CINEFORUM
ISSN : 0009-7039
Vol. 65. No. 2, 2025

Studios in the Metaverse: An Illustration of the Future of Production and Creation of Digital Assets

Wang Na*
Faculty of Humanities and Arts，Macau University of Science and Technology,
Macau，China，999078
3230002964@student.must.edu.mo

Abstract

Background:

The metaverse is redefining creative production by transforming traditional studios into immersive, decentralized digital environments. These virtual studios integrate XR, AI, blockchain, and digital twins to support collaborative asset creation, creator-driven economies, and real-time interaction, presenting both innovative potential and new challenges.

Objectives:

This review systematically synthesizes the academic literature on metaverse studios, aiming to classify studio typologies, analyze enabling technologies, examine digital asset workflows, explore user interaction, and identify critical challenges and opportunities in virtual creative environments.

Methods:

A systematic search was conducted across Scopus, IEEE Xplore, ACM Digital Library, Web of Science, and Google Scholar, covering studies published from 2011 to 2025. Thirteen eligible studies were selected and analyzed using thematic synthesis and quality appraisal based on relevance, methodological rigor, and applicability.

Results:

The studies revealed five dominant studio types—educational, industrial, performance-based, co-creative, and conceptual—supported by technologies such as XR platforms, blockchain infrastructures, AI agents, and avatar-driven interfaces. Key themes included asset decentralization, immersive collaboration, and creator monetization. Common limitations involved technological fragmentation, insufficient user validation, and ethical concerns surrounding access and data governance.

Conclusions:

Metaverse studios represent a significant evolution in digital creative practice, offering scalable, interactive, and decentralized spaces for production. However, their sustainable development

requires integrative frameworks and interdisciplinary inquiry to address current technological and ethical gaps and ensure inclusive and equitable access.

Keywords: Metaverse, digital studios, immersive environments, digital asset creation, extended reality (XR), creator economy, NFTs, collaborative production.

Introduction

The concept of the metaverse has transitioned from speculative fiction to an emerging technological and cultural reality, encompassing a constellation of immersive, interactive, and decentralized environments powered by extended reality (XR), blockchain, artificial intelligence (AI), and digital twin technologies (Allam et al., 2022; Bibri, 2022; C. Xu et al., 2023). As an evolving sociotechnical paradigm, the metaverse promises to redefine not only how individuals engage with information and one another, but also how work, learning, entertainment, and creative production are structured (Dolata & Schwabe, 2023; Dwivedi et al., 2022; Koohang et al., 2023). Central to this transformation is the emergence of virtual spaces that mirror or extend real-world functions—most notably, the creative studio (Bojic, 2022; Damaševičius & Sidekerskienė, 2024; Richter & Richter, 2023). These digital studios are no longer confined to physical infrastructures or professional silos; rather, they are becoming interoperable, user-driven, and augmented by computational intelligence, enabling novel forms of production and collaboration (Banfi & Oreni, 2025; Bhambri, 2025; Rehman et al., 2025).

Traditionally, studios have been associated with spatially fixed, materially resourced environments—such as design labs, recording rooms, or film sets—where creative output is generated through tactile engagement with tools, media, and peers (Jacob & Grabner, 2010; Krajač, 2024; Monacella & Keane, 2022). However, as technological capacities expand, the studio is undergoing a process of dematerialization and reconfiguration (Bruno & Tagliasco, 2022; Salter, 2010; Sun, 2017). In the metaverse, studios exist as immersive digital environments where users engage with virtual interfaces, avatars, and decentralized platforms to create, manipulate, and distribute digital assets (Ali et al., 2023; Dwivedi et al., 2022; Sutopo). These studios vary in form and function: from educational VR classrooms and collaborative music production platforms to AI-driven scene generators and blockchain-based asset creation systems (Abilkaiyrkyzy et al., 2023; Doherty, 2023; Freeman, 2022). This reconceptualization necessitates a deeper examination of what constitutes a "studio" in the context of the metaverse, and how such environments are reshaping the mechanics and economics of digital creation.

The rise of creator economies further complicates and enriches the discourse on studios in the metaverse (Lee et al., 2021; Malerba, 2023; Mohammed et al., 2024). Unlike traditional models of creative production, which often rely on institutional gatekeeping and centralized distribution, metaverse studios frequently operate within decentralized ecosystems (Chien; Ryu et al., 2024;

Sommers, 2024). These systems empower individual creators with ownership tools such as non-fungible tokens (NFTs), smart contracts, and interoperable avatars, enabling them to monetize their work, build communities, and establish persistent digital identities (Fairfield, 2022; Harris, 2024; Σταματάκης, 2023). The convergence of social interaction, creative labor, and virtual economies within these platforms transforms the studio from a mere site of production into a hub of cultural, economic, and even political significance (Assoé, 2022; Saurabh et al., 2023; Singla et al., 2024). Such shifts raise important questions about access, equity, governance, and sustainability in the emergent digital creative industries (Ghosh et al., 2024).

The complexity of metaverse-based studio environments is further amplified by their interdisciplinary nature and technological fluidity (Ayiter, 2012; Grossi, 2021; Sarwatt et al., 2024). Unlike traditional digital platforms that cater to specific use cases, metaverse studios operate at the intersection of spatial computing, immersive media, and real-time collaboration (Hatami et al., 2024; Hutson, 2024; H. Xu et al., 2023). Their design requires the coordination of multiple modalities—visual, auditory, haptic, and behavioral—while ensuring adaptability across devices, user demographics, and content types (Hopkins, 2023; Ismail & Buyya, 2023). This multidimensionality makes the study of metaverse studios particularly challenging, as it involves the confluence of architectural logic, interaction design, digital rights management, and human-computer symbiosis (Hales, 2019). Moreover, the implications of this complexity extend beyond the technical sphere, influencing pedagogical practices, content moderation protocols, and creative economies on a global scale.

Despite the growing proliferation of metaverse platforms and immersive studios, the academic literature remains fragmented, with studies dispersed across fields such as human-computer interaction, immersive media, education, industrial engineering, and digital economics (Yang et al., 2024; Yasar et al., 2023). Some contributions focus on the technical infrastructure enabling metaverse environments, while others explore user behavior, educational applications, or architectural frameworks (De Masi et al., 2025). However, few reviews have synthesized this diverse body of work to provide a coherent understanding of how studios are being conceptualized and operationalized within the metaverse (Varvatsoulis). In particular, there is a lack of integrative research examining the relationship between studio environments, digital asset pipelines, user roles, and collaborative affordances within immersive and decentralized contexts.

Given the complexity and interdisciplinary nature of this topic, a systematic review is both timely and necessary. By collating and critically analyzing studies that engage with metaverse-based studios and their role in digital production, this review seeks to provide conceptual clarity, identify dominant technological and experiential trends, and highlight methodological and practical gaps in the existing literature. It aims to inform future research, design, and policy efforts that will shape the evolution of virtual creative spaces in the years to come. The scope of

the review includes both empirical and theoretical works, encompassing various types of studio configurations, production pipelines, technological integrations, and user experiences that define the future of digital asset creation within the metaverse.

In addressing these objectives, this review also interrogates broader implications of immersive studios on creative practice, labor relations, and epistemologies of production. As the boundaries between physical and virtual, human and algorithmic, creator and consumer continue to blur, understanding how studios in the metaverse operate is critical to framing future narratives of innovation, education, and cultural participation. This inquiry not only contributes to an emerging body of metaverse scholarship but also serves as a foundational effort to theorize and design next-generation creative infrastructures that are adaptive, inclusive, and technologically sustainable.

Aims and Objectives

The aim of this systematic review is to critically examine the conceptual, technological, and practical development of studios within metaverse environments, with a particular focus on their role in enabling digital asset production and immersive collaborative workflows. As the metaverse continues to evolve into a convergent space for creativity, commerce, and community, understanding how studios function in these environments is essential for informing future design, policy, and research.

