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A Research Agenda for the Advancement of Digital Fashion

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Abstract

This commentary aims to define Digital Fashion (DF), pinpoint critical research areas for its evolution, and provide frameworks for academics and professionals to navigate its complexities, ultimately documenting key practices and applications to support future research and creative and commercial experimentation.

KEYWORDS: digital fashion, fashion value chain, research agenda

Introduction

Digital Fashion (DF) is stuck. Caught in the "innovation chasm" between niche and mass adoption. Following a surge in adoption during the COVID-19 pandemic – when brands relied on DF to showcase and sell products to both organizational and consumer buyers – interest in DF has waned. As of 2024, brands and retailers no longer view DF as an urgent priority (Kalypso 2024). This decline is unfortunate, as DF's potential to enhance creativity, efficiency, and immersive experiences in the fashion industry has only grown, driven largely by advancements in Artificial Intelligence (AI) (Roberts-Islam 2024).

This commentary seeks to establish a consensus on the definition of DF and identify critical areas requiring empirical research to ensure its continued evolution. Our goal is to offer terminology, frameworks and insights that academics and professionals can use to navigate DF's complexities and accelerate its path toward mass adoption. Surfacing awareness of its current operational value across the fashion value chain could de-risk both initial DF experimentation and longer-term integration for practitioners. Additionally, we document several key DF practices and applications for the first time, providing original contributions and pathways for future research.

Definitions

Divergent opinions on the definition and categorization of DF present a significant barrier to its adoption (Baek et al. 2022; Grant and Alexander 2026; Kotsoni 2024; Sayem 2023). While ambiguity in terminology is common for emerging technologies, in DF's case, it has become particularly problematic. The lack of consensus hampers the industry's ability to establish a clear identity and demonstrate its value. Table 1 offers a chronological synthesis of DF definitions, evaluating their effectiveness, and introduces a new definition to provide a foundation for the remainder of this work. The definitions are concentrated from 2020 onwards as previously DF was addressed within research as '3D fashion' or 'virtual fashion' and was rarely individually defined apart from those identified first in the table. It is useful to note that DF academic research emerged first within the fashion design and technology disciplines, before moving into retail and marketing, reflecting its industry application as a design tool to a marketing tool and then most recently as an end product.

Historically, definitions of DF have centered on its technological aspects and applications in enhancing garment design and production processes. However, its role in marketing communication – particularly as a virtual try-on experience – was only recently emphasized by Chan

collective cultural ownership platform and started a PhD at the University of Manchester.

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Table 1. Definitions of DF from academics and practitioners (authors' own).

Author / year	Definition	Definitional critique
Rizzi, Fontana, and Cugini 2004	"Virtual Prototyping comes in two forms: Cloth visualization software, which aims to produce images that look real for computer animation and cloth design software, which focuses on the definition and construction of functional cloth shapes for real manufacture".	Early exploration of virtual prototyping of clothing from a technical CAD perspective. Useful to highlight its two main forms of the time.
Sayem, Kennon, and Clarke 2010	"Designing virtual garments can be categorized as 2D to 3D and 3D to 2D. The former refers to draping flat digital pattern pieces on a virtual mannequin, and the latter indicates the development of clothing design on a realistic body and subsequent flaring into 2D pattern pieces"	Effective at defining the process of virtual garments and their form, but does not address the function or benefit of this.
Park and Ko 2017	"DF refers to fashion design using computers and software"	Simplistic perspective focusing on only one vertical.
Santos et al. 2020	"The virtual representation of clothes which can acquire new characteristics and new forms of existence. A piece of clothing digitally created can originate a physical version of itself or can exist only in a digital environment"	A successful description as it refers to diversity of form, new creativity and its literal description in the first 5 words is useful in its breadth.
Noris et al. 2021	"Any overlapping fashion and Information and Communication Technologies (ICTs) fields".	Too broad, outdated tech terminology
Nobile et al. 2021	"All the processes that include (1) marketing and communicating tangible and intangible products; (2) the development and implementation of processes that support the advancement of the industry; (3) the effects of digital advances on society".	Lack of inclusion of digital product creation tools, inferred by the second point, but unclear. Wider societal impact is usefully included.
Baek et al. 2022	"The virtual creation, production and representation of one's identity *via* computer-generated design".	Too focused on identity, designs are not always computer-generated, they are human generated with computers.
True Search & BFC 2023	"How we express ourselves through virtual clothing, powered by cutting-edge frontier technologies, in virtual, physical and augmented environments".	Useful inclusion of self-expression, tech and interaction with the environment. DF is not just virtual clothing it includes accessories, footwear, jewelry etc. Phygital is missing.
Sayem 2023	"A multi-disciplinary field which can be clustered into (1) digital design and prototyping (2) digital business and promotion (3) digital human and metaverse (4) phygital apparel and smart wearable technology".	Complexity and diversity alluded to, key contributions in the value chain are listed. DF's function is missing.

