



Prospecting non-fungible tokens in the digital economy: Stakeholders and ecosystem, risk and opportunity



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Abstract Non-fungible tokens (NFTs) are a highly nascent and emerging phenomenon revolutionizing how digital assets are traded. NFTs embody immutable rights to unique digital assets such as digital art and collectibles and are represented as digital tokens that can be traded across marketplaces utilizing blockchain technologies. NFTs engender new ways to organize, consume, move, program, and store digital information and have experienced a rapid rise in various adaptations across art, sports, broadcasting, content creation, and tech-crypto businesses. In this article, we define NFTs and look at how they fit with blockchain and cryptocurrencies, how they are used by various industries, and the opportunities and risks they present. Our key contribution is a conceptual map of an initial NFT ecosystem. In doing so, we provide relational mapping between and among key stakeholders: content creators, core and related technical and business intermediaries, consumers, investors, and speculators. We also highlight implications for managers and tie them to conceptual exploration and exploitation frameworks.

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1. Is it time to start exploring NFTs?

Non-fungible tokens (NFTs) represent a new and novel way for blockchain technology to certify

ownership of and tradeable rights to digital assets (Dowling, 2022a; Jones, 2021). NFTs link to underlying assets that are unique in some way and cannot be exchanged like for like (Bowden & Jones, 2021). As such, NFTs represent an emergent digital phenomenon that involves innovative ways of tethering content creation to blockchain applications, creating a new way of authenticating, for example, art or videos of sporting moments (Hughes et al., 2019). While digital

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technologies have transformed the way content is structured, saved, used, transferred, shared, and consumed, NFTs provide further advancement toward the digitalization of assets or chains of ownership for physical and intangible assets in a more transparent, secure, and concrete form. According to Dowling (2022b), *fungibility*, or interchangeability, is a key aspect of cryptocurrencies (e.g., one bitcoin is equal to another bitcoin); *non-fungibility* is what differentiates NFTs as a unique asset.

Representing a highly emergent application, NFTs align with organizational exploration and exploitation frameworks. An organizational exploration framework can be seen to operate in the space of novel technological applications like NFTs, including the creation of products with unknown demand, future uncertainty, and distant benefits (Greve, 2007; Levinthal & March, 1993; March, 1991). Organizations that seek or explore such novel innovations may also seek to exploit those innovations in time. Organizational exploitation is defined as the use and fine-tuning of existing knowledge, technologies, and products. Exploitation has more certain and proximate benefits than organizational exploration settings (Greve, 2007). Scholars recently moved the explore-exploit framework to encapsulate ambidexterity or paradox theory, whereby organizations create value, compete better, and win market share by attempting to explore distant benefits while exploiting current benefits (Gilbert, 2005; Knight & Harvey, 2015; Smith & Lewis, 2011) simultaneously.

In this article, we eschew the explore–exploit ambidexterity framework and related paradox theory. Instead, we recommend that organizations interested in NFT applications follow a more punctuated equilibrium—which is a temporal differentiation cycling through periods of initial exploration, and then later exploitation—instead of simultaneous pursuit of the two (Gupta et al., 2006). Our suggested temporal split speaks to the reality of organizations cautiously exploring the organic, emergent, volatile, and dynamic operating environment of the NFT ecosystem. The exploitation stage is more likely to flourish on a larger scale when the volatile and unpredictable nature of the NFT ecosystem has stabilized, as is likely (Jansen et al., 2009).

Congruent with an exploration framework, NFTs could fit into pre-existing conceptions of radical innovation. NFTs introduce new knowledge and processes for storing, embedding, coding, and verifying unique digital content and assets. Further, they maintain the utility and provenance

of the digital assets they represent, allowing them to be more easily traded, exchanged, authenticated, and transferred than previous systems. In this article, we aim to explore the uncertainty predicted by the organizational exploration framework (Levinthal & March, 1993) that is highlighted by the highly rapid and volatile rise in popularity of NFTs.

Closely related to exploitation frameworks, disruption occurs when small-sized entrants can successfully challenge larger, incumbent businesses (Christensen et al., 2015). Disruptive innovation occurs if a new product, service, invention, or technology is initially not valued—and indeed shunned—by existing consumers, but improves its performance at such a fast rate that the new development can rapidly invade and upend established markets (Bower & Christensen, 1995). The result is that consumers may initially shun but then later rapidly adopt disruptive innovations. Therefore, managers in established markets can be too late or indeed fail to recognize the threat of disruptive innovation until their business is overthrown (Christensen & Raynor, 2003; Schmidt & Druehl, 2008).