To achieve this overarching aim, the review is guided by the following specific objectives:

- To identify and categorize the types of studios conceptualized or implemented within metaverse platforms across academic and technical literature.
- To analyze the technological infrastructures—such as XR, AI, blockchain, and digital twins—that underpin metaverse-based studio environments.
- To examine the processes of digital asset creation and the integration of creator tools, pipelines, and ownership models within these virtual spaces.
- To evaluate user roles, interaction modalities, and collaborative dynamics as they manifest in immersive studio settings.
- To assess the challenges, gaps, and opportunities identified in the literature concerning the design, deployment, and sustainability of metaverse studios.

Through these objectives, the review seeks to synthesize the current state of knowledge, identify critical trends and limitations, and provide a foundation for future interdisciplinary research and development in the domain of virtual studios and digital creation ecosystems.

Methodology

Study Design

This study employed a systematic review methodology to examine the conceptual, technical, and applied dimensions of studios in the metaverse, with a specific focus on their role in digital asset production and creative collaboration. Given the interdisciplinary and rapidly evolving nature of the field—spanning immersive technology, creative industries, and decentralized systems—a systematic approach was deemed appropriate to ensure comprehensive coverage and analytical rigor. While the review followed the general principles of the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework, adaptations were made to accommodate the inclusion of conceptual papers, technical reports, and case studies that characterize the literature in digital and immersive media domains.

Eligibility Criteria

To ensure the relevance and quality of the selected literature, clearly defined eligibility criteria were applied during the study selection process. Studies were considered eligible for inclusion if they were published in English between January 2011 and March 2025 and appeared in peer-reviewed journals, academic conference proceedings, or credible institutional white papers. Only studies that substantively addressed the development, deployment, or theorization of studios within metaverse environments—particularly those relating to digital asset creation, immersive collaboration, or virtual production—were included. Both empirical and theoretical contributions were considered, provided they demonstrated clear relevance to the review's objectives. Studies were excluded if they failed to engage with the notion of studios or creative environments in the metaverse, consisted of speculative commentary without scholarly grounding, were duplicates of already screened records, or if full-text versions were unavailable through academic databases or institutional repositories. This set of inclusion and exclusion parameters ensured that the final dataset was both thematically coherent and methodologically robust.

Search Strategy

A comprehensive search strategy was employed to identify eligible studies. The search was conducted across multiple academic databases, including Scopus, Web of Science, IEEE Xplore, ACM Digital Library, and Google Scholar. Search terms were formulated using Boolean operators to capture a wide range of relevant studies. The following search string was used and adapted as necessary for different databases:("metaverse" OR "virtual world" OR "immersive environment") AND ("studio" OR "creation" OR "production" OR "digital assets" OR "collaborative space" OR "XR" OR "avatar"). The search was conducted over the period of January 2011 to March 2025. In addition to database searches, backward and forward citation chaining was employed to identify relevant studies that may not have been captured in the initial

search. Titles and abstracts were exported into a reference management tool to support screening and deduplication.

Study Selection Process

The study selection process was conducted in two stages. In the first stage, all retrieved records were screened based on their titles and abstracts to assess relevance against the predefined eligibility criteria. In the second stage, full-text articles of potentially eligible studies were reviewed for final inclusion. To minimize bias and ensure methodological transparency, the screening was conducted independently by two reviewers. Discrepancies were resolved through discussion and consensus, with a third reviewer consulted when necessary. The inclusion and exclusion process was documented in a PRISMA flow diagram, illustrating the number of records identified, screened, assessed for eligibility, and ultimately included in the final synthesis.

Data Extraction and Coding

A structured data extraction protocol was developed to ensure consistency across the included studies. Key variables were extracted and organized into six primary data matrices: (i) study characteristics (author, year, country, study type); (ii) studio typology and focus; (iii) digital technologies and platforms; (iv) asset creation pipelines; (v) user roles and interaction dynamics; and (vi) contributions, challenges, and future directions. Data were extracted manually into tabular formats and cross-validated for accuracy. The extracted content was analyzed thematically to identify patterns, divergences, and emergent constructs relevant to the conceptualization and operationalization of metaverse-based studios. Additional synthesis tables were developed to map technology integration, asset ownership models, and collaboration mechanisms.

Quality Appraisal

To assess the methodological quality and relevance of the included studies, a bespoke appraisal rubric was employed. Each study was evaluated based on three criteria: (i) relevance to the metaverse studio context; (ii) methodological rigor (e.g., clarity of research design, empirical grounding, or theoretical sophistication); and (iii) generalizability or applicability to real-world studio environments. Ratings were assigned as high, medium, or low for each criterion, with a narrative justification recorded for each score. This approach allowed for the inclusion of both empirical and conceptual literature while maintaining analytical rigor and ensuring the relevance of all sources to the review's central research questions.

Results

Characteristics and Scope of the Included Studies

The final dataset comprised thirteen studies published between 2011 and 2024, encompassing diverse methodological designs, disciplinary perspectives, and geographic contexts. Methodologically, the studies included conceptual frameworks, systematic surveys, experimental case studies, narrative reviews, action research, and platform evaluations. The included studies originated from a range of countries, including South Korea, Germany, the United States, Australia, China, and India, reflecting global engagement with metaverse technologies and virtual production environments. Collectively, these investigations addressed both theoretical and applied aspects of studios within the metaverse, including immersive design, digital asset creation, platform infrastructure, user experience, and technological integration. Several studies (e.g., (Bhattacharya et al., 2023; Dolgui & Ivanov, 2023)) adopted a macro-architectural view of the metaverse as a socio-technical ecosystem, whereas others (e.g., (Cairns et al., 2023; Tonkin)) focused on micro-level studio applications involving real-time, multi-user interaction. The heterogeneity in focus and method provided a robust foundation for synthesizing key themes relevant to the future of digital asset production and creative studio practices in immersive environments.

Table 1. Study Characteristics Table

Study ID	Author	Country	Type of Study	Focus Area	Platforms / Technologies	Key Contribution
1	(Tonkin)	Australia	Reflective case study	VR production in creative arts education	Mozilla Hubs, Spoke, WebXR, Meta Quest, Blender, Adobe Premiere	Demonstrated open-source VR tools for creative collaboration in education
2	(Ullrich et al., 2024)	Germany	Technical feasibility study	Industrial metaverse and virtual commissioning	NVIDIA Omniverse, USD, Apache Kafka, OPC UA, Visual Components, CIROS	Showed integration of digital twins for full-factory simulation
3	(Dionisio et al., 2013)	USA	Narrative review / Conceptual	Technical foundations and future of the Metaverse	Second Life, OpenSim, WebGL, ActiveWorlds, Blue Mars	Defined metaverse with core features: realism, ubiquity, interoperability, scalability
4	(Mourtzis, 2023)	Greece	Conceptual framework study	Human-centric industrial metaverse in Industry 5.0	XR, AI, Blockchain, Web 4.0, CPS, IoT, Digital Twins	Proposed framework for personalized design, healthcare, and education in Industry 5.0
5	(Wang et al., 2023)	China	Systematic survey	Intelligent scene content generation in metaverse	GANs, CNNs, EEG, RL, CycleGAN, HMM, emotion recognition, U-Net	Classified AI-driven scene generation techniques across simulation and personalization
6	(Cairns et al., 2023)	UK	Experimental case study	XR audio latency and performance in metaverse music studio	Ambisonics, Reaper, OSC, JackTrip, Meta Quest 2	Studied real musicians' experience with immersive XR-based studio simulation
7	(Kohler et al., 2011)	USA, Austria	Action research	Virtual co-creation in Second Life	Avatars, 3D prototyping, chat tools, SL scripting	Designed framework for user engagement

