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NFT Art: A Systematic Review of Research and Market Dynamics

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Abstract: *NFT (Non-Fungible Token) art, fueled by blockchain technology and its connection to virtual currencies, gained significant attention beyond the art world. However, after peaking in 2021, interest and trading activity declined and eventually stagnated. This study examines the research landscape and market dynamics of the NFT art system from a systemic perspective, proposing future research directions. We utilize the Technology Adoption Life Cycle (TALC) and the concept of the Chasm, compiling abstracts of 153 Scopus-indexed articles up to October 2024, along with market data from various platforms. Using VOSviewer, we categorize the literature by research type while analyzing transaction data.Our findings reveal that prior research on the NFT art market predominantly focuses on the pre-chasm stage of the TALC, highlighting the innovative nature of digital art as a medium of exchange and the decentralization it promotes. Based on these results, we recommend that future studies investigate the reasons behind the stagnation of the NFT art market, particularly by addressing the challenges of valuing intangible assets from the perspective of market stakeholders. Furthermore, additional research should explore system-level strategies that can enhance broader adoption and support the sustainable growth of NFT art.*

Keywords: NFT (Non-Fungible Token); NFT Art; Technology Adoption Life Cycle (TALC); Chasm; Bibliometric Analysis

1. Introduction

The rapid adoption and booming development of new technologies, particularly blockchain, have provided robust technical support for NFT art, marking a significant moment in the ongoing digital transformation [1]. As of 2021, the market size of NFT art has surged to more than $15 billion, while the number of active wallets is approaching 2 million [2]. Since 2020, NFT arts have dominated the market, consistently achieving the highest average prices among all NFT categories [3]. For example, in March 2021, American artist Beeple's digital artwork 'Everyday: THE FIRST 5000 DAYS' sold for $69.3 million at Christie's, making it the most expensive NFT artwork sold globally [4]. Following the auction, interest in NFT art surged, with an increasing number of young people, wealthy celebrities, influencers, and artists participating in the emerging scene [5]. After peaking in 2022, the total value of NFT art sales declined significantly through February 2025 [6]. However, experts believe that the market still has the potential for a recovery driven by its utility and value-driven projects, creative collaborations, and demand for real-world applications [7].

NFT is a unique digital asset stored on the blockchain, whose main features include non-fungibility, unique identifier, permanent record, smart contract support, decentralization, etc. [8, 9]. On this basis, NFT helps to verify and protect the uniqueness and ownership of digital content [10, 11], which can have an all-encompassing impact on society, and the field of the arts is no exception. The application of NFT to the field of the arts closely connects digital artwork and its owners [9], [12], to prove the authenticity of the digital artwork. The emergence and development of NFT art has stimulated the interest of creators, collectors, investors, and scholars to attracting their active participation [3], [8], [13].

Previous research on NFT art focuses on the fields of computer science, economics and finance, law and security, and ecosystems. In computer science, the main focus is on NFT art generation methods and its creative

thresholds [14, 15]; In economics and finance, the relationship between prices and cryptocurrency values fluctuations [16], trading methods [17], and financial transaction properties [12]; In law and security, research has focused on lawmaking, contracts, privacy, copyright, and regulations [18-20].

As NFT art has contribute to creating new ecosystems, some scholars have begun to study the ecosystem's stakeholders [21] with discussing the risks faced by the stakeholders [22-25]. For instance, on the potential of NFT art in brand value has been conducted by blending ownership of online and offline goods to facilitate brand-consumer connections [26, 27]; and there have also been studies addressing the application of NFT art to new exhibition cultures [28]. However, we find that although prior research on NFT art has covered a wide range of areas, existing research lacks a comprehensive understanding of both the research landscape on NFT art and the current conditions of the market.

To address this academic gap, drawing on prior research and recent market trends, this study examines both academic perspectives and the evolving dynamics of NFT art, and proposes directions for future research in light of market acceptance and diffusion. To accomplish the aim, we raise the following key questions: (1) What are the main themes and gaps in current research on NFT art? (2) How is the NFT art market evolving, and what factors are driving these changes? (3) What are the future directions for research on NFT art?

To this end, to better understand the acceptance and dissemination characteristics of NFT art in different market stages, this study applies the Technology Adoption Life Cycle (TALC) [29] and the concept of Chasm [30] to analyze the status of NFT art research. The TALC, proposed by Geoffrey Moore, builds on Rogers' research on diffusion of innovations and describes the process of adoption of new technologies in the marketplace, emphasizing the behaviors of groups of adopters at different stages and at different points in time [29, 30]. Meanwhile, the concept of Chasm highlights a key challenge in the market adoption process: the 'chasm' faced by new technologies as they transition from 'early adopters' to the 'early majority' [30]. Both concepts have been widely applied to the study of market diffusion and consumer adoption of innovations [31-36]. Though theories such as "innovation diffusion" can be applied to analyze NFT art, the TALC and chasm models are more appropriate for the present study. First, these models are specifically designed to explain the typical shifts in adoption stages characterized by explosive growth, cooling, and stagnation in the market. Second, they jointly account for three core elements: the attributes of innovation, the types of adopters, and the speed of market diffusion. Third, by doing so, they enable the positioning and interpretation of scholarly discussion topics and empirical market indicators within the adoption curve, thereby providing a systematic framework for analysis.

Given this conceptual framework, this study conducts a meta-analysis of NFT art literature published between 2021 and 2024, utilizing VOSviewer to systematically identify research themes, hotspots, and the relationships among them. This approach allows for a comprehensive assessment of the current academic landscape and its positioning within the 'early adopters' phase of the TALC. In addition, user and transaction data are collected from Google Trends and OpenSea to analyze real-world market trends. By applying the TALC and the concept of Chasm to both literature and empirical market data, this study demonstrates that NFT art has entered the "chasm" phase—situated between 'early adopters' and the 'early majority'. The integrated analysis not only clarifies the present stage of NFT art in both research and practice, but also highlights the specific factors underlying this transitional period, thereby offering future research directions to facilitate broader adoption and sustainable development in the field.