(*Continued*)

Table 1. (*Continued*).

Author / year	Definition	Definitional critique
Chan et al. 2024	"The integration of fashion and 3D virtual technologies, where 3D CAD rendered garments are created and produced virtually. It can be used as a tool to enhance tangible product development for design and production and facilitate communication and marketing by enabling virtual previews for shoppers. It can also be sold as a digital end-product, such as digital skins for gamified environments, digital skins for virtual influencers, superimposed image-based, AR filter-based, Fashion NFTs, and Digital twins".	Dual form of DF is recognized – tool and end product – however its function is not addressed. Accessories absent from the definition.

et al. (2024). Another critical dimension is the use of digital garments in gaming and virtual environments, which must also be incorporated into a comprehensive definition. Chan et al. (2024) and Voyer and Ko (2021) further highlight DF's evolution from a tool or process to an end product, as demonstrated during the fashion NFT boom of 2021 (Alexander and Bellandi 2022). We contend that the existing definitions are incomplete and therefore propose a more holistic, accessible, and enduring definition that accommodates DF's dynamic and rapidly evolving nature (see below). This definition recognizes that DF's form extends beyond garments and functions both as a tool and an end product. It also situates the rationale for DF's use within a broad, inclusive context. Finally, it avoids specifying particular technologies, acknowledging that these are subject to rapid change.

> "*Digital Fashion is a realm of fashion involving digital representations of clothing, footwear and lifestyle products. Manifesting both as an operational tool and an end product, it offers an augmentation of creativity as well as new forms of identity expression, culture, experience, efficiency and value for all players across the fashion ecosystem. Its omni-dimensional form and functions evolve with the progression of new technologies and its purpose in the value chain*" (Grant and Alexander 2026).

Approach

While uncommon in commentaries, a clear explanation of the methodological approach is provided to enhance the rigor and robustness of this contribution. The research design comprised three key stages: a literature review, personal practitioner experience, and elite interviews with DF experts. The first stage involved reviewing recent peer-reviewed journal articles that focused on DF systematic literature reviews and research

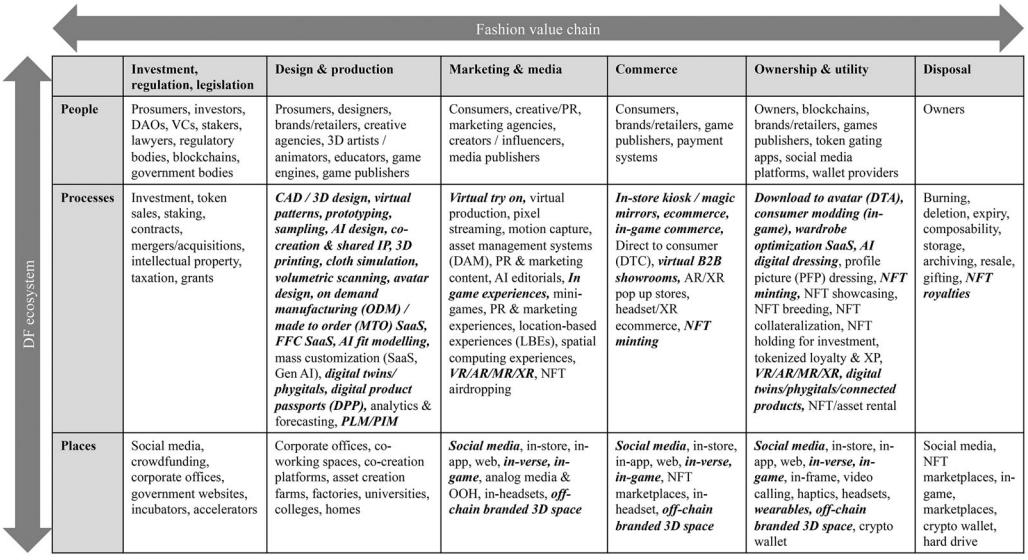
agendas. Comparing the theoretical frameworks in these papers revealed key issues: differences in *positionality* (tactical/operational versus strategic perspectives), *research focus* (ranging from narrow questions to broader intellectual paradigms), and *timing* (earlier papers were outdated due to rapid technological advancements, excluding key technologies). Despite these limitations, delineating the previously articulated research areas was essential to underpin our proposed framework. The second stage involved analyzing current industry articles on DF and drawing on the lead author's personal experience as a DF specialist. This informed the development of a research agenda and led to our effort to articulate the DF ecosystem within the value chain – a gap not addressed in existing scholarly or practitioner literature. The goal was to identify DF types and applications already explored in research and highlight areas ripe for further investigation. To improve the validity and utility of the framework, the third stage engaged ten elite industry specialists to review it for clarity and practical application. The identification and participation of the experts were decided by the following criteria: more than five years of daily DF experience, a role as a DF founder or C-Suite executive, an equal division of domain expertise (i.e. design, retail, marketing). Experts were each emailed a version of the framework, and a video call was scheduled to capture initial feedback, future rounds of feedback were gathered by email. After seven iterations, the final DF ecosystem framework was agreed upon for inclusion in this commentary.