While it is not clear yet if mainstream businesses are being, or will be, overthrown by the potentially disruptive innovation presented by NFTs, there are already some prescient sentiments of a bright future for such applications (Kietzmann & Archer-Brown, 2019). These upbeat prescient sentiments would seem to predict a degree of organizational exploitation (Levinthal & March, 1993). For example, immutable smart contracts are created as part of NFTs or blockchain technology, which cannot be easily tampered with or altered. Scholars predict that these will likely be used in the future to replace processes that involve human-centered guarantors of authenticity via lawyers and escrow agents in industries such as property and vehicle sales (Angelis & da Silva, 2019; Bowden & Jones, 2021). Smart contracts for NFTs can ensure that money and assets change securely and that parties are clear about the content of agreements, reducing the need for middle agents (Morkunas et al., 2019). NFTs simplify the process of converting assets to tokens, facilitating ease of movement within the legal/escrow ecosystem.

This article is structured in three main parts. The first introduces NFTs, expands on their associations with blockchain, outlines opportunities, and highlights industries currently benefiting from NFTs. The second part builds an NFT stakeholder and business ecosystem framework and outlines the role and inter-relationships of stakeholders.

The third part examines implications for managers as well as the various innovations associated with NFTs. We build an NFT exploration and exploitation framework and look toward future developments.

In this article, we contribute an early, exploratory scholarly conversation about NFTs and develop conceptual framing of NFTs. This is critical given the initial uncertainty as a result of the rapid emergence of NFTs in different industries. The article provides a vision of how to frame stakeholders and the related ecosystem that can optimize NFTs as a digitally capable solution. NFTs also present as an emergent value proposition, and a potential radical or disruptive innovation for businesses adapting to new blockchain-supported technologies.

2. NFTs and NFT exchange

2.1. Defining NFTs

NFTs are blockchain-enabled applications that encode, either on-chain or off-chain, unique content in smart contracts for secure verification of provenance. NFTs feature identity and ownership supported and substantiated by distributed ledger technology. They are based on a highly secure system, in a peer-to-peer network, and use mathematical cryptography, referred to in this article as crypto-verification (Chen, 2018; Samarbakhsh, 2021). Fungible assets are identical and interchangeable, much like coins or gold bars, whereas the non-fungible aspect of NFTs signals a uniqueness of state. Examples include an art masterpiece or a unique moment like a video recording of a match-winning basketball shot (Karg & Wilson, 2021).

While there is considerable variability between established business life cycle models, common contextual dimensions include age, size, growth rate, and focal tasks or challenges faced by the industry (Levie & Lichtenstein, 2010). NFTs can be placed early in the classic business life cycle model, having moved rapidly from genesis to growth. For example, a search of 'non-fungible tokens' in Google Trends (2021) plotted NFTs as a trend of public interest detailing an extraordinary rise from a score of zero on January 30, 2021 to reach relative popularity of 100 (maximum score) on March 14, 2021. Frank (2021) reported in quarter one of 2021 that NFTs faced record-high transaction volume and generated over \$2 billion.

NFTs engender creativity and represent a novel idea that helps create new markets. An example of this is that NFTs allow content creators to access

new markets in which to sell art, music, or written material. Before the introduction of NFTs, these markets presented limited access and high barriers to entry. Digital artist Mike Winkelmann, known as Beeple, provides an insight into this new market, and its accessibility (ABC News, 2021). After selling his digital art NFT for \$69 million via a public art auction, he noted that before NFTs, none of the artwork had sold for more than \$100. This was because there was no easy way of selling digital art aside from the cumbersome process of printing and shipping. He felt traditional art auctions and physical collections failed to adapt to the newer world of digital art. In this example, NFTs encapsulate radical innovation in that they have the potential to disrupt industries spanning art and, more widely, music, property, and sports (Hughes et al., 2019).

2.2. The role of blockchain and cryptocurrency

Blockchain underpins the NFT process by providing a decentralized process for guaranteeing the unique property of the NFT. Each NFT sits on a block resembling a digital ledger that is secured through mathematical cryptographical algorithms and verified through blockchain processes. Once information is recorded and verified on the blockchain digital ledger, it is transparent to all parties and cannot easily be altered. This provides the guarantee of non-fungibility: the NFTs' unique and unchangeable properties.

The foundation of NFTs is linked to users adapting to alternate standards established by one particular cryptocurrency. In October 2017, ERC-721 tokens were popularized, paving the way for NFTs to be used to adopt, breed, and trade digital cats in a game called CryptoKitties (McCormack, 2021). Although NFTs were originally developed using the Ethereum blockchain, many other blockchain networks now facilitate the trade and exchange of NFTs. The emergence of new NFT formats is a result of increasing congestion on the Ethereum network, which is leading to larger and larger gas fees, which are the fees charged to successfully conduct and process a transaction of Ethereum using Ether, the native currency of the Ethereum network. This issue has seen the process of creating and exchanging NFTs become increasingly expensive. One alternate mechanism to Ethereum is the Solana blockchain, which has comparatively high speed and performance and low transaction costs (Butcher, 2021).