2. Theoretical Background

2.1 NFT Art

Within the realm of blockchain technology, tokens are typically classified into two categories: fungible tokens and non-fungible tokens (NFTs). An NFT is a digital asset distinguished by a unique identifier, which is immutably recorded on a blockchain. The concept of NFTs was initially introduced in the Ethereum Improvement Proposal (EIP)-721, which underwent a period of community discussion and review before being formalized. NFT functionalities were further advanced in EIP-1155. Upon approval, EIP-721 was ratified as the ERC-721 standard—the inaugural standardized token model for NFTs on the Ethereum blockchain [11]. ERC-721 integrates metadata and timestamping functionalities into digital content, enabling comprehensive provenance tracking from the original issuer to the current holder, which in turn substantiates the value of digital assets [25], [37]. As one of the earliest applications of blockchain, NFTs' defining feature lies in their non-fungibility, rendering them uniquely identifiable digital assets [8]. These digital assets have seen widespread application across both tangible and intangible sectors, including artworks, collectibles, sports, gaming, music,

and tokenized real-world items such as vehicles, racehorses, and branded sneakers [3], [38]. Ownership and transfer records of NFTs are securely stored within blockchain-based smart contracts, ensuring authenticity and safeguarding against forgery or duplication [8]. Most NFTs representing physical or intangible goods are minted and traded on Ethereum, a decentralized, open-source platform, providing reliable and transparent transactional support for global users [39]. Disruptive innovation occurs when an emerging technology, initially overlooked or resisted by mainstream consumers, rapidly advances and penetrates existing markets, fundamentally altering the industry landscape [40]. NFTs exemplify such disruptive innovation [21], challenging and transforming traditional paradigms of ownership, transaction, and perception within the art world [21], [25].

NFT art refers to digital artworks issued using NFT technology, and represents one of its primary application domains [3]. A defining characteristic of NFT art is the transparent and open artistic ecosystem it offers, removing barriers and allowing all participants equal access [9]. Within this ecosystem, three principal stakeholder groups emerge: creators (artists), collectors (consumers), and trading platforms (marketplaces). Marketplaces such as OpenSea, SuperRare, Foundation, and Nifty Gateway enable artists and collectors to display, acquire, and trade NFT artworks [9]. The advent of these platforms has revolutionized the trajectory of the traditional art sector, making NFT art transactions publicly visible and imbuing each artwork with unique identification and verifiable ownership [13].

Despite their intangible nature, NFTs serve as credible proofs of authenticity and ownership for digital artworks, which notably stimulates purchasing behavior among consumers [20]. This dynamic contributed to the enthusiastic early adoption of NFT art by a select group of high-profile consumers [12]. However, skepticism persists among the wider public; many mainstream consumers remain cautious and seek assurances that NFT art can be sold or resold to realize its commercial value [21], [25]. With NFT art yet to deliver significant functional utility, achieving wide-scale consumer adoption continues to pose a challenge [20]. This ambivalence reflects the broader market obstacles facing NFT art, emphasizing the need for ongoing education and outreach to shift consumer perceptions [26].

2.2 The TALC and the Chasm

The Innovation Diffusion Theory was proposed by Everett Rogers [41], who provided a model for how innovations such as new technologies, products, and services spread among members of a social system over a certain period through specific channels [29], [42]. This theory has been applied in multiple fields such as agricultural products and technologies [29], medical solutions [43], new energy vehicles [44], and the adoption of solar systems [45-47].

Within this theory, consumers who adopt innovations are grouped into five categories, which are depicted in a bell-shaped curve (also known as the adoption curve) showing the proportion of each group in the target market (Figure 1) [48]. The specific classifications are ‘innovators’ (2.5%), ‘early adopters’ (13.5%), ‘early majority’ (34%), ‘late majority’ (34%), and ‘laggards’ (16%) [49, 50]. This categorization is based on personality, behavior, values, and attitudes of consumers [29], [42], [44]. Each adopter group has distinct psychological characteristics [41] (Table 1).

Table 1. Classification and characterization of adopters [31].

Categories	Characterization
Innovators	First users, new idea enthusiasts and developers, risk-takers
Early adopters	Visionaries, opinion leaders, opportunity takers, need for change realizers, willingness to take risks
Early Majority	Evidence seekers, pragmatists seeking value for money
Late Majority	Most followers, followers of conservatives
Laggards	Rejection of innovation, skeptics

The TALC is a specific application of Rogers’ Innovation Diffusion Theory, particularly focusing on the market adoption of technological products [51]. This theory serves as a means to categorize markets and their responses to high-tech products and is a key tool for determining the product itself, product pricing, and marketing strategies for high-tech products [30], [49]. The TALC analyzes adopters’ demographic and psychographic characteristics to describe the adoption or acceptance of innovations [32], [41]. Moore pointed

out that there are five stages in the TALC (Figure 1), and each adopter group has unique psychological profiles; their innate personalities and preferences differ greatly [32], [42], [48], [51] (Table 1).

Similar to Rogers' adopter categorization (Table 1), the first stage of the TALC consists of 'innovators', who occupy a very small proportion of the market—only 2.5%. They are willing to try all kinds of new things and are naturally curious and passionate about new technologies [49, 50]. The second stage, 'early adopters', often receive considerable attention in the literature [44]. Often known as "visionaries," they are willing to take risks, rely on intuition, and are driven by future opportunities, thus becoming opinion leaders in innovation adoption [32]. The third stage, the 'early majority', are more analytical and risk-averse. They are called pragmatists and only adopt new products when their needs are completely met [41]. Moreover, they prefer a simple and relatively effortless adoption process [51]. The last two stages are the 'late majority' and 'laggards'. The 'late majority' represent conservative adopters who will only adopt innovations after witnessing obvious product advantages; 'laggards' take pride in not adopting and strictly adhere to traditional ways until they are left with no alternative. Throughout the market development process, companies use each stage's consumer group as the basis for expanding to the next adopter group's market. Value recognition from 'innovators' is a crucial precondition that helps companies further develop a solid 'early adopters' market. Likewise, the 'early adopters' recognition is also fundamental in opening the 'early majority' market. This sequential relationship persists all the way to the 'laggards' at the right end of the bell curve [30], [51]. Thus, the differing characteristics among adopter groups hinder information exchange, especially between the 'early adopters' and "early majority", making transitions difficult for companies. Focus on the traits of these two stages is a key factor for a smooth transition [30], [52].