						in co-creation platforms
8	(Koles & Nagy, 2014)	Hungary	Conceptual / Theoretical	Organizational affordances of metaverse	Second Life, avatar platforms	Framed metaverse as “third place” to enhance collaboration and flatten hierarchy
9	(Bhattacharya et al., 2023)	India, Romania	Systematic survey + case study	Functional reference architecture for Industry 5.0 metaverse	AI, Blockchain, Web 3.0, NFTs, XR, edge computing, semantic web	Proposed scalable architecture with real estate use-case
10	(Song, 2022)	South Korea	Platform strategy case study	Meta’s pre-launch platform design	Horizon Worlds, Meta AI, NFTs, Spark AR, Microsoft Azure	Applied Rocket Model to analyze Meta's platform development strategy
11	(Dolgui & Ivanov, 2023)	France, Germany	Conceptual + framework development	Metaverse supply chain and operations	Digital Twins, ERP, 3D Printing, Blockchain, Edge, XR	Triple-SCOM model for digital coordination across supply chains
12	(George et al., 2021)	India	Narrative review / Conceptual synthesis	Internet evolution via the Metaverse	XR, NFTs, AI, 6G, Spatial Computing, Blockchain	Created layered framework spanning experience, decentralization, infrastructure
13	(CHUNG et al., 2022)	South Korea	Technology status report	XR + Digital Twin ecosystem classification	HoloLens, ZEPETO, Unity, Unreal, ARKit, motion capture	Classified metaverse platforms and XR enabling technologies in South Korea

Table 2. Focus on Metaverse and Studios

Study ID	Author	Metaverse Definition	Studio Type	Platforms Used	Digital Assets	Technologies	Use Cases
1	(Tonkin)	Spatial immersive web using open-source VR tools	Educational creative VR studio	Mozilla Hubs, WebXR, Spoke, Blender, Adobe	360° videos, scanned 3D models, virtual galleries	WebXR, Blender, Mozilla tools	Art education, storytelling, psychogeography
2	(Ullrich et al., 2024)	Industrial metaverse for factory commissioning	Linked industrial production cells	Omniverse, Apache Kafka, OPC UA, CIROS, Visual Components	Digital twins, robotic arms, conveyors	USD, Omniverse connectors, real-time PLC sync	Factory simulation, predictive testing
3	(Dionisio et al., 2013)	Interconnected 3D worlds focused on realism, scalability, interoperability, ubiquity	General metaverse platforms	Second Life, OpenSim, WebGL	Avatars, environments, identity models	Shader tech, HRTF audio, VR engines	Architecture modeling, social interaction
4	(Mourtzis, 2023)	Human-centric, value-driven metaverse systems for Industry 5.0	Conceptual industry design studio	Web 4.0, AI, XR, Blockchain, IoT, CPS	Avatars, 3D designs, personal health data, NFTs	XR, cognitive computing, digital twins, fuzzy logic	Smart education, personalized manufacturing
5	(Wang et al., 2023)	AI-generated immersive scenes for simulation and	Scene generation (non-physical	GANs, CNNs, HMM, EEG, RL,	Personalized avatars, agent designs,	Neural networks, emotio	Healthcare, education, gaming, cognitive

		personalization	studio)	U-Net	emotional scenes	n recognition, agent design	learning
6	(Cairns et al., 2023)	XR-based immersive studio for real-time musical collaboration	Networked virtual music studio	OSC, Ambisonics, Reaper, Meta Quest 2	Studio avatars, immersive audio tracks	XR headsets, OSC tracking, Ambisonic rendering	Live music, latency testing, immersive rehearsal
7	(Kohler et al., 2011)	User-led co-creation platforms using avatars and social presence	Co-creation design studio in Second Life	Second Life, SL scripting, avatar design tools	3D models, community ratings, virtual prototypes	Virtual prototyping, live interaction, avatar mediation	Product ideation, virtual innovation labs
8	(Koles & Nagy, 2014)	Metaverse as a third place for professional growth and social flattening	Workplace communication hubs	Second Life, 3D social platforms	Avatars, virtual offices, breakout rooms	Avatar customization, chat tools, identity layers	HR, team building, professional collaboration
9	(Bhattacharya et al., 2023)	Integrated industrial metaverse using 6G, blockchain, NFTs, XR	Architecture-level industry platform	Web 3.0, NFTs, AI, semantic web, edge computing	Digital twins, smart buildings, NFT property, user avatars	Smart contracts, semantic AI, 6G	Real estate, healthcare, governance, education

10	(Song, 2022)	Social + commerce platform model using Rocket Model design	Meta's Horizon Worlds & creator economy	Horizon Worlds, Meta AI, Meta Quest, Spark AR	Avatars, immersive brand spaces, NFTs	Avatar monetization, translation AI, immersive UIs	Social interaction, content creation, avatar-based commerce
11	(Dolgui & Ivanov, 2023)	Socio-technical framework for immersive supply chain planning	Metaverse-enabled SCOM ecosystem	Digital Twins, 3D Printing, Blockchain, ERP, Edge Computing	Supply chain twins, real-time avatars	Smart factories, generative planning, integrated XR	Planning, resilience, disruption recovery
12	(George et al., 2021)	Next-gen cultural space merging creator economy, spatial computing, and decentralization	Conceptual – focuses on experience layers	XR, NFTs, Blockchain, Haptics, Web 3.0	Creator tools, NFTs, immersive web, digital culture	Spatial computing, smart infrastructure, identity modeling	Education, entertainment, commerce, digital public space
13	(CHUNG et al., 2022)	XR-integrated metaverse supported by avatar engines and immersive sensors	Classified platform types: social, market, assistant	ZEPETO, Roblox, Earth2, Microsoft Mesh, Unity, Unreal, ARKit, HoloLens	Avatars, 3D spaces, virtual property, sensory environments	Motion capture, spatial UI, XR lenses, blockchain	Entertainment, remote work, smart cities, healthcare

As outlined in Table 2, studies varied widely in their engagement with metaverse technologies and studio types. While several papers emphasized industrial or educational studios using immersive XR and AI, others focused on social co-creation platforms, blockchain integration, or conceptual spatial computing layers.

CINEFORUM
ISSN : 0009-7039
Vol. 65. No. 2, 2025

Typologies and Conceptualizations of Metaverse Studios

The analysis of the included studies revealed distinct typologies of studios functioning within metaverse contexts. These environments were categorized into five main types: educational creative studios, networked performance studios, industrial simulation and commissioning studios, innovation co-creation labs, and organizational or conceptual metaverse workspaces. Educational VR studios, such as those discussed by (Tonkin), employed open-source tools to facilitate collaborative learning and creative expression. (Cairns et al., 2023) presented a networked XR music studio enabling real-time performance and audio latency testing.

In contrast, industrial metaverse applications—highlighted by (Ullrich et al., 2024) and (Dolgui & Ivanov, 2023)—integrated digital twins and real-time system monitoring for simulation and production planning. (Kohler et al., 2011) described virtual co-creation studios within Second Life that supported distributed innovation and participatory design, while (Koles & Nagy, 2014) theorized the metaverse as a 'third place' facilitating social flattening and professional growth. These diverse configurations underscore the evolution of the studio from a bounded physical locale to a highly dynamic, immersive, and distributed digital construct.