Though volatile, cryptocurrencies have generally been rising in value, benefiting NFT markets.

Given NFTs are purchased with cryptocurrency—particularly Ether—their value can rise on the back of increasing cryptocurrency values (McCormack, 2021). This provides uncertainty regarding the value of the NFT based on the underlying cryptocurrency used to purchase it, or the actual value of the NFT asset (i.e., the artwork or sporting video).

Another critical component in the NFT exchange is decentralized apps, or DApps, that provide a combination of a front-end user interface and a smart contract. Over 900 DApps were developed in 2018 (Lee, 2019). When smart contracts, or self-executing automation software, interact with DApps, they remove administrative overheads, which Mearian (2019) claimed to be one of the most attractive features of decentralized systems. Smart contracts execute predetermined conditions, performing much like a computer executing on conditional, if/then programming (Mearian, 2019). The blockchain network also acts as an immutable electronic ledger, providing clear proof of transactions.

3. NFT opportunities

Until recently, artists, brand owners, musicians, and sports organizations were among those lacking easy ways to sell digital art or collectibles. Such content found its way onto the internet and could be easily accessed through public platforms such as Google Images or YouTube. However, artists, athletes, agents, bands, and rights holders had no clear pathway to generate revenue from their digital content.

Regarding sports, some professional athletes are paid well, and the teams and organizations that pay them receive significant revenue via broadcasts, licensing, and media deals (Shilbury et al., 2017). Likewise, highly respected artists may command high fees for commissioned work or gallery residencies. However, many sub-elite athletes, smaller artists, and content creators have less opportunity to share or commercialize their work or wares or formalize a chain of rights for owned assets. Digital forms such as NFTs provide new ways for them to do so, while engaging others with their work.

Further, for fans who may enjoy owning artwork, sporting collectibles, or recorded moments, until now there has been only non-digital options such as prints, books, trading cards, or branded clothing and badges. Further, many physical sport collectibles and artworks present problems in authenticity; many are replicas or their provenance is not clear. For example, an

Organisation for Economic Co-operation and Development (2016) report found that global trade in fake branded goods was worth almost half a trillion dollars per year.

NFTs provide the scope to revolutionize methods of content creation and exchange for fans, artists, art collectors, and dealers, as well as athletes and sport clubs. Their use has implications for a variety of other business and technical and transactional intermediaries. Specifically, NFTs provide a new way for various stakeholders to create, commoditize, authenticate, exchange, and store digital content that can benefit many parts of the ecosystem (Malhotra et al., 2022).

NFTs offer access to unique digital content for interested stakeholders, many of whom are willing to pay a premium for high quality and potentially rare assets. Content can comprise individual or combinations of images, videos, audio, text, graphics, and metadata. NFT content is typically minted by a creator or content owner using underlying blockchain technology to verify its provenance and ownership. The NFT content, once minted, is typically offered for sale through a mediated NFT marketplace. Some early marketplaces for NFTs include OpenSea, Rarible, SuperRare, Atomic Hub, and Foundation. While some markets offer services generally to industry, specific art or sport platforms are also common. For example, NBA Top Shot and Autograph are sports-oriented NFT marketplaces.

4. Industries benefiting from NFTs

It became clear in the first quarter of 2021 that NFTs had spawned a revolution in the art and the sport industries, among others (Karg & Wilson, 2021; Samarbakhsh, 2021). As sales and the profile of NFTs increased, managers started becoming aware of the effect and potential of NFTs for sales channels and business models (Bowden & Jones, 2021).

As of the first half of 2021, one primary way NFTs have been used in business is generating revenue from digital collectibles. The types of collectibles generating high revenues include art, with a potent example being the sale of a digital art piece known as *Everydays—The First 5000 Days* by Mike Winkelmann, for \$69.3 million on March 11, 2021 (Riegelhaupt, 2021). In this manner, the sale of NFTs has created a new marketplace for artists and content creators to generate valuable sales.

Collectibles in the form of digital highlight videos are also generating revenue for sports organizations. The primary example of this is the

National Basketball Association (NBA) through its online Top Shot platform. From its open beta launch on October 1, 2020, NBA Top Shot has generated sales and trade worth over \$944 million, involving more than 553,000 traders (Dappradar, 2022). As well as the NBA benefiting from sales of digital content, it has a revenue-sharing model in place with athletes and player associations (Scotto, 2021). Other sport events, organizations, teams, and athletes have also established significant revenue streams and platforms for engagement via NFTs.