Research agenda: an ecosystem approach

An industry ecosystem approach was adopted to encompass all players within the value chain and uncover potential interlinkages and interdependencies. The decision to structure the ecosystem around key value chain activities was driven by two factors: first, it builds on an established and widely accepted theoretical foundation; second, industry research and personal experience suggest a lack of clarity and awareness about where DF creates value – both tangible and intangible – within the value chain. The value chain variables for this framework included:

1. Investment, regulation and legislation
2. Design and production
3. Marketing and media
4. Commerce
5. Ownership and utility
6. Disposal

Three key facets of the DF ecosystem were examined: *What* (processes), *Where* (places), and *Who* (people). *Processes* were prioritized as the fundamental question – *what is DF used for?* – remains unanswered. *People* were included to identify relevant stakeholders and ensure a



	Investment, regulation, legislation	Design & production	Marketing & media	Commerce	Ownership & utility	Disposal
People	Prosumers, investors, DAOs, VCs, stakers, lawyers, regulatory bodies, blockchains, government bodies	Prosumers, designers, brands/retailers, creative agencies, 3D artists / animators, educators, game engines, game publishers	Consumers, creative/PR, marketing agencies, creators / influencers, media publishers	Consumers, brands/retailers, game publishers, payment systems	Owners, blockchains, brands/retailers, games publishers, token gating apps, social media platforms, wallet providers	Owners
Processes	Investment, token sales, staking, contracts, mergers/acquisitions, intellectual property, taxation, grants	***CAD / 3D design, virtual patterns, prototyping, sampling, AI design, co-creation & shared IP, 3D printing, cloth simulation, volumetric scanning, avatar design, on demand manufacturing (ODM) / made to order (MTO) SaaS, FFC SaaS, AI fit modelling,*** mass customization (SaaS, Gen AI), ***digital twins/ phygitals, digital product passports (DPP),*** analytics & forecasting, ***PLM/PIM***	***Virtual try on,*** virtual production, pixel streaming, motion capture, asset management systems (DAM), PR & marketing content, AI editorials, ***In game experiences,*** mini-games, PR & marketing experiences, location-based experiences (LBEs), spatial computing experiences, ***VR/AR/MR/XR***, NFT airdropping	***In-store kiosk / magic mirrors, ecommerce, in-game commerce,*** Direct to consumer (DTC), ***virtual B2B showrooms,*** AR/XR pop up stores, headset/XR ecommerce, ***NFT minting***	***Download to avatar (DTA), consumer modding (in-game), wardrobe optimization SaaS, AI digital dressing***, profile picture (PFP) dressing, ***NFT minting,*** NFT showcasing, NFT breeding, NFT collateralization, NFT holding for investment, tokenized loyalty & XP, ***VR/AR/MR/XR, digital twins/phygitals/connected products,*** NFT/asset rental	Burning, deletion, expiry, composability, storage, archiving, resale, gifting, ***NFT royalties***
Places	Social media, crowdfunding, corporate offices, government websites, incubators, accelerators	Corporate offices, co-working spaces, co-creation platforms, asset creation farms, factories, universities, colleges, homes	***Social media***, in-store, in-app, web, ***in-verse, in-game***, analog media & OOH, in-headsets, ***off-chain branded 3D space***	***Social media***, in-store, in-app, web, ***in-verse, in-game***, NFT marketplaces, in-headset, ***off-chain branded 3D space***	***Social media***, in-store, in-app, web, ***in-verse, in-game***, in-frame, video calling, haptics, headsets, ***wearables, off-chain branded 3D space***, crypto wallet	Social media, NFT marketplaces, in-game, marketplaces, crypto wallet, hard drive

Figure 1
Digital fashion ecosystem framework (author's own).

holistic perspective in empirical research. Listing all potential stakeholders helps provide a comprehensive overview. Similarly, *Places* were considered to offer methodological and sampling guidance, particularly for qualitative or naturalistic research approaches.

