


Review

# Not So New Kid on the Block: Accounting and Valuation Aspects of Non-Fungible Tokens (NFTs)

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**Abstract:** Aggregated trading volume in February 2023 across the leading six NFT marketplaces totalled USD 1.89 billion. This reflects a continuing positive trajectory, marked by a 91.9% month-on-month (MoM) growth from January 2023, where NFT trading volume amounted to USD 987.9 million. This study conducts a systematic review and textual analysis of industry and academic articles on NFTs primarily related to Accounting, Finance, and Information Systems where the NFT is treated as a tradable digital asset. The sample period spans 2012 to 30 June 2023, using an initial set of 5549 and a final set of 146 articles. In addition, the authors develop an NFT valuation framework, using Scopus bibliometrics data and public domain materials, that can aid in the fair valuation of NFTs and understanding their accounting implications. We further examine the accounting implications of NFTs in terms of international accounting standards, fair value recognition, taxation, auditing, and the metaverse. NFTs have the potential to become a cross-technology and cross-field topic, attracting interest from auditors, accountants, financial institutions, accounting professional bodies, regulators, governments, and investors.

**Keywords:** blockchain; tokens; accounting; non-fungible tokens; NFT; digital assets; smart contracts; collectibles; metaverse



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## 1. Introduction

The finance and accounting landscape has witnessed significant technological developments in the past decade (Yermack 2017; Bellucci and Manetti 2017; Locke et al. 2018; Troshani et al. 2019; Jayasuriya and Sims 2020, 2021, 2023).

Non-fungible tokens (NFTs), which began to be used in 2014, are an example of one such development (McCoy 2022). An NFT, for the purpose of this article, is a digital asset linked to physical or intangible property, such as music, art (Benson 2021a, 2021b), video, games, real or virtual land, or even a tweet. Of particular note, the nascent platform, Blur, took a substantial lead by contributing 56.8% of the total trading volume of NFTs in February 2023 (Wong 2017; Cryptokitties Team 2021; NonFungible 2021; OpenSea Developer Documentation 2021; Sako et al. 2021; Serada 2021; Serada et al. 2021). This is equivalent to USD1.1 billion, thereby surpassing OpenSea's USD 691.3 million trading volume during the same period, and securing a dominant market share of 36.5% (Reyburn 2021; Riegelhaupt 2021; CoinGecko 2023). This sustained pattern of growth over four months, commencing from November 2022, suggests a resurgent NFT market (CoinGecko 2023). The rise of NFTs has significant implications for accounting and financial markets, and further research is needed to fully understand their impact (Xie and Muralidharan 2023; Abbott 2023). NFTs, however, are considerably broader than digital assets that are traded. NFTs can and are being used for a broad range of uses in many areas. Examples include digital identity (Bellagarda and Abu-Mahfouz 2022; Mentzer et al. 2022), medical health records (Tanwar and Thakur 2023), and their use to combat counterfeit pharmaceutical

drugs (Turki et al. 2023) and food (dos Santos et al. 2021). This article does not look at the wider use of NFTs.

The existing literature on NFTs focuses primarily on technical aspects such as blockchain-based protocols desired properties (Bongini et al. 2022), as well as legal aspects such as copyright (TFL 2022) or applications in the marketing (Beqiri et al. 2022; Hofstetter et al. 2022; Cheah and Shimul 2023; Chohan and Paschen 2023), art, property, health and fashion industries. In this paper, firstly, we conduct a systematic review of prior literature on NFTs related to accounting, finance, and information systems from 2012 to 30 June 2023. Some studies not included in the systematic review analysis are referenced in the article due to their relevance in accounting, finance (Campino et al. 2021), and systematic reviews. Secondly, we focus on the accounting aspects of NFTs, identifying key NFT valuation factors, existing accounting standards and regulations (Jabotinsky 2020; Zhang 2023), and potential amendments for the future. We identify the implications of NFTs on various accounting functions, including valuation (Cheung and Keung 2022), taxation (CT Corporation Staff 2023), and auditing (Andon et al. 2015). Additionally, we examine the accounting practices related to NFTs, investigating the challenges and opportunities they present for accounting and accountability and links to the metaverse (Bojic 2022; Yoo et al. 2023).

The key findings include the following. There is limited research specifically focused on NFTs and accounting, highlighting the need for further investigation in this area. The publication trends indicate a surge in articles related to NFTs post-2021. Journals such as *Finance Research Letters*, *Journal of Business Research*, *Journal of Risk and Financial Management*, and *Research in International Business and Finance* emerge as the top publishing journals in our sample. The analysis of authorship distribution shows a prevalence of single and two authors. Geographically, Europe and North America unsurprisingly lead in terms of the number of publications. Textual analysis using word cloud, PCA (Xu et al. 2019), and t-SNE techniques identifies key themes such as NFTs, metaverse, blockchain, markets, value, and digital, shedding light on the primary research focus and trends in the field. The results of this study contribute to the understanding of the current state of NFT research and the development of an NFT valuation framework for accounting and provide valuable insights for future investigations.

This article is structured as follows. Section 2 provides an in-depth exploration of NFTs, highlighting their unique features and technological foundations. Section 3 reviews extant NFT literature, delineating key themes, debates, and gaps in the current body of research. Section 4 explains the study's methodology, including data collection, analysis tools, and rationale. Section 5 presents a detailed analysis of the findings, offering insights into prevailing trends and perspectives on NFTs. Section 6 discusses the complexities of NFTs within the accounting context, addressing recognition, measurement, auditing, and reporting considerations. Section 7 introduces a novel NFT valuation framework, detailing factors contributing to their perceived value. Finally, Section 8 concludes by summarizing the study's contributions and implications for academia, industry, and policy-making and suggesting future research directions in the evolving field of NFTs.

## 2. NFT Background

Table 1 provides a comprehensive and structured summary of the key features and considerations related to NFTs, serving as a valuable resource for understanding this emerging digital asset class (Kelly 2022; Abbott et al. 2022). A complicating factor is that NFTs are not a homogeneous group: in one respect, NFTs mirror the traditional art and collectible fields. In this study, the majority of NFTs are akin to a traditional artist who creates an artwork and sells it, whether that is a one-off art piece or a limited edition (Christensen et al. 2018). In contrast, the other NFTs are similar to collectibles issued by an organization; the organization decides what and how many collectibles it creates and sells.