Broadcasters and digital content creators are also engaging with NFTs. For example, Fox Entertainment is creating a new company called Blockchain Creative Labs, which will merge art, brands, and technology (Redmond, 2021). Fox is starting to create NFTs of animations such as *The Simpsons*, as well as creating new broadcast material directly on the blockchain. Fox executives believe that doing so will help directly connect fans of their content through the production, promotion, and sale of NFTs (Redmond, 2021).

Technology businesses are also reaping revenue via cryptocurrency exchanges within underlying digital ecosystems. For example, Dapper Labs—which developed NBA Top Shot and has an expanding partnership network to provide specialist technical services to facilitate NFT production and sales—was established in February 2018 and is now a \$7.5 billion company (Clark & Heath, 2021). However, the sudden growth of technology and mainstream interest in NFTs has not been without problems. Dapper Labs admits users of NBA Top Shot multiplied 100 times from January to April 2021, causing a need for frequent maintenance and issues for users trying to withdraw money efficiently (Sarlin, 2021).

NFTs are also influencing legal practice via the generation of third-party smart contracts. NFTs conveniently and transparently convert assets into crypto-verified tokens to enable ease of movement through these complex systems. NFTs are difficult to tamper with, and the block ledger clarifies and records alterations made to contracts. This also has implications for property and vehicle ownership, which can be indisputably authenticated by NFTs. The future need for middle-agents, therefore, may be greatly altered or diminished (Bowden & Jones, 2021).

NFTs are also fully programmable through *on-chain programming*, where code is embedded directly into the NFT. This has allowed—for example—NFT gaming engendering deeper engagement for users. An example is CryptoKitties, an NFT-based game allowing gamers to

buy, collect, breed, and sell virtual digital cats. For NFT developers and entrepreneurs, design spaces present many possibilities to push boundaries around complex embedded mechanics, like forging, crafting, redeeming, and random generation. There are other NFT programming nuances. The on-chain programming logic also may interact with other metadata, such as the reading of internal-state metadata embedded in a smart contract. In CryptoKitties, all breeding happens on-chain and the generational level of each CryptoKitty influences speed of breeding (Open Sea, 2020).

5. NFT stakeholders and ecosystem relationships

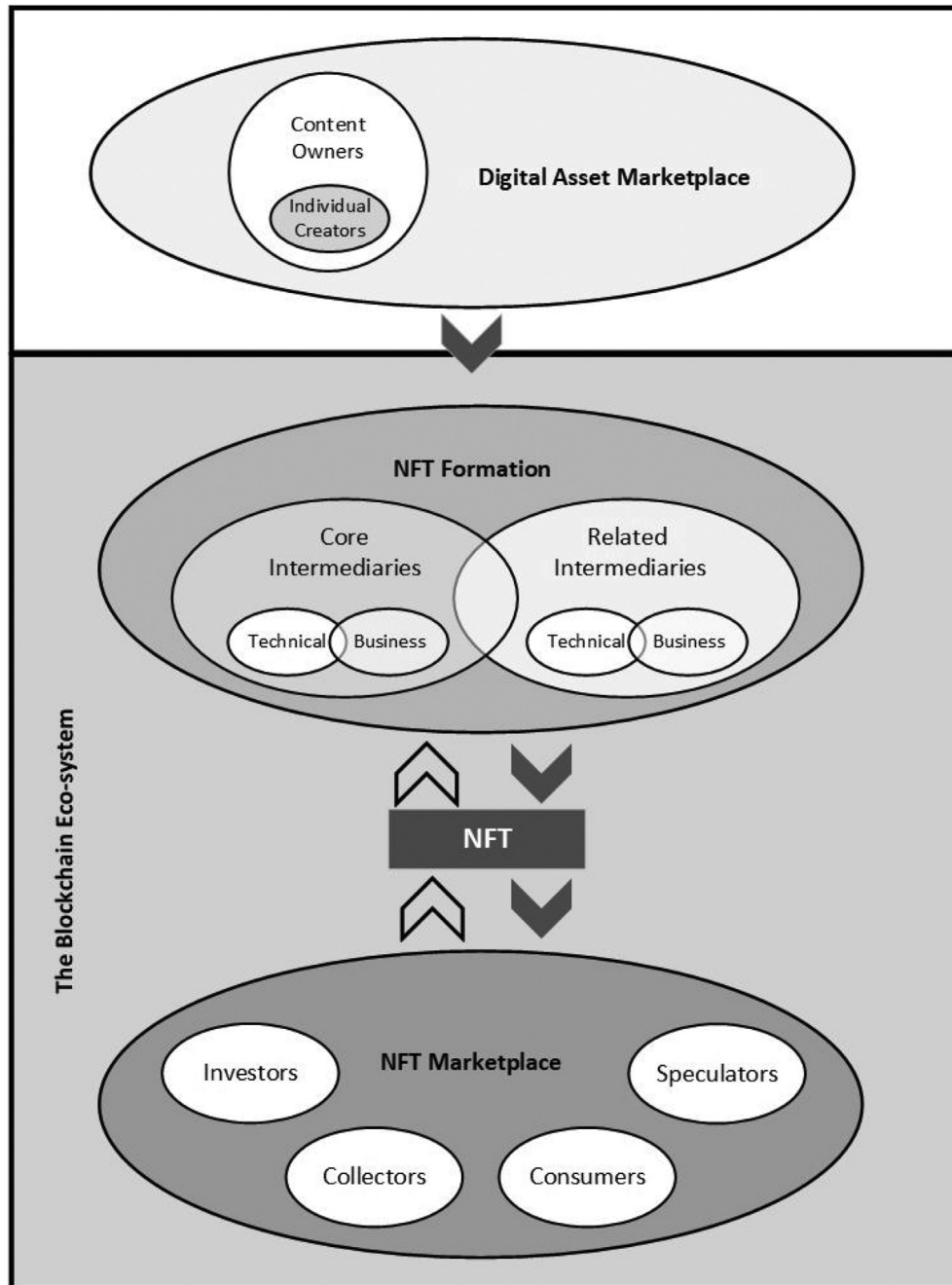
Because of the rapid emergence of NFTs as a novel, exploratory, and evolving phenomenon, there have been limited cohesive descriptions of the various stakeholders who exist in the NFT ecosystem. We provide a nascent description and example of each main stakeholder, which to the best of our knowledge, is the first high-level conception of the emerging NFT stakeholder relational ecosystem (Figure 1).