Figure 1 presents the DF ecosystem framework, with bolded items indicating topics previously addressed in scholarly research. This highlights significant knowledge gaps in the field, which are revisited in the article's conclusion.

Investment, regulation and legislation

This stage of the value chain focuses on stakeholders and activities that can add or subtract value. Key areas include finance, regulation, and legal aspects of DF, with critical stakeholders being investors, venture capitalists (VCs), lawyers, government agencies, and regulatory bodies. These actors can either support or hinder a DF startup or an established business pursuing a DF project (Grant 2024). Businesses must carefully assess liquidity sources and, for on-chain business models, consider the influence of chain owners and stakers on their success. While still niche, Decentralized Autonomous Organizations (DAOs) – such as Red DAO and Flamingo DAO – serve as alternative funding sources within DF. Additionally, prosumers play a dual role as consumers and value creators, contributing *via* crowdfunding, DAOs, Wear-to-Earn (WTE) mechanics or cryptocurrency staking (Chong 2023; Boughlala and Smelik 2025).

Challenges at this stage include securing investment through funding rounds, crowdfunding, token sales, or grants. Negotiations leading to signed contracts can be lengthy, especially with large legacy fashion businesses. Intellectual property (IP) clauses often complicate projects involving multiple industries (e.g. fashion, media, and music collaborations). In-house legal teams, unfamiliar with decentralized legal frameworks, may cause projects to stall in legal back-and-forth, preventing them from reaching the build or consumer stage (Grant 2024). Projects may also fail due to leadership and culture changes at the C-Suite level (Larocheski 2024).

Key places for these activities include social media, where investors scout for talent and emerging technologies, and crowdfunding platforms, where startups seek funding and PR exposure (Morris 2025). Physical places include corporate offices of VCs and established brands, where investment and partnership discussions occur, as well as industry conferences, which are critical venues for investment conversations (Grant 2024). Additionally, organizations often launch incubator or accelerator programs through physical or virtual events. Government websites remain a primary resource for innovation-related grants, vital for DF startups focused on research and development.

Design and production

At this stage of the value chain, key stakeholders include designers and brands/retailers, depending on who commissions and owns the DF work. 3D artists and animators are critical contributors to digital asset production (Grant and Alexander 2026). The gaming industry, with its longstanding tradition of trading DF assets as cosmetics and skins, holds significant influence, particularly on game engines and publishers (Boughlala and Smelik 2025; Harrop 2023). However, they have faced criticism for restricting content interoperability beyond their platforms (Cointelegraph 2024). Prosumers also play a role here, participating in production through co-creation or modding (self-modifying in-game). Activities at this stage represent some of the most concentrated DF-related efforts within the value chain. For clarity, these activities are segmented into three key areas, as shown in Figure 2.

Like the first stage, many activities occur in corporate offices or co-working spaces, depending on the organization's size and culture. Additionally, factories in manufacturing hubs are increasingly important as brands and producers adopt 3D technologies across the supply chain. Conglomerates similar to VF Corporation and PVH are among the most digitally integrated in the sector (Young 2023). As demand for digital assets grows, asset creation farms – common in sectors such as gaming and Visual Film Effects (VFX) – are emerging as key production hubs, often operating in a distributed manner in low-cost labor countries (Grant 2024). Notably, many 3D designers are self-taught, nonprofessional and skew younger, particularly Roblox players creating custom

