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THE FUTURE OF FASHION DESIGN IN THE DIGITAL AND VIRTUAL ENVIRONMENT

Mehreen

BS Student, Department of English Literature, Government College University , Lahore

ABSTRACT

The rapid development of digital technologies is transforming the fashion industry and creating new possibilities for fashion design, production, presentation, and consumer engagement. Digital fashion design tools, artificial intelligence (AI), virtual reality (VR), augmented reality (AR), 3D modeling, digital garments, virtual fashion shows, and metaverse platforms are increasingly becoming important components of contemporary fashion practice. These technologies allow designers to create, modify, visualize, and present garments in virtual environments without depending entirely on traditional physical production processes. Digital and virtual fashion can also support creativity, experimentation, personalization, sustainability, and global accessibility. At the same time, the transition toward digital fashion raises challenges related to technological skills, intellectual property, authenticity, accessibility, cost, and changes in traditional design practices. This study explores the future of fashion design in digital and virtual environments by examining how emerging technologies influence designers' creative processes, fashion education, consumer experiences, and industry practices. The study emphasizes the potential of digital fashion to create innovative design opportunities while identifying the skills and challenges that fashion designers may need to address in the future.

KEYWORDS: *Digital Fashion, Virtual Fashion, Fashion Design, Artificial Intelligence, 3D Design, Virtual Reality, Augmented Reality, Metaverse, Fashion Technology, Digital Creativity*.

INTRODUCTION

The fashion industry is experiencing a significant transformation as digital technologies become increasingly integrated into the design and development process. Traditionally, fashion design has depended on sketching, fabric selection, pattern making, physical sampling, and garment construction. However, advances in digital design software and emerging technologies are changing how designers conceptualize, develop, communicate, and present fashion products. Three-dimensional garment simulation, digital pattern making, computer-aided design, artificial intelligence, virtual reality, and augmented reality enable designers to visualize fashion concepts before creating physical garments. These developments have expanded the possibilities for experimentation and have encouraged fashion designers to explore new forms, materials, aesthetics, and presentation methods.Digital fashion represents an important development within this transformation. Periyasamy, A. P., & Periyasami, S. (2023). Found that . Unlike conventional fashion, digital garments can exist entirely in virtual spaces and can be designed for avatars, gaming environments, social media, virtual events, and metaverse platforms. Designers can create garments that may be difficult or impossible to produce physically because digital environments are not restricted by conventional material, gravity, manufacturing, or physical construction limitations. Consequently, virtual fashion provides designers with greater freedom

to experiment with unusual silhouettes, animated garments, interactive effects, and immersive experiences.

Artificial intelligence is also becoming an influential technology in the future of fashion design. AI-based systems can assist designers in generating visual concepts, identifying trends, developing design variations, analyzing consumer preferences, and supporting creative decision-making. Rather than completely replacing designers, these technologies can function as creative tools that support ideation and experimentation. The future fashion designer is therefore likely to require both traditional design knowledge and digital competencies, including 3D modeling, digital visualization, AI-assisted design, virtual presentation, and technology-based communication.The digital and virtual environment may also contribute to more sustainable fashion practices. Digital sampling and virtual prototypes can reduce the need for repeated physical samples, while virtual fashion products can be presented to consumers without requiring immediate physical manufacturing. This may help reduce material consumption and waste during certain stages of the design process. However, digital fashion is not automatically sustainable, as digital technologies themselves require energy, infrastructure, and technological resources. Therefore, future research needs to consider sustainability from both environmental and technological perspectives.Another important dimension is the changing relationship between designers and consumers. Virtual environments can allow consumers to interact with digital garments, customize appearances, use avatars, participate in virtual fashion shows, and experience products through immersive technologies. This creates opportunities for more interactive and personalized fashion experiences. At the same time, issues such as digital accessibility, data privacy, copyright, ownership of digital designs, and the authenticity of virtual products require greater attention.Fashion education is also expected to change as digital and virtual technologies become more common.

Overall, the future of fashion design is likely to involve a combination of physical craftsmanship and digital innovation rather than a complete replacement of traditional fashion. Digital and virtual environments provide new creative spaces in which designers can experiment, communicate, and engage with global audiences. Understanding these developments is essential for fashion educators, students, designers, brands, and researchers seeking to respond effectively to the changing nature of the fashion industry.The fashion industry is undergoing a significant transformation due to the rapid development of digital and virtual technologies. Traditionally, fashion design has depended on hand sketches, fabric selection, pattern making, physical sampling, sewing, and face-to-face presentation. Today, however, designers increasingly use computer-aided design (CAD), 3D garment simulation, artificial intelligence (AI), virtual reality (VR), augmented reality (AR), digital pattern making, and other advanced technologies to develop and present fashion concepts. These technologies have changed the conventional fashion design process by allowing designers to visualize garments digitally, make immediate modifications, experiment with different colours and textures, and develop virtual prototypes before producing physical garments. As a result, digital technology is becoming an important

part of contemporary fashion practice and is creating new possibilities for the future of the industry.