The NFT ecosystem comprises various stakeholders including digital NFT creators (individual content creators); and organizations and businesses that own content, intellectual property (IP) rights, trademark, or copyright potentially for sale through NFT marketplaces (content owners). In addition, NFT business and/or technical-enablement core intermediaries are necessary elements of NFT infrastructure, security, and policy, while related intermediaries include non-core entities including fintech marketplace companies, related technical specialists, and ancillary legal and business entities that support NFT marketplace providers. The final group of stakeholders consists of NFT marketplaces, and include consumers, collectors, investors, and speculators.

Figure 1 provides a high-level conception of relationships among the various stakeholders and structures in the ecosystem. Content creators initiate content and individual creators may also be content owners. Alternatively, NFT content creators and content owners may represent two separate, interrelated actors. Therefore, original content creators and content owners may be one and the same. However, if creators and owners are separate actors, then content creators are likely to be a subsumed relational class.

Intermediaries are required prior to NFTs reaching consumers, and are necessary for NFT sales and exchange processes to be completed

Figure 1. NFT stakeholders and relational ecosystem conception



and authenticated. There are two classes, namely core and related intermediaries, based on the closeness of the intermediaries' role. Core intermediaries are required for ongoing blockchain verification and storage technologies, or for providing NFT infrastructure such as technical input, security, or policy to guarantee the actual existence, maintenance, and ongoing viability of NFTs. Once NFTs are created and made available

to consumers, related intermediaries, such as business and exchange marketplaces, figure in this stage as well as in ongoing support in after-market and re-sale activities. Related intermediaries also include legal, accounting, and taxation specialist business intermediaries. Consumers may purchase, trade, display, and invest or speculate in the NFT. A summary of each form is provided below.

5.1. Individual creators

Individual creators include originators of the NFT art, video, image, sound, or metadata. These creators, such as artists or athletes, typically own IP rights and copyright to the digital content sold as part of NFTs. Marketplaces for individual art creators include both open marketplaces like OpenSea and Rarible, where any artist may upload their content, or closed marketplaces such as SuperRare, where creators are vetted. Individual creators also include athletes, with multiple cases where celebrity athletes have commanded over \$200,000 for an NFT. However, individual creators are also emerging on a smaller scale; for example, the Ladyjacks basketball team created an NFT of a National Collegiate Athletic Association win, which they auctioned and sold to the winning bidder for \$100 (Fan Block, 2021).