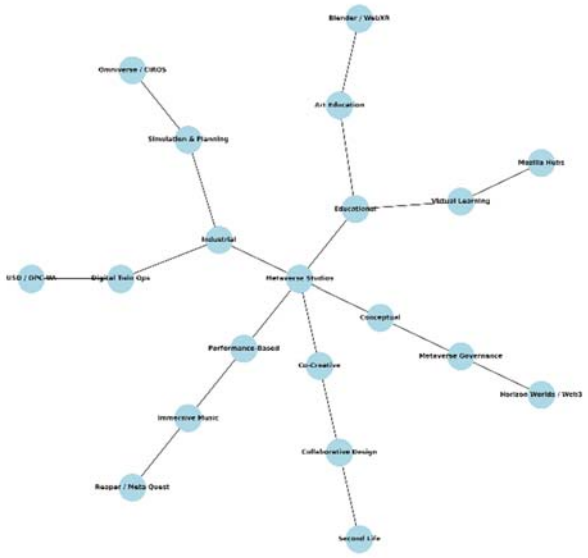

Figure 1. Radial diagram showing the typological structure of metaverse studios and their associated platforms and domains.

This radial hierarchy graph illustrates the relationship between metaverse studio categories and their downstream thematic domains, use cases, and platform implementations. It highlights how conceptual, industrial, co-creative, educational, and performance-based studios branch into specific operational focuses, technologies, and metaverse environments.

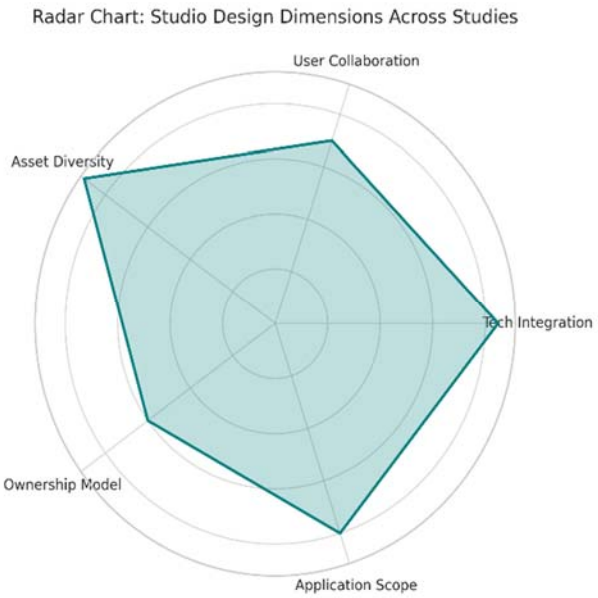

Figure 2. Radar chart showing relative emphasis on five core design dimensions across the 13 included studies.

This figure presents a radar chart comparing five core design dimensions observed in metaverse studio implementations across the reviewed studies. The plotted values represent the aggregated prominence of each dimension—namely, technology integration, user collaboration, asset diversity, ownership model, and application scope—indicating the relative emphasis each received in the conceptualization or deployment of digital studios.

Table 3. Metaverse Studio Typology Table

Study ID	Author	Studio Type	Centrality of Studio	Collaborative Features	Physical/Virtual/Hybrid	User Role Type
1	(Tonkin)	Creative VR art studio	Core	Multi-user shared space	Virtual	Creator/Student
2	(Ullrich et al., 2024)	Industrial simulation	Supportive	Real-time team commissioning	Hybrid	Engineer/Developer
3	(Dionisio et al., 2013)	General platform overview	Contextual	User-driven	Virtual	Participant/Explorer
4	(Mourtzis, 2023)	Industry 5.0 smart studio	Theoretical	Human-centric design	Conceptual	Designer/Operator
5	(Wang et al., 2023)	AI scene generation studio	Implied	Not collaborative	Virtual	AI Agent/System
6	(Cairns et al., 2023)	XR music studio	Core	Real-time musician interaction	Virtual (networked)	Musician/Performer
7	(Kohler et al., 2011)	Co-creation innovation lab	Core	Social, design-oriented	Virtual	Co-creator/Designer
8	(Koles & Nagy, 2014)	Organizational third-place	Conceptual	Social/Collaborative	Virtual	Employee/Team Member
9	(Bhattacharya et al., 2023)	Reference architecture	Supportive	Smart environment integration	Virtual	Agent/User/Designer
10	(Song, 2022)	Meta social-commerce studio	Strategic	Creator-focused monetization	Virtual	Creator/Consumer
11	(Dolgui & Ivanov, 2023)	SCOM framework studio	Theoretical	Digital coordination	Hybrid	Coordinator/Planner
12	(George et al., 2021)	Metaverse framework	Meta-level	Creator economy + culture	Virtual	Creator/User
13	(CHUNG et al., 2022)	Platform classification	Contextual	Dependent on platform type	Virtual	User/Content Producer

Technologies Underpinning Metaverse Studio Functionality

The technological foundation of the studios examined in the selected studies demonstrated considerable diversity and complexity. XR technologies, blockchain systems, artificial intelligence, digital twins, and Web 3.0 infrastructure constituted the core enablers across the sample. High levels of integration were particularly evident in industrial and architectural studies (Bhattacharya et al., 2023; Ullrich et al., 2024), which employed layered architectures to support decentralized operations, NFT transactions, and smart asset creation. Several studies (CHUNG et al., 2022; Song, 2022) examined corporate-level metaverse ecosystems comprising immersive platforms (e.g., Horizon Worlds, Roblox), avatar engines, creator tools, and decentralized marketplaces. While foundational studies like (Dionisio et al., 2013) laid out the theoretical parameters of realism, scalability, and interoperability, more recent investigations advanced operational frameworks that integrated AI-driven scene generation (Wang et al., 2023), real-time sensor inputs, and blockchain-based asset validation. Notably, the confluence of these technologies has facilitated the emergence of intelligent, modular, and highly interoperable virtual studio environments that support both production and economic engagement.

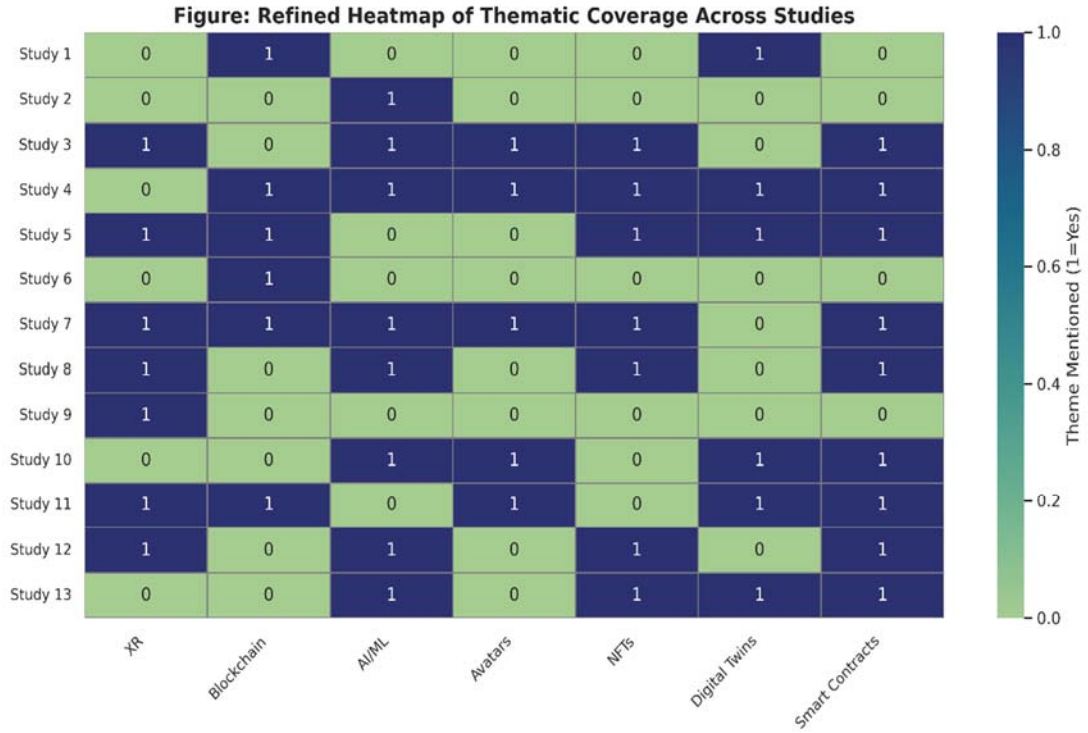

Figure 3. Heatmap illustrating the thematic presence of key technologies across the 13 included studies.