Moore extended and refined the TALC (Figure 1) by introducing the Chasm. The theory posits the existence of a "chasm"—a significant market acceptance barrier—between 'early adopters' and the 'early majority'. The concept of Chasm emphasizes that successfully crossing this chasm is critical for technological products in moving from a niche market to the mainstream. Each pair of adjacent adopter stages in the technology adoption lifecycle is separated by a gap, as depicted in the bell-shaped curve in Figure 1. The five types of adopters are grouped into three segments: 'innovators' and 'early adopters' comprise the early market, early and 'Late Majority' make up the mainstream market, and 'laggards' form the late market [35]. The adoption of new products is not seamless across these groups; the gaps represent the challenges each group faces when accepting new products [35].

There are mainly three gaps: the first is between 'innovators' and 'early adopters', the second (the "chasm") is between 'early adopters' and the 'early majority', and the third is between early and late majority. The chasm—between 'early adopters' and 'early majority'—is especially daunting, regarded as the most concealed and perilous gap in the lifecycle [41], [49], [51]. Not all new products cross this chasm and are adopted by the mass market. Consumer groups in the market have different needs, so differentiated marketing according to adopter characteristics is needed to avoid declines in sales and loss of market share [49]. Moore argued that the key to successfully entering the 'early majority' stage during new product promotion is to effectively bridge this chasm. To do so, companies should, first of all, identify the needs of pragmatists and provide a "whole product" (that is, both product and services). Second, companies are encouraged to focus on specific market segments, strive for dominance, or combine two adjacent segments and provide a comprehensive set of products tailored for each segment [30], [41], [51]. Through these effective strategies, new technologies or products can eventually succeed in entering the mainstream market.

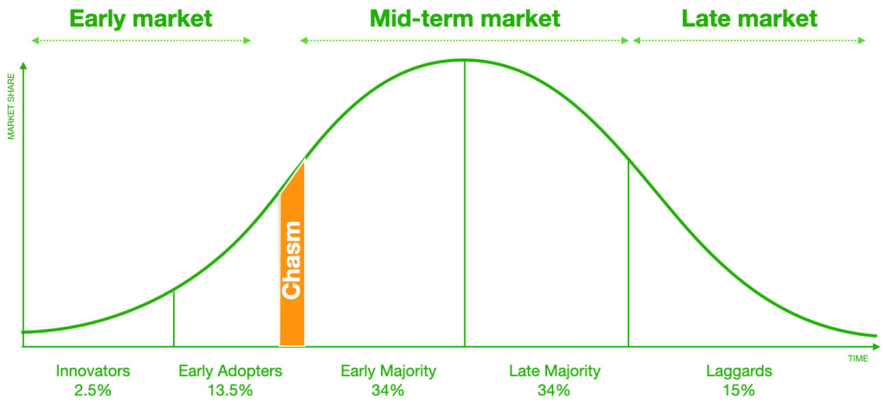

Figure 1. The TALC with identifying the gap between 'early adopters' and 'early majority' [41].

In the literature surrounding the TALC and the concept of Chasm, the characteristics of adopters and innovations themselves are considered key predictors for the adoption of an innovation [46]. As discussed above, the features of adopters and the differences between each stage can pose significant barriers to the adoption of innovations. Another critical factor influencing adoption lies in the characteristics of the innovation itself. An innovation typically needs to possess five principal attributes: relative advantage, compatibility, observability, trialability, and complexity. Before adopting a new product or innovation, consumers will assess it based on these features and form their expectations accordingly [29], [42].

Taking the example of solar systems, financial, economic, and aesthetic concerns often limit their widespread adoption, highlighting insufficient relative advantage and low compatibility with existing systems. When consumers are unable to identify these relative advantages, the probability of adoption drops [42]. Another example of technology not yet widely accepted is the use of classroom response systems in education. Individuals who have not adopted such technologies often cannot recognize clear advantages or compatibility with established systems, which becomes a significant barrier to broader adoption [32], [41]. Therefore, only when adopters perceive that an innovation delivers a distinct advantage, aligns well with current systems, and is simple to understand, can that innovation spread more broadly and rapidly.

3. Methods

This study integrates bibliometric analysis with NFT art market data analysis to comprehend the current status of research and the market for NFT art, thereby proposing future research directions. Initially, a systematic collection of academic literature related to NFT art was performed, following the PRISMA Statement to ensure comprehensive and systematic literature screening [19], [53, 54]. Market data concerning NFT art, including price, trading volume, and the number of active wallets, was obtained from the OpenSea platform, spanning from January 2021 to October 2024 on a daily basis. The reason for selecting the OpenSea platform as the primary proxy for NFT market data is that, during the period under investigation, it recorded the highest trading volume and market share, and offered the best accessibility and quality of publicly available data. Additionally, Google Trends was utilized to gather Google Search Index data, thereby capturing public interest in NFT art-related keywords [13]. In this study, adoption groups within the TALC based on such empirical data, include market participants and stakeholders who actively mint, purchase, collect, and trade NFT art. Moreover, general audiences and cultural institutions are addressed at a conceptual level by considering then as part of the wider socio-cultural environment shaping market diffusion.

Subsequently, VosViewer was employed for keyword co-occurrence analysis of the screened academic literature, enabling the identification and analysis of current research themes, hot topics, and trending topics. Time series analysis and trend analysis were conducted on OpenSea's market data to reveal the development status of the NFT art market. Finally, the findings from the literature and market data were synthesized through the lens of the TALC and Chasm theories, providing explanations for both the research and market states of NFT art.

Following the PRISMA framework and its scope definition criteria, journal literature on "NFT art" published between January 2021 and October 2024 was retrieved from the Scopus database. This study adopts Scopus as the primary database for literature retrieval for three main reasons: it offers broad interdisciplinary coverage (including humanities, social sciences, engineering, and the arts); it indexes major journal databases such as SSCI, SCI(E), and AHCI, ensuring comprehensive and reliable scholarly coverage; and it allows for the systematic extraction and management of large-scale bibliographic data for this study.