5.2. Content owners

Content owners are different from individual creators in that they may not have created the particular video, image, sound, or metadata, but they do have vested ownership rights over the NFT content. Having such rights, content owners can create NFTs in which ownership is vested away from, or shared with, content originators. Such arrangements are common in art, media and sport, where middle-agents such as art dealers, literary agents, media organizations, sport management agencies, and large sport-governing bodies may have vested rights to content. An example of a content owner is Japanese firm Sega, a video game developer and publisher that has signaled it will begin to sell NFTs based on its IP ownership of the popular animated hedgehog character Sonic. Sega is in the process of producing and selling NFT content based on its digital assets such as art and music from its games (Craddock, 2021).

5.3. Core intermediaries: Technical and business

Core business and technical intermediaries include stakeholders who are key to the development, ongoing security, and maintenance of underlying NFT infrastructure, as well as decisions on underlying technical standards or NFT scalability. For example, core technical intermediaries include the Ethereum Foundation (2021), which performs a critical role in the underlying infrastructures of NFTs supported by the Ethereum blockchain, by allocating resources to critical crypto-related

projects, and via policy influence and advocacy. In a related fashion, Ethereum.org (2021) supports maintenance, development, and policy-level initiatives such as the Ethereum Improvement Proposal. An example of a core business intermediary is the Ethereum Name Service (2021), which, like domain names for websites, creates human-readable names such as 'NBA.eth' for machine-readable identifiers linked to Ethereum addresses, other cryptocurrency addresses, content hashes, and other metadata.

Intermediaries also include the wider cryptocurrency marketplace. All decentralized blockchains use cryptocurrencies. There are blockchain networks that have their own native coin (currency), and there are also networks that are deployed on other networks using a cryptocurrency token to access elements like services, rights, and awards. The latter requires coin payment to process transactions. The cryptocurrency marketplace is an important intermediary because it allows for decentralization of the currency, so that the marketplace may operate seamlessly in a global finance setting (Larios-Hernández, 2017). Also core in a global setting are network participants (nodes) that contribute by computing power, providing processes to verify transactions, or cryptographically creating the next block on the chain.

5.4. Related intermediaries: Technical intermediaries that are non-core

Non-core related technical intermediaries in the NFT ecosystem include NFT developers who build bespoke ecosystems to allow users to transact, experience, exchange, display, and trade NFTs. These single sites provide users with a concentrated and self-limiting exposure to the domain in which they operate. An example is Dapper Labs, which created and provide the platform and user experience for NBA NFTs via the NBA Top Shot platform. This ecosystem allows users to engage in a secondary market to trade and display NFTs, as well as use NFTs in purpose-built online games. This ecosystem is also rules-based, with many terms and conditions limiting NFT usage and ownership rights. Enterprise solutions developers also offer generic ecommerce ecosystems that provide NFT platforms and services for smaller-scale operators. One example is Shopify, which provides a beta platform to allow customers to purchase NFTs from Shopify stores. This empowers shop owners to sell NFTs through their own existing online storefronts (Shopify, 2022).

5.5. Related intermediaries: Business intermediaries that are non-core

Non-core, related business intermediaries include web-hosted NFT marketplaces developed specifically to allow creators or consumers to trade NFTs commercially. The largest example is OpenSea, a fully open NFT marketplace that runs auctions spanning art, sport, domain names, collectibles, utility, virtual worlds, and trading cards. Another non-core related business intermediary is traditional art auction houses such as Christie's. These are more established or traditional businesses and auction houses that have recently extended operations to include digital art via NFT auctions. Law and accounting firms are also classified as related business intermediaries in terms of providing advice and support for business issues relating to NFTs. These issues include taxation, company set-up, (anti) money-laundering, IP and copyright issues, securities and exchange, asset protection, asset evidence, digital first sale doctrine, long chain liability, dispute resolution, estate planning, and smart contracts (Dilendorf Law Firm, 2021; Rodman Law Group, 2021; Sullivan, 2021).

5.6. Consumers, collectors, investors, and speculators

NFT consumers or collectors claim ownership of the original digital record of the item—video, image, animation, text, or sound. Consumer rights governing NFT ownership are highly nuanced. In many cases, the NFT-owning consumer will not be able to claim ownership of the underlying copyright or IP. This is the case, for example, in the NBA Top Shot exchange, where terms and conditions governing NFT ownership limit what NFT consumers can do with the NFT and provide restrictions through copyright and IP regulations.

Consumers include a class of NFT stakeholders utilizing NFT 'assets' to build a portfolio of increasing value as an investor or speculator. NFTs have been coined a 'bubble' or a 'fad' (La Monica, 2021; Ossinger, 2021) because of the large and sudden numbers of parties entering the market to invest or speculate on rising values associated with 'rare' NFTs. These perspectives are coupled with rising and, at times volatile, cryptocurrency values. While investors have a more long-term philosophy of investing and may have a passion or interest in the field in which they invest, speculators' interests tend toward the shorter-term financial gain. As Levy (2021) points out, such speculators may or may not care about the domain

of the investment and may view NFT markets as purely short-term speculative investments.