This heatmap visualizes the occurrence of core technological themes—such as XR, blockchain, AI/ML, avatars, NFTs, digital twins, and smart contracts—across each of the 13 studies. A value of "1" indicates the technology was thematically addressed, enabling comparative insight into their distribution and prominence.

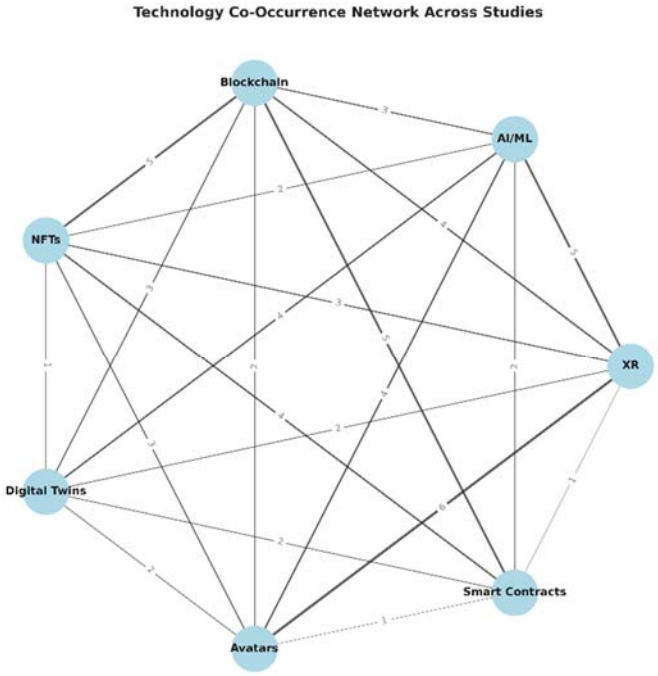

Figure 4. Network diagram showing co-occurrence of core technologies

This co-occurrence network illustrates how frequently pairs of technologies—such as XR, blockchain, AI/ML, avatars, NFTs, digital twins, and smart contracts—appeared together within individual studies. Thicker edges represent stronger co-occurrence relationships, highlighting commonly coupled technologies in metaverse studio environments.

Production Pipelines and Digital Asset Ecosystems

A central theme identified across the studies was the increasing sophistication of digital asset production pipelines within metaverse-based studios. These pipelines varied in complexity depending on the application domain, ranging from manual asset creation using 3D modeling tools (e.g., Blender, Unity) to fully automated generation systems driven by machine learning algorithms. In (Tonkin), students created immersive visual narratives through open-source tools, while (Wang et al., 2023) proposed the use of generative adversarial networks (GANs) and neural decoding systems for emotionally responsive scene construction. Multiple studies emphasized the role of avatars, NFTs, and virtual environments as primary units of digital

production. For instance, (Song, 2022) detailed Meta's platform monetization strategy based on avatar personalization and commerce, and (Bhattacharya et al., 2023) applied smart contracts in decentralized real estate scenarios. The extent to which creators maintain ownership over their assets varied across studies, with some advocating open, user-owned models (George et al., 2021), while others adhered to platform-centric approaches. Overall, the emergence of robust digital asset ecosystems represents a paradigm shift in creative production, emphasizing decentralization, traceability, and interoperability.

Table 4. Digital Asset Types and Creation Pipeline Table

Study ID	Author	Asset Types Created	Creation Tools / Systems	Asset Ownership Model	Integration with Economy
1	(Tonkin)	3D scans, VR scenes, digital galleries	Blender, Mozilla Hubs	Open / Creator-owned	No
2	(Ullrich et al., 2024)	Digital twins, robot models	Omniverse, USD, OPC-UA	System-based	No
3	(Dionisio et al., 2013)	Avatars, virtual worlds	Game engines, user input	Platform-owned / mixed	Variable
4	(Mourtzis, 2023)	Product prototypes, health data assets	XR tools, AI models	Not discussed	Potential
5	(Wang et al., 2023)	AI-generated avatars, scenes	GANs, EEG, CNNs	Implied user-based	Possible (health, emotion)
6	(Cairns et al., 2023)	Music tracks, spatial environments	Reaper, Ambisonics, Meta Quest	Performer-owned	No
7	(Kohler et al., 2011)	Design concepts, 3D prototypes	Second Life, SL tools	User-contributed	Yes (innovation funnel)
8	(Koles & Nagy, 2014)	Avatars, social spaces	Second Life	User / Org Shared	No
9	(Bhattacharya et al., 2023)	NFTs, smart property records	Web 3.0 stack, smart contracts	Decentralized	Yes
10	(Song, 2022)	Avatars, fashion items, digital goods	Meta Quest, Spark AR	Creator economy model	Yes
11	(Dolgui & Ivanov, 2023)	Digital supply chain models	Digital Twin systems	Enterprise-controlled	Yes

12	(George et al., 2021)	NFTs, virtual assets, user-generated content	Creator tools, Web 3.0 APIs	Decentralized / hybrid	Yes
13	(CHUNG et al., 2022)	Avatars, property, 3D models	Unity, Unreal, ARKit, HoloLens	Platform mixed	Yes

User Roles, Interaction Dynamics, and Collaboration

The studies highlighted varied user roles and interaction dynamics that characterize studios in the metaverse. In collaborative environments, users often functioned as co-creators, designers, or performers, engaging in real-time content creation and asset manipulation (Cairns et al., 2023; Kohler et al., 2011). In other contexts, users assumed observational or managerial roles, overseeing simulations and coordinating distributed operations (Dolgui & Ivanov, 2023; Ullrich et al., 2024). Interaction levels ranged from asynchronous content editing to highly immersive, synchronous collaboration through embodied avatars and spatial audio interfaces. Several studies underscored the importance of personalization and social presence, with avatars serving as both identity constructs and creative instruments (CHUNG et al., 2022; Koles & Nagy, 2014). The reviewed literature consistently emphasized the potential of metaverse studios to support inclusive, distributed, and identity-rich participation in creative and professional workflows. However, limitations in interface design, avatar fidelity, and platform interoperability were frequently noted as barriers to seamless interaction and sustained engagement.

Table 5. User Roles and Interactions in Studios Table

Study ID	Author	User Type	Interaction Level	Personalization	Social Collaboration	Embodiment (Avatar/Voice /etc.)
1	(Tonkin)	Student-creator	High	High	Moderate	Voice, avatar
2	(Ullrich et al., 2024)	Developer	Medium	Low	High	No avatar
3	(Dionisio et al., 2013)	Explorer/user	Medium	High	Medium	Avatar-based
4	(Mourtzis, 2023)	Industry stakeholder	Theoretical	High	High	Conceptual avatar
5	(Wang et al., 2023)	AI system, user	Low	High (emotion-based)	None	None
6	(Cairns et al., 2023)	Musician	High	Medium	High	Avatar + spatial sound
7	(Kohler et al.,	Co-designer	High	Medium	High	Full

	2011)					embodiment
8	(Koles & Nagy, 2014)	Employee/participant	Medium	Low	High	Avatar-based
9	(Bhattacharya et al., 2023)	User/Agent	Medium	Medium	Medium	AI/Avatar
10	(Song, 2022)	Consumer + Creator	Medium	High	Medium	Avatar/voice
11	(Dolgui & Ivanov, 2023)	Planner/operator	Medium	Medium	High	Not defined
12	(George et al., 2021)	Cultural participant	High	High	High	Voice/avatar/content
13	(CHUNG et al., 2022)	User/content producer	Medium	Medium	Variable	Avatar

Discussion

Reframing the Studio: From Physical Site to Immersive Production Ecosystem

The findings of this review suggest a paradigmatic shift in how creative and productive work is conceived within virtual environments. Traditional studios, often limited by spatial constraints, infrastructure, and geographic co-location, are being reimagined as dynamic, immersive, and distributed ecosystems. This transformation is particularly evident in the migration of studio functionalities—design, iteration, collaboration, and content delivery—into metaverse platforms that operate across XR interfaces, AI systems, and real-time networked architectures. Studies such as (Tonkin) and (Cairns et al., 2023) highlight how such platforms enable students and performers to bypass physical limitations and engage in embodied, synchronous production. The studio, thus, is no longer a confined space but an elastic, user-configurable, and asset-rich environment. This reconceptualization aligns with broader discourses on spatial computing and post-physical workspaces, where creative labor is increasingly decoupled from its material base while retaining its collaborative and experiential character.