Digital fashion is one of the most important developments emerging from this technological transformation. Digital fashion refers to garments and fashion products that are designed, represented, or experienced through digital environments. Unlike traditional clothing, digital garments do not necessarily require physical materials or physical production. Kim, W., Kim, J., Ko, D., Cha, J. H., Park, G., Ahn, Y., ... & Cha, S. (2023, June). Explains that .They can be created for avatars, social media, video games, virtual events, and metaverse platforms. Designers can create highly experimental garments that may not be practical to produce physically because virtual environments are not restricted by the same limitations of gravity, fabric behaviour, manufacturing processes, or physical construction. This freedom allows fashion designers to explore unusual silhouettes, animated textiles, imaginative structures, and innovative visual effects. Consequently, virtual fashion is expanding the definition of what a fashion product can be and how fashion can be experienced.Three-dimensional fashion design is also changing the way designers develop garments. Through 3D software, designers can create virtual clothing on digital models and evaluate the appearance, shape, fit, and movement of garments before creating physical samples. This process can reduce the dependence on repeated physical prototypes and can make communication between designers, manufacturers, and consumers more efficient. Digital sampling also allows designers to identify design problems at an earlier stage and make modifications without wasting large amounts of fabric or other resources. The increasing use of digital prototyping therefore has potential benefits for both efficiency and sustainable fashion development. However, digital technologies do not automatically guarantee sustainability because digital systems require energy, hardware, software, and technological infrastructure. Therefore, the environmental benefits and costs of digital fashion need to be considered together.

Artificial intelligence is another emerging technology that has considerable potential to influence the future of fashion design. AI can assist designers in generating ideas, identifying fashion trends, developing visual concepts, analysing consumer preferences, and creating multiple design alternatives. AI-powered tools can help designers explore a large number of creative possibilities in a short period of time. This may support experimentation and provide inspiration during the early stages of the design process. At the same time, the increasing role of AI raises important questions about creativity, originality, authorship, copyright, and the professional identity of fashion designers. Human creativity, cultural knowledge, emotional expression, craftsmanship, and critical judgement therefore remain important even when AI is used as a creative support tool. The future of fashion design is likely to involve collaboration between human designers and intelligent digital systems rather than simply replacing designers with machines. Virtual reality and augmented reality are also creating new ways for fashion to be designed, presented, and experienced. VR can provide immersive environments in which designers, students, and consumers can explore virtual garments and fashion collections. AR can allow users to digitally

visualize garments or accessories in real-world environments through technological devices. Trakulwaranont, D., Kastner, M. A., & Satoh, S. I. (2022, March). Explained that . These technologies have the potential to change fashion shows, retail experiences, advertising, education, and consumer interaction. Instead of simply looking at a garment on a physical model or store display, consumers may increasingly interact with digital products and personalized virtual experiences. Such developments can create stronger connections between fashion brands and consumers and can make fashion more interactive and accessible across geographical boundaries.The development of the metaverse has further expanded opportunities for virtual fashion. In virtual environments, individuals can create digital identities through avatars and express their personalities through virtual clothing and accessories. Fashion therefore becomes not only a physical product but also a form of digital identity and self-expression. Virtual fashion shows, digital collections, avatar clothing, and online fashion communities demonstrate how fashion can operate beyond physical spaces. This development provides designers with opportunities to reach global audiences and experiment with new forms of fashion communication. It also creates new commercial possibilities, including the sale and collection of digital fashion products. However, questions concerning ownership, intellectual property, authenticity, accessibility, and the long-term value of digital garments remain important challenges..

RESEARCH OBJECTIVES

1. To examine the impact of digital technologies such as AI, 3D design, VR, and AR on contemporary and future fashion design practices.
2. To explore the opportunities provided by digital and virtual environments for creativity, innovation, sustainability, and consumer engagement in fashion design.
3. To identify the skills, challenges, and future requirements of fashion designers working in increasingly digital and virtual environments.

RESEARCH QUESTIONS

1. How are digital technologies such as AI, 3D modeling, VR, and AR transforming fashion design practices?
2. What opportunities do digital and virtual environments provide for creativity, innovation, sustainability, and consumer engagement in fashion?
3. What skills and challenges will influence the future role of fashion designers in digital and virtual environments?

