, U. M.-T. (2021.). Impact of Digitalization on Customers' Well-Being in the Pandemic Period: Challenges and Opportunities for the Retail Industry. *Int. J. Environ. Res. Public Health*.
- Anderson, H. (2022.). *Unique Ways Retailers Can Embrace the Metaverse*. Retrieved from Publicissapient: <https://www.publicissapient.com/insights/unique-ways-retailers-can-embrace-the-metaverse>
- Bain, M. (2022., Jun). *Meta Balenciaga Prada Thom Browne Avatar Store*. Retrieved from Highsnobiety: <https://www.highsnobiety.com/p/meta-balenciaga-prada-thom-browne-avatar-store/>
- Bloomberg. (2021., Jun 16.). *Clothes That Don't Exist Are Worth Big Money in the Metaverse*. Retrieved from Bloomberg: <https://www.bloomberg.com/news/features/2021-06-16/non-fungible-tokens-and-the-metaverse-are-digital-fashion-s-next-frontiers?embedded-check>
- C. Anthes, R. J.-H. (2016.). State of the art of virtual reality technology. *IEEE*.
- Castronova, E. (2005.). Real Products in Imaginary Worlds. Harvard Business Review. *Harvard Business Review*, 83-88.
- Chacko, S. &. (2019.). Augmented Reality as a Medium for Human-Robot Collaborative Tasks. .
- David Rueckel, B. K. (2020.). Outsourcing in the Age of Digital Transformation. *Strategic and Competitive Uses of IT*.
- Debter, L. (2022.). Fashion And The Metaverse: Why Ralph Lauren Wants To Sell You Digital Clothing.
- Decrypt, S. (2022., May 29.). *Balmain Seeks 'Omnichannel' Immersion for Fashionistas With Help of MINT NFT*. Retrieved from Decrypt: <https://decrypt.co/101599/balmain-seeks-omnichannel-immersion-for-fashionistas-with-help-of-mintnft>
- Dogadkina, O. (2022., Jul 26.). *Transformed By The Metaverse, The Virtual Retail Experience Grows More Immersive And Engaging Than Ever Before*. Retrieved from Forbes: <https://www.forbes.com/sites/forbestechcouncil/2022/07/26/transformed-by-the-metaverse-the-virtual-retail-experience-grows-more-immersive-and-engaging-than-ever-before/>
- Elena Alexandrova, M. P. (2023.). Metaverse in fashion industry development: application and challenges. *E3S Web of Conferences*.
- Ethereum. (n.d.). *Internet of assets*. Retrieved from Ethereum: <https://ethereum.org/en/nft/#internet-of-assets>
- Hofstetter, R. D. (2022.). Crypto-marketing: How non-fungible tokens (NFTs) challenge traditional marketing. *Marketing Letters*.
- Houser, K. A. (2022.). *Navigating the Non-Fungible Token*.
- Joshua, J. (2017.). Joshua, J. (2017.). Information Bodies: Computational Anxiety in Neal Stephenson's Snow Crash. *Interdisciplinary Literary Studie*, 17-47.
- Kemec, A. (2022.). From reality to virtuality: Re-discussing cities with the concept of the metaverse. *International Journal of Management and Accounting*, 12-20.
- Lab, L. (2013., Jun 20.). *Infographic: 10 Years of Second Life*. Retrieved from Lindenlab: <http://www.lindenlab.com/releases/infographic10-years-of-second-life>
- Lee M, N. N. (2021.). Mixed Reality Tabletop Gameplay: Social Interaction With a Virtual Human Capable of Physical Influence. *IEEE*.
- Lee, L.-H. &. (2021.). All One Needs to Know about Metaverse: A Complete Survey on Technological Singularity, Virtual Ecosystem, and Research Agenda.
- Mariapina Trunfio, S. R. (2022.). Advances in Metaverse Investigation: Streams of Research and Future Agenda. *MDPI*, 103-129.
- Matthieu Nadini, L. A. (2021.). Mapping the NFT revolution: market trends, trade networks, and visual features. *SCI Rep*.
- Moates, C. (2024., April 3.). *Why fashion brands are drawn to the metaverse*. Retrieved from Landvault: <https://landvault.io/blog/why-fashion-brands-are-drawn-to-the-metaverse>
- Papagiannidis, S. (2021.). Staging the New Retail Drama: At a Metaverse Near You! *Journal of Virtual Worlds Research. Journal of Virtual Worlds Research*, 425-446.
- Popescu, A.-D. (2021.). Non-Fungible Tokens (NFT) – Innovation beyond the craze. *International Conference on Innovation in Business, Economics & Marketing research* .
- R. Chohan, J. P. (2021.). What marketers need to know about non-fungible tokens (NFTs). *Business Horizons*.
- Realm, R. (2021.). The 2021 Metaverse Real Estate Report. .
- Resty Nabukalu, A. W. (2023.). Impact of Metaverse on Marketing Communication.
- S. M. Park, Y. G. (2022.). A Metaverse: Taxonomy, Components, Applications, and Open Challenges. *IEEE*, 4209-4251.
- S. M. Park, Y. G. (2022.). A Metaverse: Taxonomy, Components, Applications, and Open Challenges. *IEEE*, 4209-4251.
- Sutcliffe, A. &. (2016.). Analysing the Role of Interactivity in User Experience. *International Journal of Human-Computer Interaction*.
- Svend Hollensen, P. K. (2023.). Metaverse – the new marketing universe. *Journal of Business Strategy. Journal of Business Strategy*, 119-125.
- Thorsten Hennig-Thurau, D. N. (2022.). Social interactions in the metaverse: Framework, initial evidence, and research roadmap. *Journal of the Academy of Marketing Science*, 889–913.
- Y.K., D. (2022.). *The State of Fashion Technology*. McKinsey&Co.
- Zakeke. (2023.). *Retailer's Guide to Metaverse, NFTs and Web 3.0*. Retrieved from Zakeke: <https://www.zakeke.com/resource-hub/ebooks-and-more/retailers-guide-to-the-metaverse-nft-and-web3/>

CORRESPONDENCE



Jovana Miletic, PhD student
University of Novi Sad
Faculty of Technical Sciences,
Trg Dositeja Obradovića 6
21000 Novi Sad, Serbia
miletic.dj10.2023@uns.ac.rs



Dr Zoran Anisic, Prof.
University of Novi Sad
Faculty of Technical Sciences,
Trg Dositeja Obradovića 6
21000 Novi Sad, Serbia
anisic@uns.ac.rs