Technology as Infrastructure and Constraint in Metaverse Studio Design

Technological convergence underpins the evolution of metaverse studios, yet it simultaneously imposes operational and conceptual limitations. While advanced tech stacks involving XR, blockchain, AI, and digital twins enable unprecedented affordances in virtual production, they also introduce challenges related to interoperability, accessibility, and computational complexity. For instance, (Ullrich et al., 2024) and (Bhattacharya et al., 2023) demonstrate how highly integrated pipelines facilitate industrial simulation and real estate modeling, yet these same systems demand high-performance infrastructure and specialized knowledge. Additionally, issues related to avatar embodiment, spatial audio fidelity, and real-time rendering persist in

performance-driven environments (Cairns et al., 2023). Importantly, the reviewed literature rarely engaged in comparative assessment of platform-specific affordances, suggesting a need for systematic benchmarking across tools and protocols. Moving forward, studio designers must balance technological ambition with user-centered design, ensuring inclusivity, accessibility, and adaptability in immersive creative ecosystems.

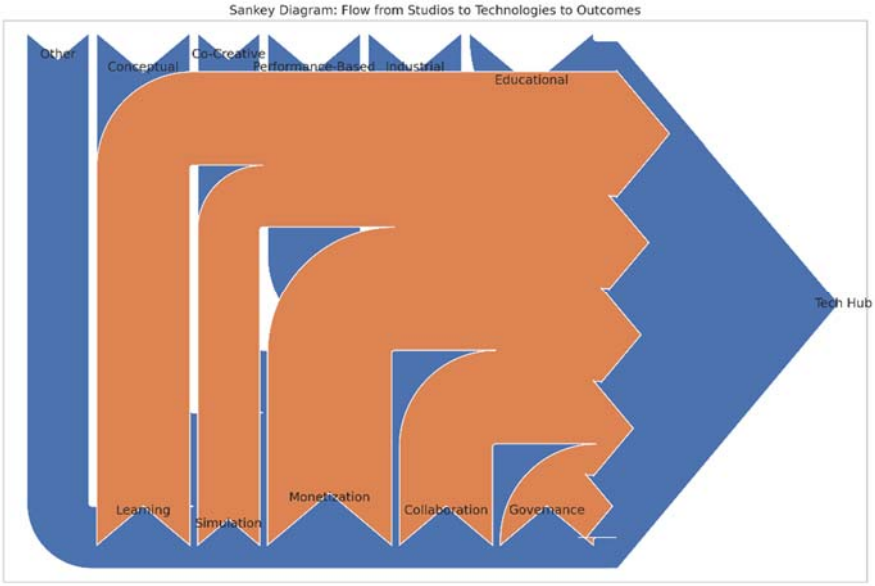

Figure 5. Sankey diagram visualizing the flow from studio types to technologies and final application outcomes.

This Sankey diagram illustrates the interrelated pathways through which various metaverse studio types (e.g., educational, co-creative, conceptual) utilize specific technologies to produce distinct outcomes such as learning, simulation, monetization, collaboration, and governance. The width of each flow represents the relative frequency of that transition pathway across the included studies.

The Metaverse as a Socio-Cultural and Economic Arena for Creation

Beyond technological affordances, the metaverse functions as a site of cultural production and economic transformation. Several studies, notably (George et al., 2021; Kohler et al., 2011; Song, 2022), explored how metaverse studios serve as nodes of identity formation, community interaction, and value generation. The emergence of creator economies—facilitated by avatar customization, NFT markets, and smart contract monetization—illustrates the growing permeability between artistic creation and commercial activity. These environments support not only the production of digital assets but also the social negotiation of authorship, ownership, and participation. However, these benefits are unequally distributed, as creators may face barriers

related to platform governance, monetization opacity, and technological gatekeeping. The metaverse thus emerges not as a neutral medium, but as a contested space shaped by socio-economic hierarchies, platform policies, and cultural imaginaries. Recognizing this dual nature is critical for theorizing equitable and sustainable studio models in immersive environments.

Collaboration and Embodiment in Immersive Studio Spaces

A defining feature of metaverse-based studios is their capacity to support collaborative and embodied interaction in real time. Unlike asynchronous digital collaboration tools, metaverse platforms afford users the ability to co-create, rehearse, and iterate in immersive environments using avatars, spatial sound, and shared digital objects. (Kohler et al., 2011) and (Cairns et al., 2023) illustrate how such interactions generate presence, engagement, and creative synergy, often mimicking or enhancing in-person collaboration. Yet, embodiment also introduces complexities—such as maintaining identity coherence across avatars, managing affective labor, and navigating spatial-cognitive load. Furthermore, while many studies emphasized the benefits of social co-presence, few examined the psychological, ergonomic, or long-term behavioral impacts of sustained avatar-mediated work. These gaps point to a critical need for human-computer interaction (HCI) research that extends beyond usability to explore embodiment, presence, and agency in metaverse studios.

Gaps in Empirical Validation and the Need for Applied Research

Although the conceptual and architectural contributions of the included studies were substantial, the review revealed a notable paucity of empirical studies that rigorously evaluated user experience, performance metrics, or long-term adoption of metaverse studios. Many frameworks—particularly those related to industrial planning (Dolgui & Ivanov, 2023), cultural architecture (George et al., 2021), and AI-based content generation (Wang et al., 2023)—remain untested beyond simulations or theoretical modeling. This disconnect between design and deployment limits the generalizability and real-world applicability of current proposals. Moreover, there is a lack of longitudinal data on creator retention, monetization outcomes, and skill acquisition within immersive studio settings.

Despite the rapid advancement of metaverse studio technologies, several persistent challenges and research gaps were identified. Key technical limitations included latency issues, device accessibility, standardization deficits, and integration complexity across real and virtual layers. Ethical concerns were equally salient, encompassing privacy risks, digital surveillance, and the regulation of asset ownership within decentralized economies (George et al., 2021; Song, 2022). Methodologically, many studies lacked empirical validation, particularly those proposing conceptual frameworks or architectural models. Moreover, while immersive collaboration and content creation were recurrent themes, few studies provided longitudinal insights into user retention, creator monetization, or platform governance.

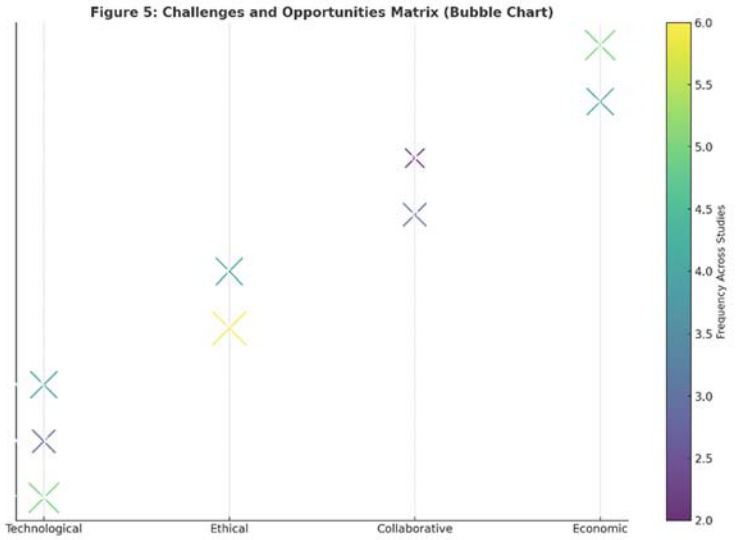

Figure 6. Bubble chart mapping the frequency of key challenges and opportunities discussed across the included studies.