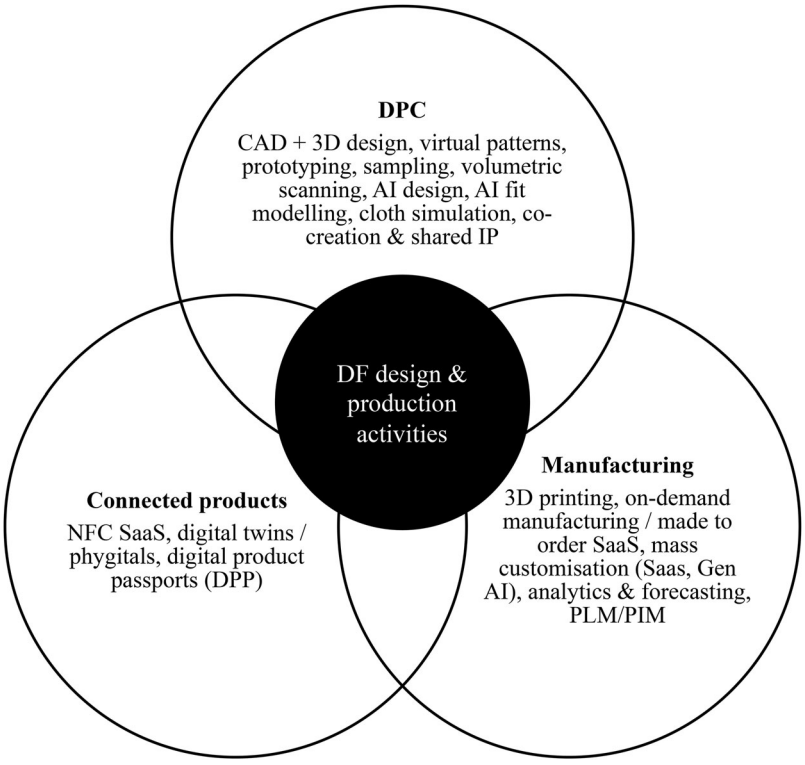


Figure 2
DF design and production activities segment (authors' own).

looks in the game *Dress to Impress* (Boughlala and Smelik 2025; Davis 2024; Park and Chun 2023). This highlights homes, alongside structured learning environments such as universities and colleges, as key locations for skill development at this stage. Lastly, co-creation platforms are becoming increasingly significant as brands and creators collaborate to cross-pollinate ideas. Examples include RSTLSS founded by Charlie Cohen (RSTLSS 2025) and Nike's recent release of AirImagination where consumers could reimagine Air Max sneakers using Nike's archive and text-to-image generative AI (Dazed 2025).

Marketing and media

This stage focuses on promotion and identity management, involving consumers as recipients of marketing communication and marketing or public relations teams and agencies as its creators. Media platforms, publishers, and influencers play a central role in DF promotion, similar to traditional fashion (Kim and Chakraborty 2024). However, DF currently receives significantly less coverage in features and editorials and is often portrayed in a dismissive manner (Grant 2024). Few influencers or creators focus exclusively on DF, with *Thisoutfitdoesnotexist*, operated

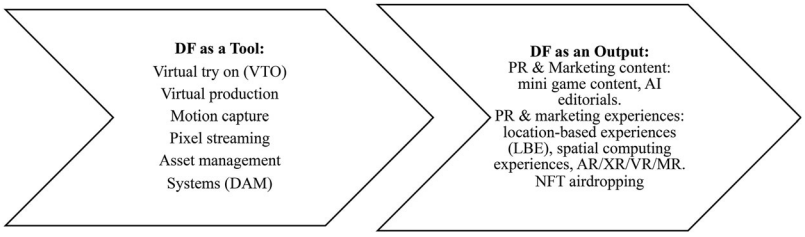


Figure 3
DF marketing and media segments of activities (authors' own).

by Dani Loftus, being a notable exception. Key activities at this stage are divided into two categories: DF as a tool versus DF as an individual output, as illustrated in Figure 3.

Virtual Try-On is categorized as a marketing activity. While it also serves as a tool for sales conversion, it is primarily utilized (and funded) as a marketing activation. This application is projected to grow rapidly in the next five years (GVR 2024). Notably, AR try-on requires a digital asset to be scanned or virtualized, whereas AI try-on does not, which could influence adoption rates.

The next two activities, *virtual production* and *motion capture*, are specific techniques for creating and animating content using computer-generated imagery (CGI). Historically expensive and requiring specialized skills, these technologies are becoming more accessible, with companies such as Nike integrating them into their operations (Grant 2024). Similarly, *pixel streaming*, a method for delivering high-resolution interactive content quickly, has emerged from the gaming sector and is now appealing to fashion brands as costs decrease. For instance, Balenciaga used pixel streaming to promote and operationalize their 2020 fashion show collection, Afterworld: The Age of Tomorrow (Unreal Engine 2021). The final tool in the marketing and media segment is the *Digital Asset Management System (DAM)*, which fashion companies increasingly require to manage the complex and extensive asset sets for each product and collection (Business of Fashion 2025). Ineffective management of DF poses challenges for both legacy brands, due to scale, and independent brands, which may lack technical expertise or resources.

Marketing and media outputs for DF primarily consist of *PR, marketing content,* and *experiences*. A recent trend involves commissioning oversized CGI versions of iconic products for social media campaigns (e.g. Jacquemus and LVMH) (Abad 2023a). Fashion brands also leverage CGI campaigns for their creative potential – unbounded by physical locations or constraints – and sustainability, eliminating the need to transport teams and products globally for on-location shoots. While the fashion industry has been slow to embrace gaming as a socio-cultural phenomenon, brands are finally experimenting with gamifying marketing experiences and creating mini games for product launches (Davis

2024). This strategy has been particularly successful for luxury brands including Chanel and Hermes, especially for entry-level products such as cosmetics and perfumes. *Editorials* often involve adding DF assets in post-production or generating entire shoots with AI, although these practices remain rare in mainstream fashion media. However, Mango recently made headlines by launching an entirely AI-generated campaign for their Summer 2024 teen line (Bloomberg 2024). Media publishers exploring DF editorials include Conde Nast, Paper Magazine, Cybr and Glitch (Abad 2023b; Glitch 2025; Showstudio 2021b; Zhao 2021).