**Table 1.** Key factors about (digital asset) NFTs.

Key Areas	Description
What is an NFT?	<ul style="list-style-type: none"> <li>-Digital assets built on blockchain platforms (including Ethereum), typically using Ethereum's ERC-721 or ERC-1155 standards (Subramanian 2020; 101 Blockchains 2021; Gunay and Kaskaloglu 2022).</li> <li>-Unique tokens that cannot be exchanged like-for-like (non-fungible).</li> <li>-Contain metadata that defines the NFT's characteristics and provenance (Zhang 2023).</li> <li>-Metadata includes attributes like title, creator, description, and links to the associated media file (Guidi and Michienzi 2023).</li> <li>-Can be bought and sold (like regular art).</li> <li>-Derives value from market demand, similar to one-off or limited-edition physical objects.</li> </ul>
How do NFTs work?	<ul style="list-style-type: none"> <li>-NFT creation, known as "minting," involves embedding digital assets (e.g., art, music) into tokens on the blockchain.</li> <li>-The minting process assigns unique metadata and attributes to each token and serves as a unique identifier for digital artworks (often does not contain the actual digital files).</li> <li>-Implemented as individual tokens on the, say, Ethereum blockchain, with off-chain components.</li> <li>-Information such as the owner's public address, often pointing to the off-chain storage location of the artwork, is stored on the blockchain.</li> <li>-Currently rare, some NFTs allow multiple owners (fractional ownership).</li> </ul>
Who can make an NFT?	<ul style="list-style-type: none"> <li>-Depends; for some NFTs, anyone can create an NFT through 'minting' on a blockchain (The Writer's Lounge 2021); for others, such as NBA Top Shots, the NFTs are created and issued by a central organization.</li> <li>-Copyright issues may arise if someone uses another's work without permission (Schmalfeld 2021).</li> <li>-Minting NFTs on Ethereum incurs a 'gas fee', and platforms may charge additional transaction fees, making it expensive for buyers and sellers (Chambers 2021; Michel 2023).</li> </ul>
Purchasing NFTs, rights, and ownership	<ul style="list-style-type: none"> <li>-Purchasing NFTs normally requires a cryptocurrency wallet with sufficient funds (Sham et al. 2023).</li> <li>-As with physical art, purchasers do not automatically obtain copyright ownership or exclusive access to the digital collectible (Async Art 2020; Munoz 2021; OpenSea 2021).</li> <li>-Holder of the private key normally controls the NFT, although possessing the private key does not guarantee ownership.</li> <li>-The creator of an NFT can continue to exert control over the NFT; for example, an NFT can be coded to have a finite life. Many NFTs are considered property, but this depends on the NFT (e.g., NBA Top Shots (collectible NFTs) are licenses).</li> <li>-It may be possible to recover lost or stolen NFTs.</li> <li>-Factors influencing NFT purchases include supporting content creators, investment diversification (Williams 2022), and asserting verifiable ownership of digital assets (Unique Network 2023; Batty 2009; Beckett 2022)</li> </ul>
Valuation of NFTs	<ul style="list-style-type: none"> <li>-Valuation can be based on market comparison, artistic value, historical significance, or utility value.</li> <li>-Market comparison involves comparing recently sold similar NFTs (Nadini et al. 2021).</li> <li>-Artistic value considers the skill and uniqueness of the artwork.</li> <li>-Historical value accounts for the significance of the NFT.</li> <li>-Utility value assesses the NFT's practical application.</li> </ul>
Risks of NFTs	<ul style="list-style-type: none"> <li>-Risks include copyright infringement, storage and security concerns, energy consumption, and environmental impact (Vranken 2017; Calma 2021; Visram 2021; Lambert et al. 2022; Schaar and Kampakis 2022).</li> <li>-Using third-party custodians carries risks as the NFT owner cannot control the NFT (e.g., the custodian can be hacked or abscond with the NFT).</li> <li>-The digital art for a digital art NFT can disappear if the off-chain file is deleted (can be mitigated by storing the digital art in another location) (Whitaker 2019; Colella 2022).</li> <li>-Significant loss of value.</li> <li>-Energy consumption of blockchain platforms (Burger and Weinmann 2022). Although Ethereum, the blockchain of main concern, has transitioned to a more energy-efficient blockchain, there are other energy-efficient blockchains and carbon offsets are available (Tepper 2017).</li> </ul>

Table 1. Cont.

Key Areas	Description
Investments in NFTs	<ul style="list-style-type: none"> <li>-NFT investments made through platforms like OpenSea, SuperRare, and NBA Top Shot, using proprietary or non-proprietary wallets (Chandra 2022).</li> <li>-Investment vehicles like the Metapurse fund offer opportunities to purchase bundles of NFTs.</li> </ul>
Integrity and Authenticity Assurance	<ul style="list-style-type: none"> <li>-Blockchain’s decentralized and immutable nature ensures NFT integrity and authenticity (101 Blockchains 2021; Oguntegbe et al. 2023).</li> <li>-NFTs use cryptographic hashing for metadata storage, ensuring their tamper-proof nature (Evans 2019).</li> <li>-Ownership and transaction history are securely recorded on the blockchain, providing a verifiable ownership trail (Harfoush 2021; Chohan and Paschen 2023; Colicev 2023).</li> </ul>

Table 1 provides a comprehensive overview of the key features and considerations related to NFTs. The table includes a description of the following features: uniqueness, ownership, transferability, scarcity, and immutability.

The surge in global interest, significant investments, and rising prices (Emergen Research 2022; Schaar and Kampakis 2022) positioned NFTs as a top asset class in 2021/2022, according to Google Trends. Figure 1 shows the Google Trends search volume index for the keywords “NFTs” and “non-fungible tokens” and their geographic dispersion.

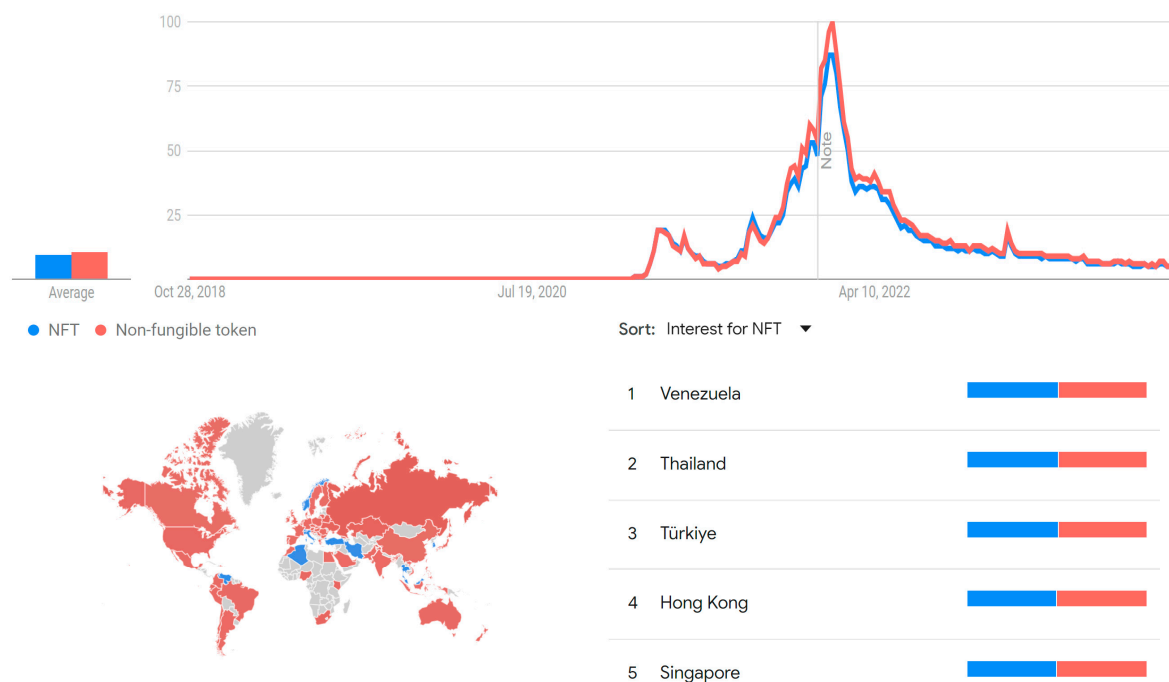


Figure 1. Google trends search volume for NFTs (2012 to 2023).