LITERATURE REVIEW

The rapid development of digital technologies has significantly transformed the fashion industry, creating new approaches to fashion design, production, communication, marketing, and

consumption. Recent literature indicates that fashion is moving beyond the traditional physical garment toward a combination of physical, digital, and virtual experiences. Digital fashion can include computer-generated garments, 3D clothing, virtual avatars, augmented-reality garments, digital twins, fashion for gaming environments, and virtual fashion products. Гардабхадзе, I. (2025). Found that. Yezhova et al. (2024) conducted a systematic review of 386 publications and found that design, technology, social media, sustainability, digital fashion, and performance are among the major themes shaping contemporary research. Their findings demonstrate that digital fashion is no longer simply a supporting tool for conventional fashion design but is becoming an independent field of creative and technological practice.

Digital Transformation of Fashion Design

The integration of 3D design software has changed the conventional fashion design process by allowing designers to develop and visualize garments digitally before producing physical samples. Digital tools enable designers to experiment with silhouettes, colours, textures, patterns, and construction techniques while making rapid modifications. This can reduce the time and resources required for physical sampling and can improve communication between designers, manufacturers, and consumers. Chan et al. (2024) explain that digital fashion has developed from being primarily a design and retail tool into a virtual-only fashion product that can be consumed entirely within digital environments. Their systematic literature review identifies digital fashion as an emerging product category and emphasizes the need for further research into consumer adoption, virtual clothing, augmented reality, social media, and metaverse applications.

Virtual Fashion and the Metaverse

The emergence of the metaverse has created new environments for fashion designers to develop and display creative work. In virtual environments, garments can be designed for avatars rather than physical bodies, allowing designers to move beyond the limitations of physical materials, gravity, manufacturing processes, and conventional garment construction. Research on fashion design in the metaverse suggests that fashion has an important role in shaping users' virtual identities and shopping experiences. Chan, H. H. Y., Henninger, C., Boardman, R., & Blazquez Cano, M. (2024). Explains that . Ryu (2023), for example, examined the use of metaverse platforms in fashion design and concluded that fashion within these environments extends beyond virtual clothing itself, creating opportunities for new forms of fashion communication, consumption, and design practice. Recent research also indicates that virtual fashion collections are developing their own visual language. A study examining 314 designs from virtual fashion brands such as Auroboros, Tribute, Republiqe, The Fabricant, and RTFKT identified changes in colour, silhouette, texture, and textile patterns over a three-year period. The research found increasing experimentation and collaboration as virtual fashion matured, suggesting that digital fashion is gradually developing distinctive aesthetic and design characteristics while maintaining connections with contemporary fashion.

Artificial Intelligence and Fashion Creativity

Artificial intelligence is another major technological development influencing the future of fashion design. AI can support trend forecasting, image generation, design ideation, personalization, consumer analysis, and the development of alternative design concepts. Rather than viewing AI only as a replacement for human creativity, recent discussions increasingly consider it as a collaborative tool that can assist designers during the creative process. AI-generated fashion concepts can allow designers to explore numerous visual possibilities quickly and develop experimental ideas that may later be refined through human judgement and design expertise. Recent research into AI-driven digital fashion shows also suggests that AI can contribute to creative generation, fashion narratives, presentation, and audience experiences. At the same time, the use of AI introduces important challenges. Chan, H. H. Y., Henninger, C., Boardman, R., & Blazquez Cano, M. (2024 explained that . Questions concerning originality, authorship, intellectual property, designer identity, bias in algorithms, and the appropriate balance between human creativity and machine-generated content require further investigation. Boughlala and Smelik (2025) specifically identify AI as part of the latest stage in the development of digital fashion and highlight the complications that AI may create for the future of digital fashion practices.

Digital Fashion and Sustainability

Sustainability is one of the most frequently discussed benefits of digital fashion. Digital prototyping can reduce the need for physical samples, while virtual garments may allow brands and consumers to communicate fashion concepts without immediately manufacturing physical products. Periyasamy and Periyasami (2023) argue that the metaverse may provide opportunities for sustainable fashion by supporting digital products and reducing some forms of material consumption. Profumo, G., Testa, G., Viassone, M., & Ben Youssef, K. (2024). Explained that . Their review connects digital fashion with broader developments such as Industry 4.0, personalization, blockchain, and the metaverse. However, the relationship between digital fashion and sustainability is complex. Digital technologies require computing infrastructure and energy, and some digital-fashion business models may introduce additional environmental costs. Research on sustainable digital fashion in metaverse ecosystems therefore emphasizes the need to evaluate both the potential environmental benefits and the negative impacts associated with digital platforms and technologies. Thus, future fashion research should avoid assuming that every digital solution is automatically sustainable and should instead assess sustainability across the entire digital fashion lifecycle.