This bubble chart visualizes the thematic concentration of challenges and opportunities across four key domains: technological, ethical, collaborative, and economic. Each bubble represents a specific sub-theme, with color intensity and size indicating how frequently it appeared across the reviewed literature, helping to prioritize future research and design focus areas.

Nevertheless, the reviewed literature presents substantial opportunities for future research and innovation. These include the development of human-centered interface standards, the application of explainable AI in avatar behavior modeling, and the expansion of decentralized, creator-driven asset markets. Emerging interdisciplinary collaborations, institutional support mechanisms, and advances in edge computing and generative AI are likely to further accelerate the evolution of studios in the metaverse as critical nodes in the digital production landscape. Addressing these limitations requires interdisciplinary research involving human factors, education, creative industries, and data science to design and validate metaverse studio environments that are not only technically sound but also pedagogically and professionally effective.

Toward a Unified Framework for Future Metaverse Studios

The reviewed studies collectively point toward the need for a unified framework that integrates technological infrastructure, user roles, creative workflows, and ethical governance within the design of metaverse studios. Such a framework should account for the modularity of digital assets, the fluidity of user identity, and the economic systems that underpin creator participation. It must also anticipate challenges related to privacy, accessibility, and platform monopolization, which threaten to replicate existing inequities in digital production spaces. Furthermore,

standardization in interface design, asset interoperability, and avatar embodiment would enable more seamless movement across platforms, fostering broader adoption. As metaverse technologies mature, interdisciplinary collaboration among technologists, artists, designers, policy-makers, and educators will be essential for translating the vision of the metaverse studio into an operational reality. Future research should aim to codify best practices, develop shared vocabularies, and create open, extensible ecosystems that democratize access to immersive creative production.

Conclusion

This systematic review synthesized findings from thirteen studies (2011–2024) to explore how metaverse studios are conceptualized, implemented, and evolving. Traditionally rooted in physical space, the studio is being redefined as an immersive, distributed, and interactive environment embedded within broader digital infrastructures. This transformation is driven by advanced technologies—particularly extended reality (XR), blockchain, artificial intelligence, and digital twins—which enable real-time collaboration, decentralized asset creation, and intelligent workflows.

Metaverse studios now function not only as creative spaces but also as socio-economic and cultural ecosystems. They support user-generated content, identity construction, and participation in emerging creator economies. However, this shift raises challenges related to equity, access, digital ownership, privacy, and standardization. While many platforms promote decentralized models and user agency, structural disparities and regulatory uncertainties remain unresolved.

Despite significant innovation, the literature shows limited empirical validation, with a lack of user-centric studies and longitudinal insights. Key gaps include the psychosocial dynamics of avatar-mediated collaboration, the efficacy of immersive learning environments, and the viability of decentralized production. Advancing this field will require interdisciplinary inquiry that integrates design, ethics, HCI, and platform economics. The future of metaverse studios lies in their ability to serve as inclusive, equitable, and sustainable spaces for collaborative digital creation across education, industry, and culture.

References

Abilkaiyrkyzy, A., Elhagry, A., Laamarti, F., & El Saddik, A. (2023). Metaverse key requirements and platforms survey. *IEEE access*, *11*, 117765-117787.

Ali, M., Naeem, F., Kaddoum, G., & Hossain, E. (2023). Metaverse communications, networking, security, and applications: Research issues, state-of-the-art, and future directions. *IEEE Communications Surveys & Tutorials*, *26*(2), 1238-1278.

Allam, Z., Sharifi, A., Bibri, S. E., Jones, D. S., & Krogstie, J. (2022). The metaverse as a virtual form of smart cities: Opportunities and challenges for environmental, economic, and social sustainability in urban futures. *Smart Cities*, *5*(3), 771-801.

Assoé, S. (2022). *Exploring the Creation and Expansion of a Value Regime through the Nascent Technology of Non-Fungible Tokens* Concordia University].

Ayiter, E. (2012). Ground: A metaverse learning strategy for the creative fields.

Banfi, F., & Oreni, D. (2025). Unlocking the interactive potential of digital models with game engines and visual programming for inclusive Vr and web-based museums. *Virtual Archaeology Review*, *16*(32), 44-70.

Bhambri, P. (2025). Innovative Systems: Entertainment, Gaming, and the Metaverse. In *Managing Customer-Centric Strategies in the Digital Landscape* (pp. 483-514). IGI Global.

Bhattacharya, P., Saraswat, D., Savaliya, D., Sanghavi, S., Verma, A., Sakariya, V., Tanwar, S., Sharma, R., Raboaca, M. S., & Manea, D. L. (2023). Towards future internet: The metaverse perspective for diverse industrial applications. *Mathematics*, *11*(4), 941.

Bibri, S. E. (2022). The social shaping of the metaverse as an alternative to the imaginaries of data-driven smart Cities: A study in science, technology, and society. *Smart Cities*, *5*(3), 832-874.

Bojic, L. (2022). Metaverse through the prism of power and addiction: what will happen when the virtual world becomes more attractive than reality? *European Journal of Futures Research*, *10*(1), 22.

Bruno, E. V., & Tagliasco, G. (2022). Body and Interaction in Dematerialisation. *Exploring Tomás Maldonado*, 212.

Cairns, P., Hunt, A., Johnston, D., Cooper, J., Lee, B., Daffern, H., & Kearney, G. (2023). Evaluation of metaverse music performance with bbc maida vale recording studios. *Journal of the Audio Engineering Society*, 313-325.

Chien, A. Y.-C. *A 4D Decentralized Spatiotemporal Mirror World: Building a Conceptual Model of Cultural Heritage Resilience Through the Integration of Co-creation, Gamification, Tokenization, and the Metaverse* Toronto Metropolitan University].

CHUNG, M., Kim, K.-A., & Kang, M.-S. (2022). The status of metaverse and digital twin technology development. *Korean Journal of Artificial Intelligence*, *10*(2), 19-24.

Damaševičius, R., & Sidekerskienė, T. (2024). Virtual worlds for learning in metaverse: A narrative review. *Sustainability*, *16*(5), 2032.

De Masi, V., Di, Q., Li, S., & Song, Y. (2025). Meta Unveiling: Exploring Aesthetic Canons and the Global Impact of Chinese Metaverse Style. *Youth and Globalization*, *6*(1-2), 124-165.

Dionisio, J. D. N., Iii, W. G. B., & Gilbert, R. (2013). 3D virtual worlds and the metaverse: Current status and future possibilities. *ACM computing surveys (CSUR)*, *45*(3), 1-38.

Doherty, P. (2023). *Unlocking the Metaverse: a strategic guide for the future of the built environment*. John Wiley & Sons.

Dolata, M., & Schwabe, G. (2023). What is the Metaverse and who seeks to define it? Mapping the site of social construction. *Journal of Information Technology*, *38*(3), 239-266.

Dolgui, A., & Ivanov, D. (2023). Metaverse supply chain and operations management. *International Journal of Production Research*, *61*(23), 8179-8191.