Given that research prior to 2021 largely focused on conceptual discussions of NFT technology, while from 2021 onwards NFTs began to be widely applied—especially in the art field, which entered a phase of explosive growth—this study limits its literature to the period from 2021 onward. The time frame of 2021–2024 is designed to capture the key developmental stages of the NFT art market: the peak of explosive growth in 2021, the sharp adjustment and downturn from 2022 to mid-2023, and the gradual absorption of volatility and movement toward relative stability or structural reconfiguration in 2024. This span enables a systematic examination of the evolution of NFT art from rapid expansion, through deep adjustment, to initial stabilization. Specific search terms such as "Non-Fungible-Token" and "NFT Art" were used in article titles, abstracts, or keywords, yielding an initial result of 201 documents. After the initial screening process, a total of 153 valid documents were identified as effective samples (Figure 2). These 153 documents were further subjected to the following exclusion criteria: not being original research published in peer-reviewed English-language scientific journals and absence of the term "NFT art" in either the title or abstract. At this screening stage, articles where "NFT art" appeared solely as a keyword without being discussed in the title or abstract were excluded, as full-text examination revealed that such articles did not engage with the concept.

Next, bibliographic information from the eligible literature—including publication year, language, journal, title, authors, affiliations, keywords, document type, abstract, and citation count—was exported in RIS format. VOSviewer was applied to analyze keyword co-occurrence and thematic structure [55-57]. The data were assessed based on the VOSviewer Manual [55], considering the frequency of keyword co-occurrences and four weighted attributes: average link weight, total link strength, occurrence count, and average publication year, to define thematic clusters. In network visualization, the size of each node represents the frequency of keyword occurrence, indicating the importance of the keyword—larger nodes correspond to higher frequency and greater importance within the network. The thickness of the links between nodes illustrates the strength of relationships between keywords, with thicker lines representing higher co-citation frequency. The distance between nodes suggests how often keywords co-occur; the shorter the distance, the more frequently the keywords appear together [55]. Node colors reflect distinct clusters and themes, which are identified through cluster analysis, indicating stronger associations among nodes within the same cluster. Total link strength quantifies each node's connectivity within the network and, through the analysis of keyword connection strength and co-occurrences, reveals core concepts, research hot spots, and the relationships among different themes. In the overlay visualization, the color of each term represents the average publication year of the articles in which the term appears.

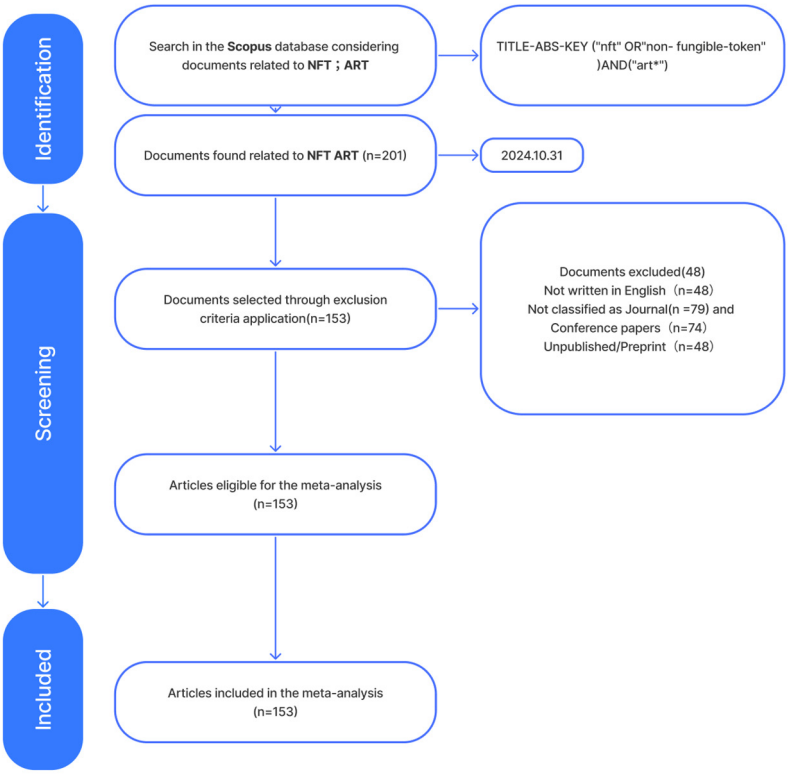

Figure 2. Stages of identifying relevant literature based on PRISMA Statement, full presentation analysis procedures and methods [53].

4. Results

4.1 Research Status and Key Clusters of NFT Art

From 2021 to 2024, a total of 153 scholarly articles focusing on NFT art were identified. The number of publications exhibited sustained growth from 2022 to 2023, with 33 papers published by October 31, 2024. The primary disciplines involved include Computer Science, Engineering, and Social Sciences, underscoring that NFT art continues to attract broad attention across diverse research domains.

Terms appearing more than twice in the database were included in the final analysis scope [57]. Approximately 970 terms were identified in total, among which 156 met the designated threshold. By default, the VOSviewer system selected the 60% most relevant terms for subsequent analysis, resulting in the identification of four distinct clusters and their associated characteristics [55] (Table 2). The most frequently

occurring terms were “blockchain technology” (with a total link strength of 517) and “digital art” (with a total link strength of 217). Among the terms with total link strengths above the average value (36), those related to “commerce”, “arts computing”, “Metaverse”, “investment”, “decentralised”, “digital asset”, “art market” and “ecosystem” exhibited higher levels of association within the overall network. Cluster analysis based on term co-occurrence index reveals that current research on NFT art is primarily concentrated in four main clusters (Figure 3): Cluster 1 (Blue), Cluster 2 (Red), Cluster 3 (Yellow), and Cluster 4 (Green) (Table 2). Blue and Red clusters display superior link weights and total link strengths, indicating greater influence within the NFT art research network, while Yellow and Green clusters demonstrate lower centrality and impact. According to the TALC, these terms reflect characteristics of ‘innovators’ and ‘early adopters’ of NFT art—namely, “enthusiasm for new things and technologies” and “willingness to take risks”—implying that leading research remains rooted largely within the early market phase.