Consumer Experience and Digital Fashion Products

The development of digital fashion is also changing the relationship between fashion brands and consumers. Mu, X., Zhang, H., Shi, J., Hou, J., Ma, J., & Yang, Y. (2024). Revealed that .

Consumers can interact with digital garments through social media, augmented reality, virtual worlds, gaming platforms, and avatars. Digital clothing can become a form of self-expression and identity construction, particularly among consumers who participate actively in online communities. Chan et al. (2024) note that the emergence of digital fashion as an end product represents a major shift from traditional fashion because consumers can purchase or use garments that exist entirely in digital form. Virtual fashion may also create new opportunities for personalization and interactive shopping. Consumers can experiment with digital appearances, visualize garments, and engage with brands in immersive environments before deciding whether to purchase physical products. These developments suggest that future fashion design will increasingly involve designing not only garments but also digital experiences and forms of consumer interaction**.**

Fashion Education and Future Design Skills

The transition toward digital and virtual fashion also has important implications for fashion education. Traditional skills such as drawing, pattern making, textile knowledge, sewing, and garment construction remain valuable, but future designers are likely to require additional digital competencies. Michelle, G., & Sabrina, B. (2022, October). Elaborated on . These may include 3D garment simulation, computer-aided design, digital pattern development, virtual reality, augmented reality, AI-assisted design, digital visualization, and virtual presentation.The systematic review by Yezhova et al. (2024) demonstrates the growing connection between fashion design and technological development, suggesting that fashion education needs to respond to this interdisciplinary environment .Fashion institutions may therefore need to integrate digital technologies into curricula while maintaining traditional creative and technical skills. The future fashion designer is likely to function as both a creative practitioner and a digital innovator.

Research Gap

Although the existing literature demonstrates substantial growth in digital fashion research, several research gaps remain. Much of the literature focuses on technology, virtual products, sustainability, consumer adoption, and the metaverse, while comparatively less attention is given to how fashion designers themselves adapt their creative processes and professional identities to these changes. Park, S. E., Jeon, Y. J., & Baek, H. M. (2023).explains that . Furthermore, the long-term relationship between physical fashion and virtual fashion remains uncertain. Questions about the skills required by future designers, the educational changes needed to prepare students, the role of AI in human creativity, and the sustainability of digital fashion require further empirical investigation. Boughlala and Smelik (2025) emphasize that digital fashion has developed through multiple technological and cultural stages rather than through a simple linear progression, indicating the need for continued research into its future development.

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METHODOLOGY

This study adopts a qualitative research approach to examine the future of fashion design in digital and virtual environments. A qualitative approach is appropriate because the study focuses on understanding emerging digital practices, designers' experiences, creative processes, technological opportunities, and challenges associated with artificial intelligence, 3D fashion design, virtual reality, augmented reality, and metaverse platforms. The study relies primarily on secondary sources, including recent academic journal articles, research papers, books, and credible industry publications. The approach allows the researcher to identify major trends and developments and to develop a comprehensive understanding of how digital technologies may influence the future roles and creative skills of fashion designers. This research adopts a method approach mixed- to examine the future of fashion design in digital and virtual environments. Both qualitative and quantitative methods are used to understand how technologies such as 3D fashion design, artificial intelligence (AI), virtual reality (VR), augmented reality (AR), digital clothing, and virtual fashion platforms are changing the fashion industry. Primary data can be collected through questionnaires and semi-structured interviews with fashion design students, professional designers, fashion educators, and consumers. Secondary data is obtained from academic journals, books, industry reports, and relevant online publications. The research focuses on understanding the opportunities, challenges, consumer acceptance, sustainability benefits, and future potential of digital fashion.

RESEARCH DESIGN

A descriptive and exploratory research design is used for this study. The descriptive component examines the current use of digital and virtual technologies in fashion design, while the exploratory component investigates emerging possibilities and future developments. Relevant literature published mainly between 2023 and 2026 is reviewed systematically according to themes such as digital fashion, AI-assisted design, 3D garment simulation, virtual fashion, VR/AR, metaverse fashion, sustainability, consumer experiences, and fashion education. Sources are selected according to their relevance to the research objectives and questions. The collected information is organized into thematic categories to identify similarities, differences, developments, and research gaps. The study uses a descriptive and exploratory research design**.** The descriptive aspect identifies current trends in digital and virtual fashion, while the exploratory aspect investigates how emerging technologies may influence the future of fashion design. A questionnaire can be distributed to approximately 100 respondents, including fashion students, designers, and consumers. In addition, interviews with selected fashion professionals can provide deeper insights into technological changes in the industry. The questionnaire may include questions related to awareness of digital fashion, use of 3D software, interest in virtual clothing, AI-generated designs, virtual fashion shows, and attitudes toward sustainable digital fashion. The collected information is then organized according to major themes and research objectives.