Figure 1 presents the Google Trends search volume index for the keywords “NFTs” and “non-fungible tokens” across different geographic regions. The figure shows the relative search interest for these keywords over time, from 2018 to 2023. The geographic dispersion of search interest is also illustrated, with regions of high and low interest highlighted.

### 3. Literature Review

There is limited research on the financial/accounting aspects of NFTs. This study provides a significant contribution to the growing body of literature on digital assets, cryptocurrencies, and fintech developments in finance (Howell et al. 2020), accounting, information systems, and commercial law.

In the realm of cryptocurrencies and blockchain, [Harvey \(2016\)](#), [Yermack \(2017\)](#), [Cong and He \(2018\)](#), [Jayasuriya and Sims \(2020\)](#), [Lombardi et al. \(2021\)](#), and [Jayasuriya and Sims \(2020, 2021, 2023\)](#) have made notable contributions. Tokens, which serve to represent unique assets, legal rights ([CNBC TV18 2022](#)), and value containers, have been the subject of several studies, including [Tomaino \(2017\)](#). As [Evans \(2014\)](#), [Pilkington \(2016\)](#), [Conley \(2017\)](#) and [Li and Chen \(2023\)](#) explain, cryptocurrencies are those that function as digital currencies, whereas tokens are an integral part of a platform's business model and functionality ([Sugino et al. 2023](#)). In addition, tokenomics refers to the analysis of the demand and supply of cryptocurrencies and tokens and involves pre-set algorithmically created schedules for issuances on a blockchain, providing stability and security for owners ([Hasanova et al. 2019](#); [Benedetti and Nikbakht 2021](#)).

[Nadini et al. \(2021\)](#) provide a comprehensive mapping of the NFT ecosystem, analyzing sales, traded volume, and relevant characteristics across different projects and stakeholders. [Dowling \(2021b\)](#) focuses on the pricing behaviour of a specific NFT project, Decentraland, which facilitates the trading of digital land plots in a blockchain-based multiverse ([Pilkington 2016](#); [Grant 2017](#)). In another study, [Dowling \(2021a\)](#) employs wavelet coherence analysis to investigate the co-movement between cryptocurrency and NFT markets ([Kireyev and Evans 2021](#); [Sundararajan 2022](#)), examining major NFT submarkets (Decentraland, CryptoPunks, and AxieInfinity) along with Bitcoin and Ether prices ([Atomic Market Team 2021](#); [Larva Labs Team 2021](#); [Aysan et al. 2023](#); [Royal and Beers 2023](#)).

#### 4. Research Design

This section details the methodology used in conducting a systematic review of the literature on Non-Fungible Tokens (NFTs). Given the wide and diverse literature on blockchain adoption, the study aims to consolidate knowledge and extract studies relevant to NFTs in the fields of accounting, finance, and information systems, drawing from both academic and industry sources.

Following guidelines from [Kaplan \(1998\)](#), [Moher et al. \(2009\)](#), [Briner and Denyer \(2012\)](#) and [Hoque et al. \(2017\)](#), we first clarify the review's objectives and formulate research questions. Next, we conduct a systematic search and review of relevant literature from academic and industry sources, applying quality assessment measures to ensure the selected articles' reliability and validity. We then perform a comprehensive analysis of the reviewed literature, constructing a final sample of articles meeting the study's inclusion criteria. Lastly, we identify key factors, gaps, trends, and similarities in both academic and industry literature and develop an NFT valuation framework. Based on an extensive Scopus search that initially yielded 5549 records, we construct a final sample of 146 articles (128 academic and 18 industry) for analysis.

##### 4.1. Research Question Development

This study explores the potential applications ([Mofokeng and Matima 2018](#); [Nobanee and Ellili 2022](#); [Mohammadi et al. 2023](#); [Kraizberg 2023](#)) of Non-Fungible Tokens (NFTs) in the accounting field and its intersection with finance ([Lee and Parlour 2022](#)), information systems, and commercial law. The multidisciplinary approach is essential as accountants work in various industries, and a nuanced understanding of blockchain adoption is required ([Behl et al. 2023](#)). Despite considerable attention, gaps remain in the areas of taxation ([Calvin 2019](#)), crypto-asset and liability treatment ([Harwick 2016](#)), triple-entry bookkeeping, and auditing procedures ([Appelbaum and Nehmer 2020](#)), particularly regarding NFTs. This systematic review addresses these gaps and aggregates knowledge from multiple databases, leveraging prior academic and industry literature across various industries. The research questions are:

- RQ1: What are the key factors influencing NFT valuation according to prior industry and academic literature?



This question identifies factors affecting NFT valuation based on academic and industry literature in accounting and finance, linking these factors to applications in financial reporting, auditing, and taxation.

- RQ2: What are the similarities, differences, and gaps in prior academic and industry accounting literature on NFTs?

This question aims to identify well-explored areas and gaps within both academic and industry literature on NFTs. Identifying such gaps could have significant regulatory and accounting implications, given the prevalent cyber hacks, fraudulent activities (Bellagarda and Abu-Mahfouz 2022), and regulatory scrutiny in this domain. This study's findings will provide valuable insights for accountants, auditors, and consultants advising organizations managing digital assets, NFTs, and tokens.

- RQ3: What roles do regulators, professional bodies, and amendments to existing accounting standards play regarding digital tokens and NFTs?

This question examines the role of accounting standard-setting in new domains, such as digital tokens and NFTs, and relevant challenges, along with the role of professional accounting bodies in NFTs.

#### 4.2. Article Aggregation

This section describes the systematic review methodology. Scopus was chosen as the primary database for its expansive collection of articles across disciplines. An initial set of keywords and search criteria were devised for the literature search. Iteratively, the search criteria were refined based on the collected articles, resulting in a more targeted and precise search. After constructing the final sample of literature, a systematic categorization was conducted to identify the main themes and domains in the included articles. The article search included various permutations of keywords like “non-fungible tokens”, “NFT”, “coloured coin”, “unique token”, “crypto kitties”, and “unique coin”. Additionally, a thorough examination of reference sections in selected review articles was conducted to incorporate relevant articles, including industry articles, into the final sample.

#### 4.3. Construction of Final Sample

The final sample of academic articles comprises peer-reviewed works from highly-regarded journals and conference proceedings. Industry articles were sourced from reputable trade journals, consulting reports, and publications from professional bodies. To analyze the bibliometric and content attributes of the articles, we used VOSviewer, Python scripts, and NVivo software. For an in-depth description of the systematic review criteria and screening process, please see Table 2.