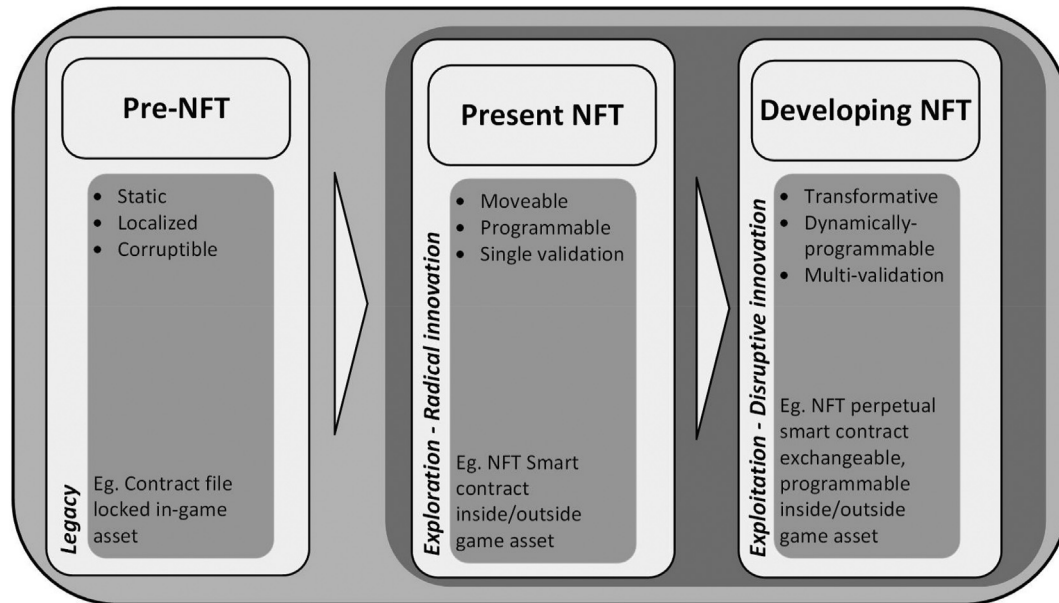
6. Implications for managers

Having described NFTs and discussed relevant industries and stakeholders, we now focus on wider implications of NFTs and how they specifically affect managers. To develop this discussion, we return to exploration and exploitation frameworks introduced earlier in the article. We also contextualize radical and disruptive innovation to introduce a timeframe for how emerging phenomena such as NFTs grow, develop, refine, and prosper (Iansiti & Lakhani, 2017). Extending on this, we posit that managers need to be aware of how evolution and refinement of NFTs is unfolding. This includes how value associated with the specific innovations represented by NFTs is being created, and how NFT growth and transformation is likely to develop. These factors make it important for managers to understand the various roles of the disparate stakeholders involved in the NFT ecosystem.

Given their rapid entrance and garnering of worldwide public interest, NFTs can usefully be characterized as a radical innovation based on an overarching organizational *exploration* framework that encompasses entering new markets, the use of unfamiliar technologies, and the creation of products with unknown demand (Gupta et al., 2006; Levinthal & March, 1993; March, 1991). Such activities create uncertainty through future and projected revenue production, which is usually neither reliable nor fast. In addition, organizational exploration typically engenders uncertainty and distant benefits (Greve, 2007). Radical innovation is generally associated with the commercialization of an entirely novel idea that is also new to markets, and is the essence of value creation achieved in large firms (Ahuja & Lampert, 2001) and entrepreneurial ventures (Schumpeter, 1934). Radical innovation also fosters transformation of established structures, patterns of activities, routines, and resources.

Figure 2 provides a framework to describe how NFTs are evolving. The framework provides a dynamic representation of legacy, exploration, and exploitation stages to represent pre-, during-, and post-NFT timeframes. Each of these three stages represents a developmental stage aligned with exploration and exploitation frameworks, and the concepts of radical and disruptive innovation. We present ideas related to these concepts and explore and exemplify how they are evolving and transforming. This representation is aimed at

Figure 2. Dynamic evolution of NFTs using exploration and exploitation frameworks



helping managers understand what changes are likely to surface as NFTs develop and become more prominent across business sectors. We believe that through the framework, executives may be able to strategize early about how NFTs may alter business practices, and develop an early understanding of improvements and implications.