Moving forward, this analysis informs the identification of key research content in NFT art. Representative, high-frequency terms within each cluster, excluding general terms such as “NFT” “blockchain”, “Ethereum”, and “digital art” were selected to analyze the unique features of each group in conjunction with related adjacent terms.

Table 2. The four clusters and key terms

Cluster	Terms
Cluster 1 (blue)	Ecosystem, art market, art world, digital content, digital technology, high price, Metaverse, new form, new technology, relationship, space, uniqueness, virtual asset, virtual space, virtual world, commerce, digital storage, distributed ledger, smart contract, intellectual property, copyright protections, social influence, sustainable development, security issues
Cluster 2 (red)	Commerce, art market, artworks, copyrights, digital storage, intellectual property, market sizes, one of a kind, sales, solidity
Cluster 3 (yellow)	web3, price prediction, profitability, sentiment analysis, visual languages, cryptocurrency, data mining, deep learning, forecasting, image enhancement, machine-learning, multi-modal data
Cluster 4 (green)	artificial intelligence, asset ownerships, creative industries, creatives, digital asset, generative art, property, state of the art

Figure 3. Research Network of NFT Art

4.1.1 Cluster 1

This cluster centers upon the NFT art ecosystem. Key terms include “digital art” (total link strength: 238; occurrences: 93), “ecosystem” (total link strength: 46; occurrences: 5), and “arts computing” (total link strength: 176; occurrences: 27). This indicates that researchers utilize the framework of “ecosystem” to interpret the operational mechanisms and technological innovations of NFT art as a whole. Literature defines the NFT art ecosystem as a comprehensive system encompassing NFT artworks, creators (artists), trading platforms, and consumers [9]. Art transactions are facilitated via platforms, providing creators with the means to market their work—whether through open markets such as OpenSea or curated platforms such as SuperRare—which are regarded as crucial for the functioning of the NFT art ecosystem [11, 12].

In scholarly research, “digital art” is frequently used as a proxy indicating NFT-based art forms, serving as a focal entry point for examining the broader NFT art ecosystem, thereby earning the highest values in frequency and network centrality. The close linkage between “ecosystem” and “digital art” demonstrates the necessity of a supportive environment for NFT art innovation and development, a theme widely addressed in the literature. Furthermore, as a pivotal application scenario of NFT technology, NFT art is intrinsically reliant on advanced technological support. Consequently, “arts computing” ranks second in terms of link strength and frequency, as researchers focus on how technological innovations are driving transformations in NFT art creation processes—especially the role of new techniques such as generative adversarial networks (GANs) and learning systems in enhancing creative and aesthetic experiences [14].

4.1.2 Cluster 2

Cluster 2 examines the value and realization of NFT art. Leading terms include “commerce” (total link strength: 208; occurrences: 28), and “smart contract” (total link strength: 156; occurrences: 23). These concepts have emerged as focal points due to their relevance in elucidating the mechanisms of value realization for NFT art in the digital economy—positioning the intersection of technology and art within market frameworks, and highlighting the role of advanced technologies in the circulation of NFT art’s value.The value of NFT art encompasses both artistic (e.g., advancement of new art forms) and commercial dimensions (e.g., profit generation) [25].

Researchers analyze market operations through terms like “commerce”, “sales” and “art market” indicating that business activities are integral throughout the value chain from creators to consumers. Studies address the interaction among creators, consumers, and art market actors, exploring how NFT art realizes both commercial and artistic value through sales and related activities. Findings indicate that creators not only drive artistic innovation using new technologies but also realize commercial value through the sale of artworks; creator recognition and audience willingness are found to be key determinants of NFT art pricing [3], [25].

Moreover, smart contracts are extensively discussed in the context of NFT art market transactions and intellectual property protection, facilitating automation and transparency in commercial activities. Smart contracts, often discussed alongside terms like “digital storage” and “intellectual property” preserve the core content of artworks, ensuring data integrity, security, and accessibility [26]. The synergy between smart contracts and digital storage supports and protects intellectual property, maintaining uniqueness in NFT artworks and fostering fast, efficient, and mutually beneficial relationships between buyers and sellers [17], [25, 26], [58], thereby enhancing value realization.

4.1.3 Cluster 3

This cluster focuses on the applications and technologies underpinning NFT art. Central terms include “deep learning” (total link strength: 75; occurrences: 8), followed by “cryptocurrency” (total link strength: 70; occurrences: 13) and “Web 3.0” (total link strength: 60; occurrences: 10). These are closely associated with practical applications such as NFT art generation, trading, and ownership assurance, and they enjoy significant scholarly attention.

Researchers directly link “deep learning” with “arts computing” and “generative art” exploring the convergence of computational technology and artistic creation [14]. Deep learning is shown to expand NFT art expression from 2D imagery to 3D models, offering a diverse evolution of artistic styles. “Cryptocurrency” is positioned as an essential payment instrument for transactions on trading platforms like OpenSea, ensuring transaction security [9], [19]. “Web 3.0” is conceptualized as an open, transparent, and user-driven internet ecosystem that secures NFT art ownership and immutability of trading records, thereby deepening trust between

collectors and creators. Advances in emerging technologies have not only boosted production efficiency but have also significantly enhanced creative autonomy and uniqueness. At the same time, NFTs can serve as tools for tourism promotion. For example, the Slovenian Tourist Board has issued digital collectibles that depict local attractions and are bundled with access rights to events or tourist sites, thereby attracting visitors' attention and encouraging participation. In addition, designing NFTs as collectible digital souvenirs (such as "travel credential" badges that record itineraries or electronic postcards) enables tourists to share and relive their travel experiences in digital environments, thereby enhancing the accessibility of tourism offerings to a broader audience [59].

4.1.4 Cluster 4

The fourth cluster investigates issues of security and legality within the domain of NFT art. Major terms include "digital asset" (total link strength: 147; occurrences: 70), "property" (total link strength: 36; occurrences: 6), "ownership" (total link strength: 52; occurrences: 11), and "digital artwork" (total link strength: 20; occurrences: 3). Early consumers and collectors predominantly purchased NFT artworks as a form of decentralized investment asset [3], [8]. The establishment of a safe and lawful market environment to protect both creators and consumers, ensuring transparent and secure ownership, is a shared concern, as evidenced by high values in connection strength and co-occurrence frequency. This cluster's focus extends to intellectual property protection and the development of market regulation for NFT art [60].