**Table 2.** Systematic Review Selection Criteria.

Criteria	Description
Source	Scopus
Field	Business, Management and Accounting and Social Sciences
Literature Typology	Research Articles and Reviews, Industry Technical/Consulting reports
Literature Language	English
Period	2012–30 June 2023

Table 2. Cont.

Criteria	Description
Primary Keywords	“NFT”
	“coloured coin”
	“non-fungible tokens”
	“unique coin”
	“unique token”
	“crypto kitties”
1st screening	Article title, abstract, key words
2nd screening	Bibliometric analysis and text mining, content analysis.

Table 2 provides a detailed description of the inclusion and exclusion criteria used to select articles for this systematic review. The table also specifies the screening process used to identify eligible articles.

Initially, we searched Scopus using various permutations of the primary keywords mentioned earlier, yielding an initial pool of 5547 academic and industry articles from 2012 to 31 July 2023. We then applied our inclusion and exclusion criteria, excluding 2604 non-English articles, books, unpublished conference or working papers, and other references (e.g., short notes, media articles), reducing the count to 2943 articles. Next, we removed 44 duplicates, highly technical articles, and articles not pertinent to accounting, business, or finance, leaving a final sample of 146 articles.

## 5. Systematic Review Results

This section uses the findings from the systematic review to offer additional insights into addressing Research Question 2. Below, the detailed systematic review identifies the following implications: 1. Literature Scarcity: Despite 128 academic articles and 18 industry reports in the final sample, there is a noticeable gap in the literature specific to NFTs and accounting, indicating a need for further research (Bao and Roubaud 2022). 2. Growing Interest: The increasing number of publications on NFTs, suggests growing interest in this field, likely spurred by high-profile sales of expensive NFTs. 3. Predominant Journals: Top journals publishing on this topic include *Finance Research Letters*, *Journal of Business Research*, and *Journal of Risk and Financial Management*. These can be primary sources for further research. 4. Authorship Patterns: Most articles are authored by one or two individuals, with 80% of the sample comprising articles authored by three or fewer individuals, as depicted in Figure 2. There is potential for more multi-author collaboration. 5. Geographic Distribution: The majority of publications originate from North America and Europe, suggesting potential for further research in other regions.

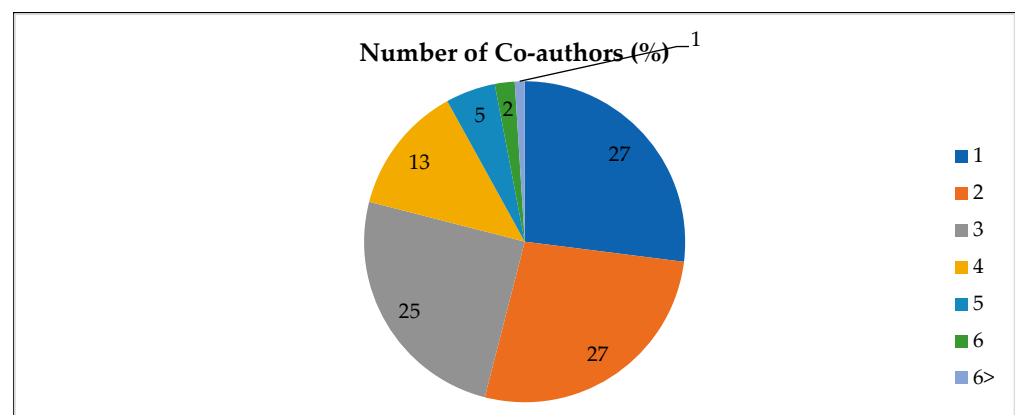


Figure 2. Co-author counts.

In summary, the field of NFTs and accounting is in its infancy, but it is growing. More comprehensive research is needed, particularly in regions outside North America and Europe, to understand the implications of NFTs on accounting standards and practices.

### 5.1. Bibliometric Analysis

Table 3 provides more categorization of the articles in our final sample, of which 146 articles highlight the limited literature specific to NFTs and accounting. As shown in Table 3, our final total sample includes 128 academic articles and 18 industry reports, with an average number of 2.55 articles per scholar and 1309 total citations. Table 4 shows the publication trends beginning in 2012, including annual citations. The highest article counts are in 2022, with 48, and 44 to 30 June 2023. The increase in articles could be due to sales of increasingly expensive NFTs such as Dragon and Founder Cat, which sold for USD 170,000 and 110,000, respectively (Nguyen 2018), setting the stage for more development in NFTs.

**Table 3.** Final sample article categorizations.

Key Statistics	Final Sample Observations
<b>Article Types</b>	
Academics	128
Industry	18
Average number of scholars per article	2.55
Year	2012–30 June 2023
Overall Citations	1309
<b>Geographic Regions</b>	
Australasia	4
Europe	63
North America	36
Asia	8
Middle East	1
Not specified	21
<b>Primary Key Words</b>	
NFT	80
coloured coin	2
unique token	13
unique coin	14
non-fungible tokens	35
crypto kitties	2

**Table 4.** Annual article and citation dispersion.

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023 June
Number of articles	0	2	1	3	0	5	3	7	8	25	48	44
Citations	0	4	7	15	15	23	40	76	110	130	306	358

Table 3 summarizes the final sample of articles included in this study. The articles are categorized into four categories: NFTs and accounting, NFTs and taxation, NFTs and auditing, and NFTs and financial reporting. The number of articles in each category is also presented.



Table 4 presents the annual publication trends and citation counts for articles on NFTs from 2012 to 30 June 2023.

Table 5 depicts the top four publication sources: *Finance Research Letters* (5 articles), *Journal of Business Research* (5 articles), *Journal of Risk and Financial Management* (4 articles), and *Research in International Business and Finance* (4 articles).

**Table 5.** Top publishing journals.

Journals	Article Count
Finance Research Letters	5
Journal of Business Research	5
Journal of Risk and Financial Management	4
Research in International Business and Finance	4

Table 5 presents the top four most prolific publication sources for articles related to the topic of NFTs and finance.

Figure 2 illustrates the distribution of authorship in the analysed articles. The most prevalent configuration is single and two collaborating authors, representing 27% of articles. Next are three-authored articles (25%), followed by articles co-authored by four individuals (13%). Nearly 80% of our sample comprises articles with three authors or fewer. Table 6 provides the geographic dispersion of the publications. Continent-wise, North America (36) and Europe (63) dominate.

**Table 6.** Geographic Article Dispersion.

Region	Unique Journal Count	Article Count
Australasia/Oceania	4	4
Europe	41	63
North America	32	36
Asia	8	8
Middle East + Not Specified	16	35

Figure 2 provides a visual representation of the authorship patterns in NFT research.

Table 6 presents the geographic distribution of publications on NFTs, categorized by continent.