Dwivedi, Y. K., Hughes, L., Baabdullah, A. M., Ribeiro-Navarrete, S., Giannakis, M., Al-Debei, M. M., Dennehy, D., Metri, B., Buhalis, D., & Cheung, C. M. (2022). Metaverse beyond the hype: Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. *International journal of information management*, *66*, 102542.

Fairfield, J. A. (2022). Tokenized: The law of non-fungible tokens and unique digital property. *Ind. LJ*, *97*, 1261.

Freeman, D. (2022). *Metaverse Investing: The Step-By-Step Guide To Understand Metaverse World And Business, Virtual Land, Defi, NFT, Crypto Art, Blockchain Gaming, And Play To Earn*. Darell Freeman.

George, A., Fernando, M., George, A. S., Baskar, T., & Pandey, D. (2021). Metaverse: The next stage of human culture and the internet. *International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)*, *8*(12), 1-10.

Ghosh, A., Hassija, V., Chamola, V., & El Saddik, A. (2024). A Survey on Decentralized Metaverse using Blockchain and Web 3.0 technologies, Applications, and more. *IEEE access*.

Grossi, L. (2021). NFTs and Metaverse. An analisys from the point of view of contemporary art and design.

Hales, D. (2019). *Assimilating the Deleuzian Objectile to a Pataphysical Clinamen: A pataphysical objectile for design research*. Royal College of Art (United Kingdom).

Harris, C. G. (2024). Challenges and Opportunities of Integrating Non-Fungible Tokens (NFTs) and Self-Sovereign AI (SSAI) in Blockchain-Based Metaverse Projects. 2024 9th International Conference on Big Data Analytics (ICBDA),

Hatami, M., Qu, Q., Chen, Y., Kholidy, H., Blasch, E., & Ardiles-Cruz, E. (2024). A Survey of the Real-Time Metaverse: Challenges and Opportunities. *Future Internet*, *16*(10), 379.

Hopkins, O. (2023). *Multispace: Architecture at the Dawn of the Metaverse*. John Wiley & Sons.

Hutson, J. (2024). *Art and Culture in the Multiverse of Metaverses: Immersion, Presence, and Interactivity in the Digital Age*. Springer Nature.

Ismail, L., & Buyya, R. (2023). Metaverse: A vision, architectural elements, and future directions for scalable and realtime virtual worlds. *arXiv preprint arXiv:2308.10559*.

Jacob, M. J., & Grabner, M. (2010). *The studio reader: on the space of artists*. University of Chicago Press.

Kohler, T., Fueller, J., Matzler, K., Stieger, D., & Füller, J. (2011). Co-creation in virtual worlds: The design of the user experience. *MIS quarterly*, 773-788.

Koles, B., & Nagy, P. (2014). Virtual worlds as digital workplaces: Conceptualizing the affordances of virtual worlds to expand the social and professional spheres in organizations. *Organizational Psychology Review*, *4*(2), 175-195.

Koohang, A., Nord, J. H., Ooi, K.-B., Tan, G. W.-H., Al-Emran, M., Aw, E. C.-X., Baabdullah, A. M., Buhalis, D., Cham, T.-H., & Dennis, C. (2023). Shaping the metaverse into reality: a holistic multidisciplinary understanding of opportunities, challenges, and avenues for future investigation. *Journal of Computer Information Systems*, *63*(3), 735-765.

Krajač, M. (2024). *A Dance Studio as a Process and a Structure: Space, Cine-Materiality, Choreography, and Revolution—Zagreb, 1949-2010* The Ohio State University].

Lee, L.-H., Lin, Z., Hu, R., Gong, Z., Kumar, A., Li, T., Li, S., & Hui, P. (2021). When creators meet the metaverse: A survey on computational arts. *arXiv preprint arXiv:2111.13486*.

Malerba, S. (2023). Exploring the potential of the metaverse for value creation: An analysis of opportunities, challenges, and societal impact, with a focus on the Chinese context.

Mohammed, S. Y., Aljanabi, M., & Gadekallu, T. R. (2024). Navigating the nexus: a systematic review of the symbiotic relationship between the metaverse and gaming. *International Journal of Cognitive Computing in Engineering*.

Monacella, R., & Keane, B. (2022). *Designing landscape architectural education: Studio ecologies for unpredictable futures*. Taylor & Francis.

Mourtzis, D. (2023). The Metaverse in industry 5.0: A human-centric approach towards personalized value creation. *Encyclopedia*, *3*(3), 1105-1120.

Rehman, S. U., Kim, I., & Hwang, K. E. (2025). Advancing BIM and game engine integration in the AEC industry: innovations, challenges, and future directions. *Journal of Computational Design and Engineering*, qwaf030.

Richter, S., & Richter, A. (2023). What is novel about the Metaverse? *International journal of information management*, *73*, 102684.

Ryu, S., Xiang, Y., & Zhang, W. (2024). Unlocking New Value With Emerging Technologies in the Cultural and Creative Industry: The Role of Blockchain Technology. *Guide to Digital Innovation in the Cultural and Creative Industry*.

Salter, C. (2010). *Entangled: technology and the transformation of performance*. MIT press.

Sarwatt, D. S., Lin, Y., Ding, J., Sun, Y., & Ning, H. (2024). Metaverse for intelligent transportation systems (ITS): A comprehensive review of technologies, applications, implications, challenges and future directions. *IEEE Transactions on Intelligent Transportation Systems*, *25*(7), 6290-6308.

Saurabh, K., Upadhyay, P., & Rani, N. (2023). A study on blockchain-based marketplace governance platform adoption: a multi-industry perspective. *Digital Policy, Regulation and Governance*, *25*(6), 653-692.

Singla, B., Shalender, K., & Singh, N. (2024). *Creator's Economy in Metaverse Platforms: Empowering Stakeholders Through Omnichannel Approach: Empowering Stakeholders Through Omnichannel Approach*. IGI Global.

Sommers, M. R. H. (2024). Thought couture in the digital atelier: Imaginaries of governance and creative production in the digital fashion'revolution'.

Song, M. (2022). Meta's Metaverse Platform Design in the Pre-launch and Ignition Life Stage. *International Journal of Internet, Broadcasting and Communication*, *14*(4), 121-131.

Sun, H. (2017). Digital disruption in the recording industry.

Sutopo, A. H. *Metaverse Programming 3D Scene using Visual Studio Code*. Topazart.

Tonkin, J. Virtually Together: on creating learning spaces for VR production using free and open-source software tools and open standards platforms.

Ullrich, M., Thalappully, R., Heieck, F., & Lüdemann-Ravit, B. (2024). Virtual commissioning of linked cells using digital models in an industrial metaverse. *Automation*, *5*(1), 1-12.

Varvatsoulis, G. *The Emergence of Metaverse Technologies and Their Implementation Across Various Industries* Toronto Metropolitan University].

Wang, J., Chen, S., Liu, Y., & Lau, R. (2023). Intelligent metaverse scene content construction. *IEEE access*, *11*, 76222-76241.

Xu, C., Zhong, R., Li, C., & Yan, X. (2023). From Fiction to Reality: Harnessing the Power of Imaginative Narratives to Shape the Future of the Metaverse. *Journal of Metaverse*, *3*(2), 108-120.

Xu, H., Berres, A., Shao, Y., Wang, C. R., New, J. R., & Omitaomu, O. A. (2023). Toward a smart metaverse city: Immersive realism and 3d visualization of digital twin cities. *Advances in Scalable and Intelligent Geospatial Analytics*, 245-257.

Yang, L., Ni, S.-T., Wang, Y., Yu, A., Lee, J.-A., & Hui, P. (2024). Interoperability of the metaverse: A digital ecosystem perspective review. *arXiv preprint arXiv:2403.05205*.

Yasar, A. G., Thomas, A., Barr, K., & Eben, M. (2023). Gaming without Frontiers: Copyright and Competition in the Changing Video Game Sector.

Σταματάκης, Δ. (2023). Blockchain and NFTs.