PR and marketing experiences in fashion encompass various formats, from fashion shows and pop-up stores to tech collaborations. However, mass adoption of AR-related location-based experiences remains limited (Grant 2024). Among the realities of AR, XR, VR, and MR, AR has achieved the highest adoption levels, largely due to social integrations and numerous activations within the beauty sector (Javornik et al. 2021). The Apple Vision Pro, a spatial computing headset, is still emerging, but luxury brands Gucci, Balenciaga, StockX, and Rimowa have begun creating experiences for it (McDowell 2024). Speculation continues regarding the mass adoption of AR glasses and XR headsets as crucial for mainstream DF acceptance. Finally, although NFTs (non-fungible tokens) still face negative perceptions among consumers and brands, the practice of receiving airdropped NFTs or earning them through loyalty programs is expected to grow as a long-term use case (Sethi 2025).

The places for marketing and media activities in DF are diverse, illustrating their omnichannel and multi-touchpoint applications. These range from traditional channels, such as out-of-home (OOH) billboards and print advertisements, to expected digital channels such as social media, websites, apps, and in-store experiences (Grant 2024). A notable subgenre is the virtual store or branded 3D environment, which primarily focuses on experiential and brand-led positioning. Recent activations have been conducted by Rimowa, Sephora, and Benefit Cosmetics (Ryder 2024). Other growing DF locations include in-game, in-metaverse, and in-headset digital experiences. DF assets have the potential for widespread visibility, as they can be 'seen' across various platforms and locations (Grant and Alexander 2026).

Commerce

The fourth stage pertains to commerce, involving stakeholders such as consumers who "consume" products and brands/retailers who sell them. Additionally, game publishers are important stakeholders when commerce occurs in-game. Payment systems are included here as essential components that can significantly impact the commerce experience by affecting the user journey (Shopify 2025).

The limitations and configuration of the commerce function's location will determine the key activities involved. These activities are

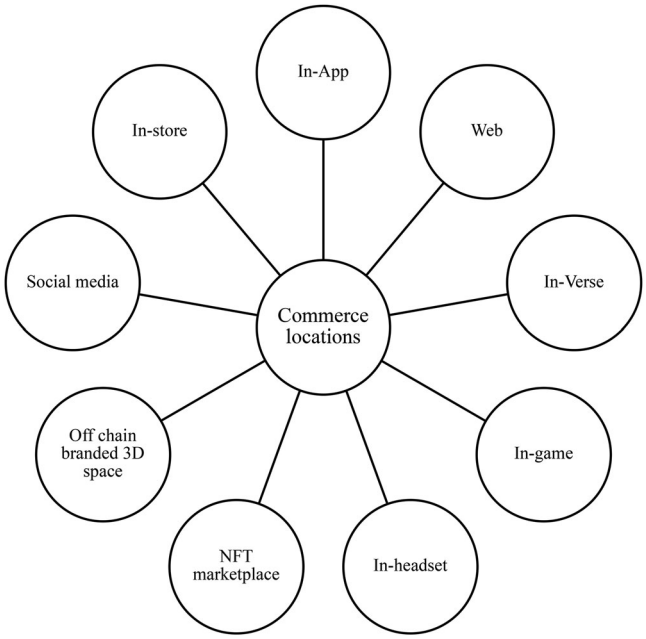


Figure 4
Key locations for digital fashion asset consumption (authors' own).

outlined first, as shown in Figure 4. They closely resemble the marketing and media touchpoints, with the notable addition of NFT marketplaces, which serve as platforms for B2C and C2C sales of DF assets.

In terms of activities, the highest volume of DF asset consumption currently occurs in-game. Although precise figures are lacking, anecdotal evidence indicates significant sales, with Roblox (2024) reporting 1.6 billion DF items were sold in the first nine months of 2023. The second-largest consumption site is on e-commerce platforms, where brands integrate 3D assets into product description pages (PDP). Evidence suggests that incorporating 3D at this critical conversion point can increase sales by 94% (Roberts-Islam 2024). For instance, fast fashion brand Shein showcases 3D assets solely on the PDP, leading consumers to commit to purchasing due to viewing the rendered item (Cronin 2024). The third highest source of DF traffic is B2B sales within the wholesale distribution chain, particularly through virtual showrooms (the most advanced approach) or CAD mockups (the most basic).