## 5.2. Textual Analysis

This section elucidates the primary research themes that emerged from our analysis. We used NVivo, VOS viewer for bibliometric analysis, and t-distributed Stochastic Neighbour Embedding (t-SNE) and principal component analysis (PCA) for machine learning-based textual analysis. Firstly, we delineated overarching themes of significant popularity encompassing both industry and academia, drawing upon the word cloud analysis and a meticulous examination of our article database sourced from Scopus.

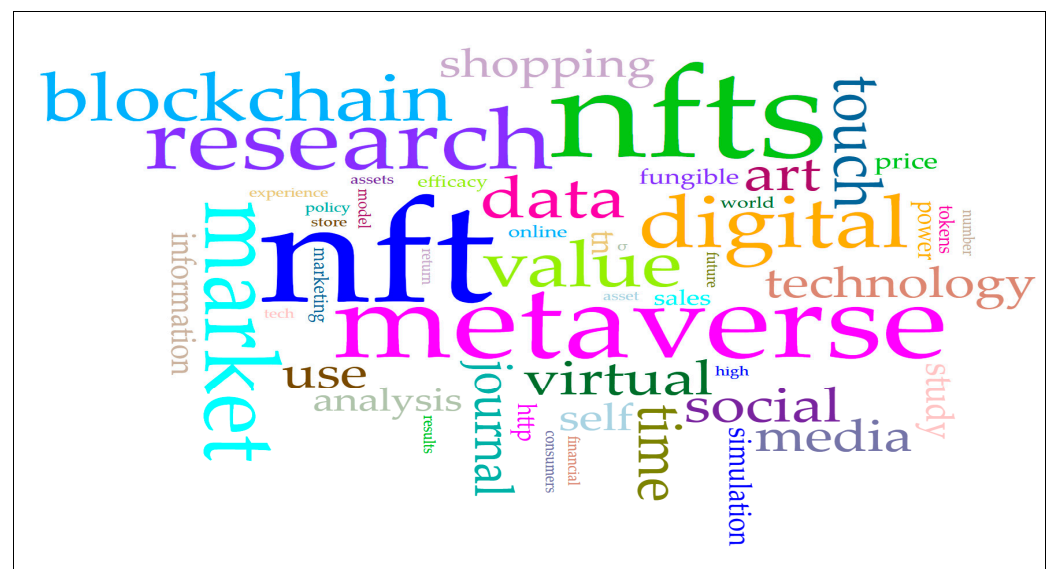
The textual analysis of the literature on NFTs and accounting below used several methods, including word cloud analysis, t-distributed Stochastic Neighbour Embedding (t-SNE), and Principal Component Analysis (PCA). In the word cloud analysis, the predominant terms included nft, nfts, metaverse, blockchain, market, digital, research, touch, media, value, and data. This suggests a concentration on the technical attributes and value implications of NFTs in the existing literature. The t-SNE results identified four prominent word clusters: NFTs, metaverse, digital, and blockchain, which indicate the primary areas of focus in NFT research. PCA revealed patterns and relationships among words in the textual data, signifying the key trends in the literature. The analysis, thus, demonstrated that

research on NFTs encompasses multiple themes, with a particular emphasis on technical characteristics and valuation issues.

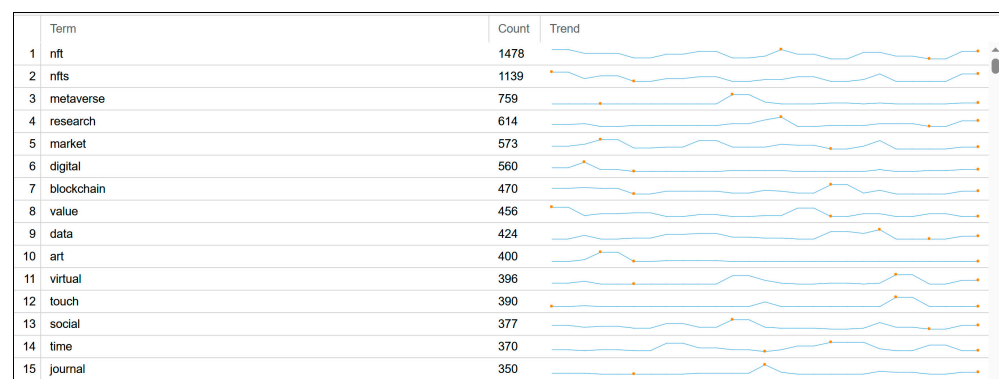
The implications of these findings for accounting and NFTs are manifold. The diverse themes revealed by the analysis necessitate that accountants have a broad understanding of NFTs and their associated technologies. The emphasis on terms such as blockchain and digital in the literature indicates a substantial focus on the technical aspects of NFTs, implying that accountants need to acquire and maintain relevant technical skills. The inclusion of the term 'value' suggests that the valuation of NFTs is a significant concern in the literature, underscoring the importance for accountants to stay abreast of current valuation methodologies. Moreover, the varied themes detected in the analysis underscore the importance of a multidisciplinary approach in addressing NFT-related issues, calling for collaboration between accountants and professionals from other disciplines. In sum, the results of this analysis indicate that NFT research spans multiple domains, with a strong emphasis on technical aspects and valuation concerns. To effectively address the challenges and opportunities posed by NFTs, accountants should strive to develop technical expertise, explore valuation methodologies, and adopt a collaborative, multidisciplinary approach.

### 5.2.1. Word Cloud and Frequencies

A word cloud arranges terms based on their frequency, with the most common terms centrally positioned and larger in size. The algorithm aims to place words closer to the visualization centre and may incorporate smaller words into spaces created by larger words. However, it is crucial to note that word colour and absolute positioning lack significance in this context. One should exercise caution when interpreting word clouds, as they fail to capture co-occurrences and potential variations in meaning. Figures 3 and 4 depict the word cloud and the top 15-word frequencies and trends. In the word cloud presented in Figure 3, the prominent terms include nft, nfts, metaverse, blockchain, market, digital, research, touch, media, value, and data. These term preferences are substantiated by the data illustrated in Figure 4. In Figure 4, the first keywords appear at a higher frequency than the other words; thus, the fifteen words demonstrate an order of importance. The trend lines in Figure 4 show the distribution of relative frequencies across documents in our sample.



**Figure 3.** Article sample word cloud.



**Figure 4.** Article sample top 15-word frequencies.

Figure 3 presents a word cloud visualization of key terms from the analyzed final sample of articles on NFTs. The word cloud highlights the most salient concepts and thematic areas in NFT research, providing a quick overview of the key issues being explored in this field.

Figure 4 provides a graphical representation of the keyword frequency distribution in NFT research. The figure demonstrates the relative importance of different keywords by plotting their frequency of occurrence in the analyzed articles. The trend lines illustrate the distribution of relative frequencies across the documents, revealing patterns of keyword usage across different studies. The figure also provides insights into the temporal dynamics of keyword usage, highlighting the emergence of new keywords and the evolution of research interests over time.