"Digital asset" exhibits strong linkage with "decentralised" (total link strength: 130; occurrences: 17) and "ownership" (link strengths: 3 and 2, respectively), reflecting widespread interest in mechanisms for property ownership protection. Scholarly research finds that NFT art, as a unique digital asset encoded on a blockchain, benefits from security through decentralization but also faces legal challenges, such as incomplete copyright or intellectual property confirmation in the early market stage [21]. With growing international attention on NFT art, legal frameworks and intellectual property protection policies for NFT trading platforms are gradually being established, providing legal support for market development [18], [23]. Looking ahead, this cluster envisions the continual advancement of legal regulations and technical standards as necessary to optimize the security and legality of NFT art.

4.2 The Market Status of NFT Art and Chasm

With Beeple's digital collage fetching an astounding $69.3 million at auction in 2021, attention toward NFTs soared, driving a rapid and dramatic expansion in global NFT art market activity. Accompanying this surge were significant increases in the numbers of artists, artworks, consumers, transaction value, and trading volume within the NFT art sector [3]. This study analyzes the current state of the NFT art market by examining four core data sets: monthly trading volumes on OpenSea, NFT art sales figures, monthly active user counts on OpenSea, and public interest/search trends for NFTs as measured by Google Trends.

OpenSea market data show that monthly transaction volumes from 2018 to 2020 were negligible [61]. Beginning in early 2021, there was a marked increase, with trading volumes peaking in July and August of that year before fluctuating. Transaction values in January and February 2022 declined from their zenith of $4.8 billion to $3.5 billion, with repeated waves of volatility; by November 2022, trading values had further dropped to $250 million. By the end of 2023, volumes had retreated to early 2021 levels. As of October 2024, monthly trading values fell to just $51.15 million.

NFT art sales figures (2019–2023) similarly reflected this explosive boom, with sales in July and August 2021 skyrocketing—August alone nearly reaching $1 billion [62]. This reveals a period of significant prosperity in the NFT market and particularly intense demand for art-related NFTs. However, following September 2021, NFT market sales began to decline sharply. Although there were minor rebounds in February 2022 and February 2023, the general trend was downward. This shift indicates that after the initial phase of explosive growth, the market eventually stabilized, with reduced speculative activity and a more clearly defined core user base [62, 63].

According to data provided by OpenSea (Table 3, Figure 4), monthly active users transacting on the platform grew gradually from single digits in 2018, climbing rapidly by the end of 2021. In January 2022, monthly active users peaked at over 700,000; however, by February 2022 the user count began a declining, volatile trend. By October 2024, monthly active users decreased to levels slightly above 100,000, comparable to those of early 2021. This suggests that since February 2022, most ongoing transactions are conducted by users who entered the market earlier, with negligible influxes of new participants [62].

Table 3. OpenSea monthly active users (at least one transaction and more) [61]

Mouth	Year						
	2018	2019	2020	2021	2022	2023	2024
Jan		1,237	3,434	6,620	711,507	589,928	291,489
Feb		1,300	3,644	15,229	653,667	534,867	250,072
Mar		1,593	3,534	43,991	548,153	470,490	221,183
Apr		1,699	3,549	31,000	590,875	506,730	286,260
May		1,653	3,148	26,528	514,324	360,736	248,080
Jun		1,603	2,585	39,877	456,193	314,413	192,738
Jul	4	1,600	2,592	74,234	468,689	347,834	151,584
Aug	87	1,710	1,735	346,959	439,490	251,734	123,358
Sept	217	1,738	4,184	523,717	422,186	218,213	113,896
Oct	283	2,880	7,143	468,816	426,126	261,358	136,325
Nov	312	2,541	6,852	416,570	420,803	251,540	103,199
Dec	732	3,490	6,300	500,895	499,229	228,995	

Figure 4. OpenSea monthly active users (at least one transaction and more) [61]

Google Trends data for public interest and search volumes often anticipate changes in OpenSea's user activity. Between mid-2021 and early 2022, both indicators rose sharply, mirroring the NFT market's explosive ascent. However, from February 2022 onward, both metrics declined steeply, indicating a cooling of market fervor and reduced public attention. Comparative analyses of OpenSea's monthly active users (Table 3, Figure 4) and NFT-related Google search volumes (Figure 5) reveal a positive correlation between user activity and public interest: heightened market participation coincides with increased public attention, and vice versa.

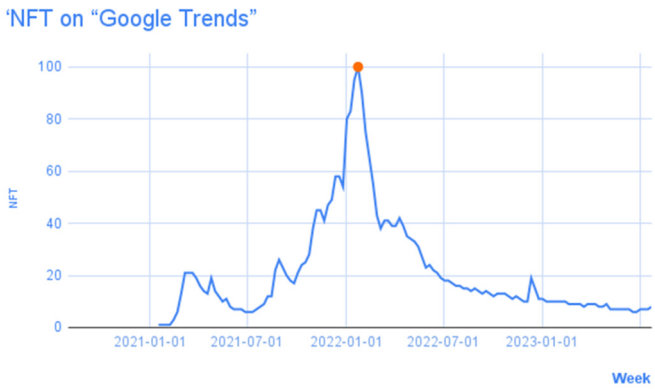

Figure 5. NFT Public Attention and Search Volume Trends (Google Trends)

In summary, analysis of these four data sets—the OpenSea monthly trading volume, NFT art sales figures, OpenSea monthly active user numbers, and NFT public attention/search volume trends from Google—provides a clear illustration: the NFT market experienced rapid growth from 2021 to early 2022, followed by an abrupt and significant decline in heat and activity.