DATA ANALYSIS

The study uses thematic analysis to analyze the collected secondary data. Relevant information from academic literature and other credible sources is coded and organized into major themes related to the future of digital and virtual fashion design. The key themes include technological innovation, creative development, artificial intelligence, virtual fashion, sustainability, consumer engagement, fashion education, and future design skills**.** The findings from different sources are compared to identify common patterns and emerging trends. The analysis focuses on how digital technologies are transforming fashion design processes, what opportunities they create for designers, and what challenges may influence their future adoption. The results are then interpreted in relation to the research objectives and questions to develop an overall understanding of the future direction of fashion design in digital and virtual environments. The collected quantitative data can be analyzed using descriptive statistical techniques, including frequencies, percentages, averages, and graphical representations. For example, responses can be compared to determine how many participants are familiar with digital fashion technologies and how many believe that virtual fashion will become an important part of the industry. Qualitative data from interviews can be analyzed through thematic analysis. Common themes may include technological innovation, creativity, sustainability, consumer experience, employment opportunities, digital skills, and challenges related to cost and accessibility. The combination of quantitative and qualitative analysis provides a broader understanding of the future development of fashion design in digital and virtual environments.

FINDINGS

The findings indicate that digital and virtual technologies are significantly transforming fashion design by expanding designers' creative possibilities and improving the speed of design development. Technologies such as artificial intelligence, 3D garment simulation, virtual reality, augmented reality, and digital fashion platforms enable designers to experiment with innovative silhouettes, materials, colours, and virtual garments without relying entirely on physical prototypes. The findings also show that digital fashion can support sustainability by reducing some physical sampling and material waste, while virtual platforms provide new opportunities for consumer interaction, personalized experiences, and global fashion. The research indicates that digital technology is expected to play an increasingly important role in the future of fashion design. Digital tools allow designers to create, modify, and visualize garments without producing physical samples, which can reduce development time and material waste. 3D design software and virtual prototyping can make the design process more efficient and allow designers to experiment with shapes, colors, textures, and patterns before manufacturing physical garments. Another important finding is the growing potential of AI in fashion design**.** AI can assist designers in generating design concepts, identifying trends, analyzing consumer preferences, and developing personalized products. However, AI is more likely to function as a creative support tool rather than completely replacing human designers because

creativity, cultural understanding, emotional expression, and human judgment remain important elements of fashion. Virtual and augmented reality also provide new opportunities for consumer interaction. Customers can potentially view garments in virtual environments, participate in virtual fashion shows, and use digital technologies to visualize clothing before purchasing. Digital-only clothing and virtual fashion products may also become increasingly popular among consumers who use avatars and digital identities on social platforms and virtual environments.The findings further suggest that digital fashion can contribute to sustainability by reducing physical sampling, unnecessary production, transportation, and textile waste. Nevertheless, challenges remain, including the high cost of advanced technology, lack of digital skills, limited access to sophisticated software, cybersecurity and intellectual-property concerns, and uncertainty regarding consumer acceptance.

CONCLUSION

The future of fashion design is increasingly shaped by the integration of digital and virtual technologies such as artificial intelligence, 3D design, virtual reality, augmented reality, and metaverse platforms. These technologies provide fashion designers with new opportunities to develop innovative designs, experiment creatively, reduce physical samplingThe future of fashion design is strongly influenced by the rapid development of digital and virtual technologies, including artificial intelligence, 3D garment simulation, virtual reality, augmented reality, and metaverse platforms. These technologies are creating new opportunities for designers to experiment with innovative forms, digital garments, virtual prototypes. In conclusion, the future of fashion design is closely connected with the development of digital and virtual technologies. AI, 3D design, VR, AR, digital clothing, and virtual platforms are transforming traditional design processes and creating new possibilities for creativity, communication, marketing, and consumer engagement. Digital fashion can also support more sustainable practices by reducing physical samples and minimizing unnecessary material consumption. However, successful adoption requires investment in technology, education, digital skills, and ethical frameworks. The future fashion designer will therefore need to combine traditional knowledge of textiles, construction, and aesthetics with technological and digital skills. Rather than eliminating traditional fashion, the digital environment is likely to expand the boundaries of fashion design and create a hybrid future in which physical and virtual fashion coexist

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