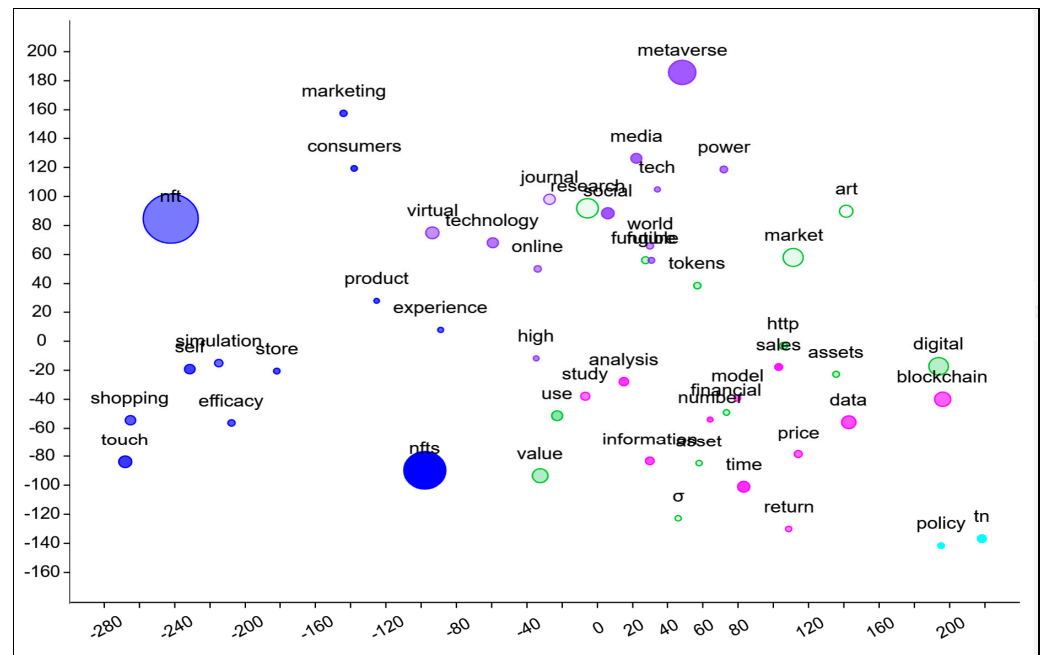
#### 5.2.2. PCA and t-SNE

Secondly, we employ Principal Component Analysis (PCA) and t-Distributed Stochastic Neighbour Embedding (t-SNE) as unsupervised machine learning methodologies for textual word classification. PCA (Jolliffe 1986) serves as a linear technique for reducing the dimensionality of a dataset by selecting the most significant features while preserving critical information.

#### 5.2.3. t-SNE

The t-distributed Stochastic Neighbour Embedding (t-SNE) technique, devised by Van Der Maaten and Hinton in 2008, is renowned for its effectiveness in analyzing high-dimensional datasets, particularly in the realm of qualitative textual data (Van der Maaten and Hinton 2008; Van der Maaten 2014). In t-SNE, colours represent data points (words in this context) belonging to the same cluster, while the size of the points is proportional to the relative occurrence frequency of the words. Points positioned closely within a cluster indicate higher similarity compared to those farther apart. The visualization in Figure 5 offers insights into word clustering and proximity, revealing semantic similarities through the dimensions depicted by the x- and y-axes. Notably, separated clusters suggest groups of words sharing co-occurrences or contextual meanings.

Figure 5 presents a word clustering visualization based on the co-occurrence patterns of five frequently used terms in NFT research. The figure utilizes a dimensionality reduction technique to project the terms into a two-dimensional space, revealing semantic relationships and thematic groupings. The resulting clusters suggest groups of words that are frequently used together in the same contexts, indicating shared meanings or conceptual connections. The spatial proximity of terms within a cluster reflects their degree of co-occurrence, with closely positioned terms indicating stronger semantic associations. The figure also highlights the presence of distinct clusters, suggesting the existence of different thematic areas or sub-fields within NFT research.



**Figure 5.** t-SNE Analysis.

The four colours show the four different clusters, with the bubble sizes depicting the raw and relative frequencies. Similar to the word cloud analysis, the blue cluster shows NFTs, the purple cluster shows metaverse, the green cluster identifies digital, and the pink cluster shows blockchain and related keywords.

#### 5.2.4. PCA

With regard to PCA, each principal component is a linear combination of the original features (words) and captures the most significant patterns or variations in the data. Words positioned closer along the  $x$ -axis or  $y$ -axis tend to have higher positive or negative loadings for the corresponding principal component. The relative positions of words along the  $x$ -axis and  $y$ -axis indicate their relationships based on the identified patterns in the textual data. The percentage values associated with each principal component indicate the proportion of variance explained by that component. For example, if the first principal component explains 35% of the variance approximately, it means that 35% of the total variability in the word in Scopus is captured by this component, as observed in Figure 6. We have removed the term labels to prevent them from overlapping with each other for the three main clusters.

The green cluster encompasses NFT-related terms, such as “NFT”, “NFTs”, “NFT art”, and “NFT marketplace”. The blue cluster comprises terms associated with blockchain technology, research methodology, and the metaverse, including “blockchain”, “research”, “smart contract”, and “metaverse”. The pink cluster contains terms related to the value, digitality, and marketing of NFTs, such as “value”, “digital”, “ownership”, and “marketing”. The relative positions of terms within each cluster indicate their semantic proximity, with closely positioned terms having stronger conceptual links. The figure provides valuable insights into the organization of knowledge in NFT research, highlighting the key thematic areas and conceptual relationships.

Figure 6 provides a visual representation of the underlying structure in the word embedding space of NFT research. The PCA plot reveals three distinct clusters of terms, each representing a different conceptual domain.

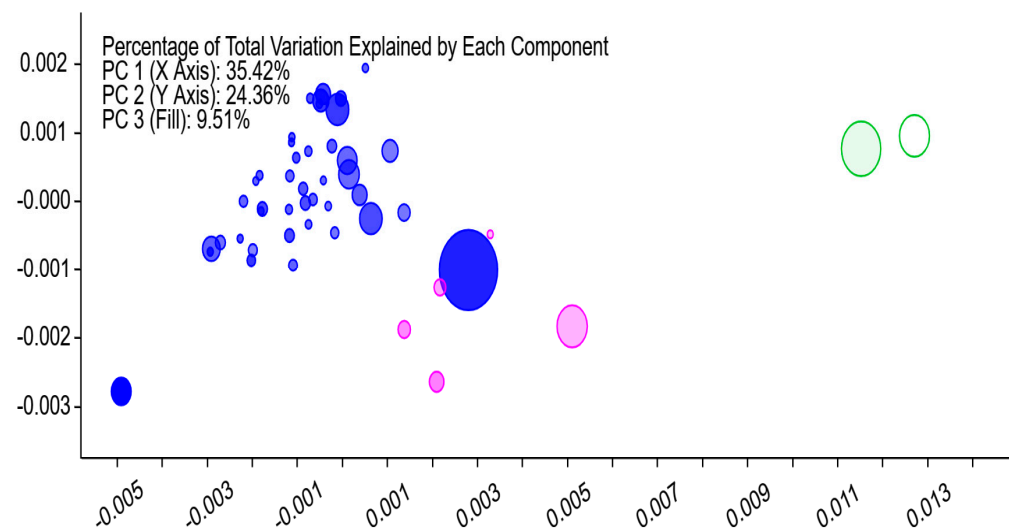


Figure 6. PCA Analysis.