On the basis of this evidence, this study employs the TALC theory, including the "chasm" model, to discuss the current condition of the NFT art market. The findings suggest that, first, the consumer base has reached the "early adopters" stage, indicating the NFT market is still in its early phases. As an innovative application of NFT technology within the art world, NFT art transactions in the early market have mainly appealed to 'innovators' and 'early adopters'—professional, risk-tolerant individuals drawn to new technologies and committed to mastering their complexities [3], [30]. Participation by these technology enthusiasts ('innovators') has subsequently attracted additional consumers—the 'early adopters' (opinion leaders)—driven by the promise of future opportunities and willing to take risks for potential advantages. These consumers, guided by intuition, were the first to engage with the emerging NFT art market, motivated by both technological and artistic value and prepared to tolerate the inevitable deficiencies, risks, and disruptions associated with nascent innovations [21], [64].

Secondly, this research posits that the NFT art market is currently navigating the "chasm" phase. According to the concept of Chasm, a deep and persistent gap divides 'early adopters' and the 'early majority' among high-tech product consumers (Figure 1). At this stage, market acceptance is hindered, and product sales may fall precipitously [30]. As demonstrated in the aforementioned data, since February 2022, metrics such as monthly NFT art trading volumes, sales, and active users have declined rapidly, accompanied by diminished public attention. Nevertheless, some experts project that the NFT market could reach a valuation of $200 billion by 2030, indicating positive long-term prospects [64]. Thus, it may be inferred that the NFT art market currently faces a temporary stagnation and demand slump—a typical "chasm" period [65]. In other words, the market is now sustained mainly by core users ('innovators' and 'early adopters'), but has yet to succeed in attracting a broader user base (the 'early majority' described in the TALC) [66]. In conclusion, this study contends that the NFT art market is positioned within the "chasm" between the early and mainstream markets.

5. Discussion

The aim of this study is to examine the current state of research and the market conditions of NFT art, and to propose future directions for scholarly inquiry in this field. To this end, the study employs VOSviewer to analyze literature related to NFT art published between 2021 and 2024, with particular attention to market indicators such as monthly trading volume and sales of NFT art, the number of active users on relevant platforms, and measures of public interest. By synthesizing insights from the literature with market data, the study insists that the NFT art market has currently entered the chasm between the "early adopters" and the "early majority" stages on the TALC curve, whereas existing academic research remains thematically focused predominantly on the early stages of market development.

5.1 Mapping Thematic Clusters onto the TALC/Chasm

From an integrated perspective on research themes and stages of market diffusion, the four clusters identified in Section 4.1 and the market dynamics revealed in Section 4.2 can be systematically aligned with the TALC and chasm framework. Clusters 1 ("Ecosystem") and 2 ("Value and Realization") primarily focus on the infrastructure, market structure, and value realization pathways of NFT art, organized around keywords such as "blockchain technology" (total link strength 517; co-occurrence frequency 87), "digital assets" (total link strength 147; co-occurrence frequency 70), "decentralization" (total link strength 101; co-occurrence frequency 14), and "investment" (total link strength 97; co-occurrence frequency 10). These clusters reflect the characteristics of an "early market" dominated by technology enthusiasts and high risk-tolerance investors [32], [49, 50], [64], and they provide the necessary transactional environment and institutional foundations for early adopters.

By contrast, Cluster 3 ("Applications and Technology") and Cluster 4 ("Security and Legality") are more closely associated with the conditions required for moving toward the early majority. Cluster 3 examines how technologies such as "deep learning" (total link strength 75; co-occurrence frequency 8), "Web 3.0" (total link strength 60; co-occurrence frequency 10), and "cryptocurrency" (total link strength 70; co-occurrence frequency 13) can expand the application scenarios of NFT art, although most studies remain at the level of technological

potential and experimental projects. Cluster 4 centers on “digital assets” (total link strength 147; co-occurrence frequency 70), “property” (total link strength 36; co-occurrence frequency 6), and “ownership” (total link strength 52; co-occurrence frequency 11), focusing on issues such as the protection of property rights, asset ownership, and legal regulation in relation to NFT art. This cluster reveals that, while decentralized technologies enhance transparency, they also entail problems such as unclear copyright attribution and underdeveloped regulatory frameworks. These questions of legality and security constitute a critical threshold for the transition from early adopters to the early majority.

Overall, the four clusters jointly depict NFT art as situated in the “early market–chasm” stage: the first two clusters account for the rapid expansion of the early market, whereas the latter two indicate—but have not yet fully resolved—the technological and institutional conditions necessary to bridge the chasm.

5.2 Market Dynamics and Evidence of an Early-Market Bias

Market data further corroborate this assessment. Monthly trading volume, sales, and active user numbers on OpenSea, together with public interest as reflected in Google Trends, all rose rapidly from early 2021 and peaked in January 2022, before declining sharply from February 2022 onward and then hovering at a relatively low level. This “short-term explosion–rapid cooling–low-level stagnation” trajectory closely aligns with the situation described in chasm theory, in which the early adopter phase has ended, the product has not yet achieved broad acceptance among the early majority, and the market falls into a state of stagnation and uncertainty.

Synthesizing the thematic focus of the literature with these market dynamics, it can be argued that NFT art has already undergone a niche diffusion process dominated by innovators and early adopters, but has not yet successfully crossed the chasm leading to the early majority, and thus remains positioned between the early market and the mainstream market. On the one hand, academic research has concentrated on early-market issues such as the emergence of new artistic forms, the implementation of decentralized technologies, investment opportunities, and price volatility. On the other hand, issues that are closely related to the early majority—such as user access barriers, the rationality of long-term value, institutional safeguards, and cultural legitimacy—have only been sporadically addressed in a limited number of studies. In other words, existing scholarship has primarily focused on explaining why NFT art rapidly attracted innovators and early adopters, while a systematic understanding of why it has not successfully entered the mainstream market and how the chasm might be bridged remains underdeveloped.