Some businesses are also offering DF assets in-store *via* kiosks and magic mirror interfaces, as seen with Hot: Second, Fabrik X, Galeries Lafayette, and DressX (McDowell 2019; Hirchmiller 2023). Brands including Nike and Machine-A have experimented with AR and XR pop-up stores, which tend to succeed with established communities or products with high demand elasticity (Adams 2021; Showstudio 2021a). It is anticipated that mixed reality (MR) e-commerce will grow as headset and glasses adoption transitions from niche to mainstream. Since its January 2024 launch, Apple Vision Pro has primarily hosted marketing-

focused experiences, although software provider Obsess has launched five e-commerce projects this year for brands Rimowa, J.Crew, Elf Cosmetics, MyTeresa, and Alo Yoga (McDowell 2024). Lastly, NFT minting is related to DF asset consumption and occurs either when an NFT is purchased (this is known as 'lazy minting') or a finite number is minted prior to sale (Grant 2024). The advantages and disadvantages of these methods depend on market dynamics, payment processes, blockchain integration, and the seller's desire for transparency regarding sales figures and remaining inventory (Chebli and Cherbal 2025).

Ownership and utility

The final two stages focus on the post-consumption experience, referring to consumers as "owners." This terminology is significant because, for DF items sold as NFTs on-chain, the term "consumption" does not fully capture the motivation for purchase, which is suggested to be 'true' ownership (Alexander and Bellandi 2022; Grant 2024). Key stakeholders in this phase include those who enhance the post-purchase utility of a DF asset. Currently, a major criticism of DF concerns its utility – what can you actually do with it in the long term (Sethi 2025)? For instance, can it be worn on your avatar in-game *via* games publishers? Can it foster long-term relationships and loyalty by unlocking brand perks through token-gating apps? Can it provide exclusive AR experiences on social media platforms? How easy is it to resell *via* secondary marketplaces?

Given the vast and varied processes and places for this stage, Table 2 presents a structured overview. It outlines key activities, provides a brief description, specifies their locations, and offers examples of best practices in the sector. The table also indicates each activity's current lifecycle position. Activities in the introduction phase include WOS, PFP dressing, NFT breeding, NFT collateralization, and rental. Those gaining traction are digital dressing, token-gated loyalty, XR experiences, and phygitals. The most widely adopted activities are DTA, modding, NFT showcasing, and NFT holding.

Disposal

In the final stage of disposal, the primary stakeholder is the owner, who decides how to dispose of the digital asset. This aspect of DF has received little academic and industry attention, likely due to the sector's nascence. However, it warrants exploration, particularly concerning sustainability and transparency in the lifecycle of DF and its assets.

The methods of disposing of a digital asset depend on its creation (file type), utility, and ownership (on-chain or off-chain). For on-chain assets, such as NFTs, disposal typically involves "burning," which means sending the NFT to a specific wallet address where it becomes permanently inaccessible (Grant 2024). Few DF projects have explored

Table 2. DF ownership and utility activities (authors' own).

Key process and activities	Stage of lifecycle	Description	Activity location	Best practice examples
Download to Avatar (DTA)	Maturity	DF asset can be downloaded in different and suitable file formats to be worn on an avatar. The future popularity of this activity is linked to the interoperability of the file types and agreements between platforms	Social media In Game In Verse In Headset Video Calling	Gucci Balenciaga Ralph Lauren Hugo Boss Alo Coach
Modding	Maturity	DF asset can be modified by the owner and worn in game	In Game	Sims Roblox
Wardrobe Optimization SaaS (WOS)	Introduction	Digital asset of a physical item is either created or sold with purchase and uploaded into a software programme that tracks and optimizes usage, repair, styling etc	In App Web	Save Your Wardrobe Whering
Digital Dressing (AI)	Growth	DF asset is created and layered onto a photo of the owner using AI prompts	In App Social media Web	DressX.AI
PFP Dressing	Introduction	DF asset is layered on a photo or avatar of the owner using Photoshop or similar tool and the owner displays the output as their profile image on social media / other digital platforms.	Social media	RTKFT DMAT
NFT Showcasing	Maturity	DF NFT may be conspicuously (or not) displayed in the owner's home and/or as part of their digital collection	In Frame Crypto Wallet Web Social media	SYKY
NFT Breeding	Introduction	DF NFT includes as part of its smart contract, component parts which can be bred with other NFTs to create derivatives	In App Web	Digitalax

(*Continued*)

Table 2. (*Continued*).