## 6. NFT Valuation Framework

The advent of non-fungible tokens (NFTs) necessitates a bespoke valuation framework (Gryglewicz et al. 2021; Powers 2021; Umar et al. 2022, 2023) to tackle the unique challenges posed by these digital assets (Jung 2022). Traditional valuation methodologies, grounded in art market principles (Renneboog and Spaenjers 2013; Barabási 2021), may prove inadequate due to the intricacies and singularity of NFTs (Ben Luke and Stoilas 2021; Pietroni 2022). Drawing on both academic and industry literature, we have assembled an array of factors integral to the valuation of NFTs. Central to the valuation of NFTs is the recognition of their claims on underlying tangible or intangible assets, which should be manifest in their valuation (Associated Press 2022; Sheldon 2022; Patairy 2022). This accentuates the need for an overhaul of accounting standards for digital assets related to cryptocurrency, as the current framework does not accommodate NFTs. As a result, the accounting treatment of NFTs remains in flux, with organizations potentially adopting disparate approaches depending on their unique circumstances (Smith 2023).

In spite of these challenges, NFTs offer substantial promise as investment assets within the digital and crypto-economy (Wang et al. 2021; Wilson et al. 2022; BlockchainHub 2017; Conley 2017) as well as for traditional portfolio investing (Ko et al. 2022). Distinctive features of NFTs, such as authenticity and scarcity, contribute to their value (Cheung and Keung 2022). However, investors should remain vigilant regarding potential shifts in economic conditions and alterations in taxation laws (Chaisse 2022; Brooks 2023). To confront these valuation challenges, we advocate for a holistic NFT valuation framework that encompasses value drivers such as authenticity and scarcity. This framework provides a structured approach for the determination of the fair value of NFTs, offering invaluable insights for investors and entities engaged in NFT investment (Kong and Lin 2021) and accounting.

### 6.1. NFT Valuation—Seven Factor Frameworks

$$\text{NFT Price}_t = a_i + b1i\text{Utility}_t + b2i\text{Provenance}_t + b3i\text{Future Value}_t + b4i\text{Scarcity factor}_t + b5i\text{Quality factor}_t + b6i\text{Liquidity Premium}_t + b7i\text{cryptocurrency price factor}_t \quad (1)$$

The preceding Equation (1) specifies the diverse potential for value creation inherent in NFTs and can be employed by NFT developers to identify strategies for enhancing value and by investors to assess the investment worthiness of a given NFT (Harrison 2021). Seven distinct factors inform the equation. The weighting of each factor can be different.

### 6.2. Utility Factor

The utility factor of NFTs is derived from their intended use and investment appeal (Klein et al. 2023). Factors such as hedonic satisfaction and rarity contribute to driving prices higher (Hayward 2022). Achieving NFT interoperability and establishing partnerships with other enterprises can enhance the utility factor and provide a broader range of use cases and benefits for NFT investors.

### 6.3. Provenance Factor

The ownership history and the identity of the current owner impact the value of an NFT. Collaborating with prominent individuals or established brands in issuing NFTs can increase interest and expand the user base. NFT markets and sellers can provide tracking interfaces to display ownership and trading history (Rosenbaum 2021; Redman 2021; Chalmers et al. 2022), further enhancing the provenance factor (Balthazor 2019).

### 6.4. Future Value Factor

The valuation of an NFT and its future cash flows significantly affect its present value. Speculation-driven demand can lead to sharp price surges, but including historical price charts and information on value appreciation and buy/sell (Howcroft 2021) demand percentages can help temper speculation. Future cash flows for NFTs can be derived from royalties, interest, leasing, or collateralization.

### 6.5. Scarcity Factor

The uniqueness and non-reproducibility of NFTs impact their valuation. Limited supply leads to speculative rightward shifts in demand and higher prices. However, prices can still decrease due to economic conditions, investor preferences, or changing expectations.

### 6.6. Quality Factor

The authenticity and quality of the underlying asset influence NFT price variability. High-quality assets linked to NFTs may experience significant price increases during high-demand periods, while lower-quality assets may see greater price differentiation during decreased demand.

### 6.7. Liquidity Premium Factor

ERC standards for NFTs on the Ethereum blockchain facilitate interoperability, cross-platform trading (Patrickson 2021; Aharon and Demir 2022), and improved liquidity risk. NFTs based on other blockchain networks typically exhibit less liquidity and may be sold at a discount (Phillips 2021).

### 6.8. Cryptocurrency Price Factor

While NFTs and cryptocurrencies have distinct characteristics (Hamacher 2021), there is a correlation between cryptocurrency prices and NFT market valuations (Alessandretti et al. 2018). Incorporating a cryptocurrency pricing factor (Fisch 2019; Hicks 2022; Ghosh et al. 2023) into the NFT valuation framework would be appropriate (Lee 2022; Bani-Khalaf and Taspinar 2023).

Overall, the proposed valuation framework considers factors such as utility, provenance, future value, scarcity, quality, liquidity premium, and cryptocurrency prices (Burton and Jacobsen 1999). It provides valuable insights for practitioners, academics, regulators, and investors in understanding and assessing the value of NFTs (Kireyev and Lin 2021; Kong and Lin 2021; Kräussl and Tugnetti 2022; Schaar and Kampakis 2022; Ante 2022a, 2022b; Yilmaz et al. 2023; Alon et al. 2023; Horky et al. 2022; Sharma et al. 2022).



## 7. Accounting Perspectives of NFTs

The proliferation of non-fungible tokens (NFTs) within decentralized finance (DeFi) applications accentuates the growing need for robust accounting, disclosure, and reporting guidelines (Pao et al. 2022; Smith 2023; Taylor 2023). However, formal accounting standards for recognizing and measuring NFTs as assets or liabilities are conspicuously absent in most jurisdictions (Jackson and Luu 2023). Consequently, companies holding NFTs are compelled to rely on existing International Financial Reporting Standards (IFRS), which offer a spectrum of accounting alternatives (Smith 2023; Jackson and Luu 2023). Crafting financial information for digital assets, such as NFTs, is a formidable task, requiring comprehensive knowledge of economic value assessment, blockchain technology (Malik et al. 2023), protocols, and pertinent accounting standards for financial statement preparation and auditing (Alkhudary et al. 2023).