6. Conclusion

Building on the preceding analysis, the TALC and chasm framework provides an analytical coordinate system for considering the future trajectory and practical strategies of NFT art. One possible path is that, if the technological and application-oriented research in Cluster 3 can move from a focus on “feasibility” to “usability”—for example, by lowering the operational barriers to opening wallets, enabling direct payments in fiat currency, and simplifying the processes of holding and transferring NFTs—while simultaneously developing “whole products” for ordinary users in contexts such as tourism, gaming, brand membership, and exhibitions, then NFT art could become more accessible to the early majority. If, at the same time, the legal and regulatory issues highlighted in Cluster 4, including copyright protection and broader governance frameworks, are gradually addressed, NFT art may progress along the TALC curve toward the early majority stage, effecting a transformation from a highly volatile speculative asset into a relatively stable cultural and artistic product. Conversely, if technological usability and institutional legitimacy fail to improve over the longer term, NFT art may remain locked in a niche market composed mainly of technology enthusiasts and high-risk investors, struggling to gain broad recognition within mainstream cultural and artistic systems.

On this basis, at the ecosystem and technological levels indicated by Clusters 1 and 3, platforms and developers should shift from a technology-oriented to a user-oriented approach, lowering both the cognitive and operational thresholds for entering the NFT art market and providing integrated solutions tailored to specific application scenarios. In line with the research on value and trading mechanisms in Cluster 2, artists and brand institutions need to strengthen long-term value narratives and cultural meaning-making, attenuate the emphasis on pure speculation, and enhance the legitimacy of NFT art as “artworks” rather than merely “speculative assets.” In the dimension of security and legality emphasized by Cluster 4, regulators and industry organizations should accelerate the development of regulatory guidelines and rules in areas such as copyright, taxation, platform responsibility, and consumer protection. At the same time, pilot projects implemented by museums, art galleries,

public cultural institutions, and tourism organizations can provide both institutional and symbolic "mainstream endorsement" for NFT art, thereby narrowing the legitimacy perception gap between early adopters and the early majority. Experiences from other sectors that have successfully crossed the chasm may also offer valuable reference points for understanding the mechanisms of stagnation and potential breakthrough paths in NFT art. For example, in the field of new energy vehicles, it was only after charging networks were gradually improved and vehicle range and prices reached an "acceptable" threshold that the early majority began to adopt them on a large scale [36], [44]. In the evolution of peer-to-peer accommodation platforms, the provision of a "whole product" (including integrated payment experiences, dispute resolution mechanisms, and rating and guarantee systems), alongside clear regulatory guidance, has been crucial for gaining the trust of ordinary users and enabling diffusion from early adopters to the early majority [35] Such coordinated efforts across technological, market, institutional, and cultural dimensions together constitute the key pathways for NFT art to cross the chasm and achieve sustainable diffusion.

In light of the above, future research should undertake more systematic theoretical inquiries into both the reasons why NFT art has entered the chasm and the mechanisms through which this chasm might be effectively bridged.

First, future research should focus on understanding why the NFT art market may currently be stalled in the chasm. Longitudinal analysis of market trends from 2021 to 2024 should be combined with both internal and external environmental factors to ascertain whether the market has shifted from a boom period to a relatively stable low point. In addition to this, the process of bestowing the value of NFT art should be examined. Prior studies have argued that artists create new art forms through new technologies, and while promoting innovation in artistic value, commercial value is realized through sales, pointing out that in market transactions, the popularity of creators and the will of the audience become important factors in determining the value of NFT artworks [3], [25]. However, due to the inherent uncertainty in the value of art, the valuation of artworks is based on the collective actions of a variety of intermediaries such as curators, artists, auction houses, critics, collectors, and platform stakeholders [67]. Thus, the connotation and extension of the value of NFT art should be clarified and many factors affecting the establishment of its value should be analyzed. To do so, a study based on interviews is needed to explore the various intermediaries involved in the construction of value and the attribution of legitimacy to NFT art.

Second, research focused on how the NFT art market can overcome the chasm should be conducted. Indeed, in order to overcome the chasm, it is crucial to find the bond that can minimize the gap between the 'early adopters' and the 'early majority' regarding NFT art [30]. Evidence from other technologies and industries suggests that crossing the chasm often depends on the combined of "bridging groups" and "bridging mechanisms" as exemplified by policy incentives and infrastructure "first movers" in the case of new energy vehicles [44]. To this end, segments that can pass on the willingness of 'early adopters' to accept are sought. Through the use of big data, key segments that share common characteristics between 'early adopters' and potential 'early majority' are identified, and empirical methods such as questionnaires and in-depth interviews are employed to deepen the analysis of their value orientations, psychological motivations, and consumption behaviors, thereby uncovering common characteristics.

The main limitations of this study can be summarized as follows. First, the NFT art ecosystem itself remains underdeveloped: market mechanisms, legal and regulatory frameworks, and academic research are still at an early stage, and cross-disciplinary integration is insufficient, which constrains a comprehensive understanding of the systemic characteristics of NFT art. Second, there are limitations related to data sources and the analytical framework. The study relies on a single database (Scopus), which may result in the omission of relevant literature. Also, the search strategy is based on specific keywords, which may affect the completeness of literature coverage; and the analysis is primarily grounded in the TALC framework, with relatively limited discussion of other influential factors such as institutional, cultural, political, and economic dimensions. Third, the empirical analysis is concentrated on the OpenSea platform. This reliance on a single platform entails the risk of bias, and caution is therefore required when generalizing the findings to the broader NFT art ecosystem or to other types of platforms (such as Blur). Consequently, future research should undertake more comprehensive comparisons and analyses based on multi-platform data to enhance the generalizability of the results.

Overall, by integrating the thematic research network on NFT art with its market diffusion trajectory and interpreting these patterns within the TALC and chasm theoretical framework, this article demonstrates that NFT art is currently situated in the chasm between early adopters and the early majority, with both scholarly

attention and market performance exhibiting a pronounced early-market bias. Only through simultaneous efforts across multiple dimensions—such as technological usability, value rationality, institutional legitimacy, and cultural recognition—can NFT art realistically hope to cross the chasm and achieve a transformation from a short-term speculative hotspot to a sustainable artistic ecosystem and a form of mainstream cultural practice. This finding not only provides systematic theoretical evidence for understanding the current developmental stage of NFT art, but also offers targeted theoretical and practical insights for subsequent research, as well as for policymakers, platform operators, and art practitioners. Such efforts can help to systematically identify and address key issues in the development of NFT art, strengthen the link between theory and practice, and thereby contribute to the sustainable evolution of the NFT art field.

Conflicts of Interest: The authors declare no conflict of interest.

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