Key process and activities	Stage of lifecycle	Description	Activity location	Best practice examples
NFT Collateralization	Introduction	DF NFT is held by a lender as collateral for an exchange of funds (crypto or fiat)	In App Web	Only seen so far with Cryptopunks and Bored Apes
NFT Holding (for investment)	Maturity	DF NFT is held by the owner long-term, in order to receive an increase on its monetary value. A form of asset holding.	Crypto wallet	MetaBirkin
NFT Token Gated Loyalty and XP	Growth	DF NFT acts as a gated entry point into a loyalty programme with brand perks and experiences	In Store In-App	Louis Vuitton
AR/XR/VR/MR Experiences	Growth	DF asset or NFT includes with it open or closed branded experiences across the reality spectrum.	Social media In-Store In-Headset Wearables	The Dematerialized (DEMAT)
Digital Twins/ Phygitals/ Connected Products	Growth	DF asset or NFT has a physical counterpart which could be an exact twin, a variation or totally different. This could be housed in a Digital Product Passport (DPP)	Wearables Web	9dCC RTFKT Tribute Brand Mugler MMerch
Asset Rental	Introduction	DF asset or NFT is rented out with restrictions as to what can be undertaken with it.	In App Web In Verse	Not yet undertaken commercially

composability – an aspect that can be programmed into an NFT's smart contract. This allows for features such as expiration after a certain period or transformation into another asset. Digitalax attempted to implement such creative and sustainable features in 2020, highlighting exciting opportunities that remain largely untapped (Digitalax 2020).

One of the simplest disposal methods is for the owner to delete the asset from its storage location. If the asset is on-chain, this likely involves a crypto wallet. Alternatively, the owner can gift the asset by transferring it directly to another wallet or store it on their hard drive or wallet. While not widely practiced, archiving the asset themselves or donating it to a formal archive service or digital repository is also an option (Oakford 2025). The owner may choose to resell the item, with the location depending on whether it is an NFT. If so, it would typically be sold on secondary marketplaces similar to OpenSea or Rarible. If the

Table 3. Un-researched DF activities (authors' own).

Segment	Design + Production	Marketing + Media	Commerce	Ownership + Utility	Disposal
Activity	Mass Customization (SaaS, Gen AI) Analytics + Forecasting	Virtual (RealTime) Production Pixel Streaming Motion Capture Asset Management Systems (DAM) AI Editorials Mini Games PR and Marketing Content and Experiences Location Based Experiences (LBEs) Spatial Computing Marketing Experiences NFT Airdropping	AR and XR Pop Up Stores Headset/XR eCommerce	PFP Dressing NFT Showcasing NFT breeding NFT collateralization NFT holding for investment Tokenized loyalty NFT/Asset Rental	Burning Deletion Expiry Composability Storage Archiving Resale Gifting

owner is the creator (or co-creator) listed in the smart contract, they will receive a royalty fee with each resale. This feature was a significant motivation for some brands and designers to enter the NFT space during the boom of 2021, especially among luxury brands looking to track and protect revenue from iconic physical pieces (Sethi 2025). Additionally, social media platforms can facilitate private NFT sales between sellers, albeit with a high risk of scams (Grant 2024). Lastly, if the DF asset has in-game utility, it may be tradable within that platform's marketplace.

Research gaps

Several areas of DF remain empirically unresearched, as highlighted in Table 3. The least explored segments are in marketing and media, as well as in disposal.

Conclusion

DF is a diverse and fragmented research field. This article first addressed the challenges of definitional clarity and aligned future research recommendations from previously published papers, which were essential for conceptualizing a research framework. The authors propose an effective current working definition of DF as:

> "*A realm of fashion involving digital representations of clothing, footwear and lifestyle products. Manifesting both as an operational tool and an end product, it offers an augmentation of creativity as well as new forms of identity expression, culture, experience, efficiency and value for all players across the fashion ecosystem. Its omni-dimensional form and functions evolve with the progression of new technologies and its purpose in the value chain*".

A value chain ecosystem approach proved most logical, allowing mapping against past articles and current industry thinking. We outlined five value chain segments through three key lenses: people (stakeholders), processes (activities), and places (locations). This framework provides a comprehensive, accessible landscape for academics and practitioners to explore the "Who," "Where," and "What" questions related to DF. Given the sector's dynamic nature, the authors acknowledge that this framework must be reevaluated at least annually to accurately reflect industry developments. The frameworks can be utilized by practitioners as a menu for potential marketing differentiation and value adding commercial and creative opportunities. For academics and students, it provides ample inspiration for progressive research projects. While it was beyond the scope of this piece to explore the motivations behind DF – specifically the "why" and "when" – we suggest that

understanding these motivations from a multi-stakeholder perspective is essential. Additionally, the timing of DF activities could be a critical success factor, as the sector has not yet achieved mass adoption.

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