### 7.1. Accounting for NFTs

In striving to attain global comparability of financial statements, the convergence of U.S. Generally Accepted Accounting Principles (U.S. GAAP) and IFRS encounters challenges posed by the unique nature of NFTs. Existing tax, legal, and accounting regulations tend to be technology-neutral, focusing on the economic context of a digital asset transaction rather than the blockchain technology underpinning it (Shanaev et al. 2020; Allen et al. 2020; Gillpatrick et al. 2022). This emphasis is particularly crucial for NFTs, where rights and obligations are tethered to the digital asset (Krol and Zdonek 2023). The International Accounting Standards Board's Conceptual Framework for Financial Reporting, updated in March 2018 (International Accounting Standards Board 2018a, 2018b), should serve as a guidepost for NFT financial reporting. Nevertheless, uncertainties surrounding future cash inflows, resource management efficiency, and transaction volumes render NFT financial reporting a complex endeavour (Bonifazi et al. 2023).

### 7.2. Principle of Substance over Form

The principle of substance over form, a cornerstone of accounting and taxation, dictates that transactions and events should be measured and recognized based on their economic substance rather than their legal form (Financial Accounting Standards Board 2016a, 2016b). Accounting standards codification (ASC) 905-20-25-35. This principle is crucial for recognizing and measuring tax balances for NFTs, with particular consideration for the unique nature of the underlying asset. Thus, commercial balance sheet principles are recommended for NFTs.

### 7.3. Disclosure Requirements, True and Fair Value Reporting Principle

Compliance with the International Financial Reporting Standards (IFRS) presentation guidelines is paramount in accounting. IFRS mandates that financial statements accurately depict a company's financial position, performance, and cash flows (IAS 1.15) through adherence to IFRS (IAS 1.17). However, exceptional circumstances may necessitate deviations from these requirements (IAS 1.19), which must be disclosed (IAS 1.20d). For NFTs, it is essential to ascertain the economic ramifications of transactions, the rights and liabilities linked to the NFT, potential losses upon sale based on the underlying asset, and other pertinent factors (International Accounting Standards Board 2018a, 2018b; Securities and Exchange Commission 2022).

### 7.4. NFT Underlying Asset/Liability Recognition and Derecognition

Assessing the economic substance of an NFT involves evaluating whether the transaction generates new assets/liabilities or alters existing ones, which must be measured with reliable monetary values (Financial Accounting Standards Board 2016a, 2016b). Accounting standards codification (ASC) 985: Impairment of assets. An NFT is derecognized when sold, and all associated rewards and ownership rights to the underlying asset are transferred, with no retained risks by the seller.

### 7.5. Tax Reporting

In contrast to financial reporting and auditing, some tax guidelines (Barrett 2019) exist for digital assets (Allen et al. 2020; Cao 2023) applicable to NFTs (Internal Revenue Service 2014a, 2014b, 2019, 2022a, 2022b, 2022c, 2023a, 2023b). Generally, NFTs are classified as property for tax purposes (Garcia-Teruel and Simón-Moreno 2021), and tax treatment differs for NFT creators, buyers, and sellers. NFT creators incur taxes upon sale, with sales proceeds deemed as ordinary income. NFT buyers and sellers are typically taxed on short-term gains/losses as ordinary income and long-term gains as capital gains. However, the lack of uniform tax regimes for various token types may facilitate cross-border tax structures (Hacker and Thomale 2018; Di Bernardino et al. 2021; European Parliament 2020; Goforth 2023).

### 7.6. Auditing

Auditing NFTs under IFRS and International Accounting Standards (IAS) presents distinctive challenges and opportunities (NonFungible Corporation 2021; American Institute of Certified Public Accountants 2022). Key standards like IFRS 13, IAS 38, and IAS 12 are vital for evaluating the fair value, recognition, and taxation of NFTs. Our NFT valuation approach employs blockchain verification (Laurence 2021; AlMeasam et al. 2023) and comprehensive market price and demand factor analysis, enhancing audit accuracy and reliability.

### 7.7. Metaverse, NFTs, and Accounting

The rise of the metaverse (Hirsch 2022; Joy et al. 2022), a vast virtual realm enabled by augmented and virtual reality technologies, brings new accounting considerations (Goldberg et al. 2021; Besson and Gauttier 2023; Pandey and Gilmour 2023; Sung et al. 2023). NFTs have become essential components within the metaverse, representing and authenticating digital item ownership (Deloitte 2022a, 2022b). These NFTs pose accounting challenges (Ali et al. 2023), including valuation, recognition, taxation, and auditing (International Auditing and Assurance Standards Board 2017; Department of Internal Affairs 2021; Baer et al. 2023). As the metaverse and NFTs continue to evolve, accounting practices must adapt to ensure transparency, accountability, and trust in this digital ecosystem.

## 8. Conclusions

In conclusion, this study offers a holistic analysis of the existing literature on non-fungible tokens (NFTs) and their ramifications for the accounting sector. Our findings highlight a dearth of research explicitly examining the intersection of NFTs and accounting, signalling a need for further exploration in this domain. We observed a surge in interest in NFTs post-2018, as evidenced by publication trends. In examining the accounting facets of NFTs, our study delves into their valuation, taxation, and auditing dimensions, elucidating key determinants, standards, and regulatory considerations relevant to NFT accounting. By illuminating these areas and their implications for the accounting profession (Warren and Parker 2009) and organizations, our study offers a valuable contribution to the evolving discourse on NFTs. Textual analysis of the extant literature uncovers salient themes and trends, affording insights into the predominant research focus within the NFT space. In sum, this research augments our comprehension of the current state of NFT scholarship, advances an accounting-centric NFT valuation framework, and establishes the groundwork for subsequent inquiries in this field.

Moreover, our analysis reveals that NFTs pose distinct challenges for financial reporting (ElBahrawy et al. 2017; ElBahrawy et al. 2019; Devlin 2021; Efendioglu 2022; IRS Tech 2023), auditing, and taxation. Adherence to the principle of substance over form is essential for the precise recognition and measurement of NFTs in financial statements. The guidelines set forth by the International Financial Reporting Standards (IFRS) should be strictly followed, with any deviations from these standards transparently disclosed to preclude misleading representation. Regarding taxation, NFTs are typically classified

as property and taxed as such. However, there is scant guidance on this matter, and the emergence of cross-border tax structures may be inevitable due to the absence of consistent tax regimes for different token varieties (Calvin 2019; McGinnis 2023). Furthermore, the economic substance of NFT transactions should be meticulously assessed to ascertain the creation or alteration of assets/liabilities. Given the unique characteristics of NFTs and their underlying assets, a more comprehensive recognition and measurement approach is imperative for accurate representation. As NFTs continue to gain traction, it is incumbent upon regulators and standard-setting bodies to furnish additional guidance to address the extant uncertainties regarding their treatment in financial reporting and taxation (Huston 2021).

Future research should extend beyond the exploration of NFTs in isolation to investigate their integration within broader digital ecosystems, such as the metaverse. A more granular analysis of the regulatory landscape across different jurisdictions would shed light on the tax implications of NFT transactions and provide valuable insights for cross-border tax planning. Researchers could also explore how NFTs intersect with other innovative technologies, such as decentralized finance (DeFi) and smart contracts, and examine the potential synergies and challenges arising from these intersections. Finally, an interdisciplinary approach to NFT research would be valuable, incorporating perspectives from fields such as economics, law, and sociology to provide a more comprehensive understanding of NFTs and their broader implications.

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