6.1. Legacy stage

The legacy stage prior to NFTs being widely available was characterized by personal computer-based files containing text, images, and video that were 'static.' These were limited to residing on localized networks and were guarded by local firewalls; they could easily be altered or corrupted by ill-intentioned third parties. A legacy issue solved by NFTs relates to transparency of provenance and a superior technical regimen making ownership clearer.

In the pre-NFT stage, files could, in most cases, be transferred across computer networks. Nonetheless, content was not locked and verified to the standard of crypto-blockchain files, which use complex mathematical cryptography to confirm, lock, and verify the file content and transfer. An example of the legacy (pre-NFTs) stage is a contract file, characterized as a static document where transparency and provenance may be invisible, and where monitoring, safeguarding, and checking by third parties such as lawyers or escrow bodies is often required to ensure fairness and

validity for the contract parties. Another example, within gaming, includes purchasing in-game assets, such as seed in *Farmville*. In the legacy (pre-NFT) stage, such in-game assets remained locked inside the game and were unable to be exchanged, traded, or sold outside the game.

6.2. Exploration stage

The exploration stage is characterized by the creation of products and services with unclear demand, uncertainty, and the possibility of only distant benefits (Greve, 2007; Levinthal & March, 1993). Many companies are grappling with how value may emerge from NFTs, given their relatively recent appearance in what is, essentially, an exploratory entrepreneurial environment. At this point, there is an emerging but volatile demand for NFTs across various industries, translating to an uncertain landscape regarding future demand. This means the NFT value proposition is still in flux, adding entrepreneurial risk to NFT adoption.

NFTs represent a radical type of innovation that improves on the pre-NFT legacy stage by enhancing the ease, speed, simplicity, validation, and traceability of digital assets trade. In the present stage, NFTs are stored as unique data entities on the blockchain. As such, they have the advantage of existing in a protected environment where historical provenance is preserved, while allowing long-term storage and archiving of the underlying NFT asset.

One current limitation is the ‘single validation’ that creates decentralized value on-chain. This means that NFT-linked assets do not interface with data and systems located off-chain. Also, NFTs are minted or created and generally remain inert from that point until they are traded again. This means that most NFTs currently embed relevant information at a point in time. Effectively, they are not able to be dynamically updated; for example, with an athlete’s updated player statistics (Chainlink, 2020).

An example of the current state of play is the advent of the embedded smart contract. When an NFT is created or minted, any associated smart contract is governed by the ERC-721 standard. This information is added to the blockchain where the NFT is being managed.

Smart contracts can be embedded in an NFT, to call and access assets within a particular NFT. Often relevant details are stored directly on-chain and usually embed important information such as the assignation of ownership and management of the transferability of the NFT, as well as linkage(s) to relevant digital file(s) pertaining to the NFT, such as video or artwork files. Storing such files on-chain is currently largely seen as impractical and prohibitively expensive due to size, so there is usually a URL link embedded in the smart contract. The value of any NFT is pegged to the smart contract process of defining a specific file as the verified original, and thereby establishing its *bona fides* and provenance.

Unlike legacy stage contracts, NFT smart contracts alter or reduce the role of third-party actors such as lawyers or escrow organizations, to oversee and validate the contract process (Bowden & Jones, 2021). With the advent of NFTs, the contract can be created simply, quickly, and efficiently through the blockchain medium, with crypto-verification processes being part of NFT creation, transfer, and storage processes. Another example is that computer game assets, unlike in the legacy stage, can still exist and be traded outside the game.

6.3. Exploitation stage

It is argued that companies and organizations at the forefront of NFT exploration stages are already reaping some financial rewards. This is evidenced by over \$2 billion in sales in the first half of 2021 alone (Frank, 2021). However, the full extent of the exploitation stage is largely yet to be realized. As the stage beyond exploration, we characterize exploitation as a stage of technology refinement, proximate value realization, and increasing

marketplace improvement (Greve, 2007; Gupta et al., 2006). Exploitation also fosters the emergence of issues with the new innovation. As such, evolution of the exploitation stage fosters many necessary considerations and implications for managers and adopters, and are outlined below.

6.3.1. Technical issues in the exploitation stage

The first issue relates to off-chain characteristics—as distinct from on-chain—whereby storage of critical data related to the NFT is not ‘baked in’ to the NFT coding, but simply references a URL link. There have already been instances of NFTs with broken URL links. This issue is being countered through the ongoing development of novel consensus mechanisms—the model through which NFT transactions are verified on the blockchain—that allows users to store large amounts of data on-chain (Escalante-De Mattei, 2021). The result, over time, will be a reduction in NFT smart contracts with external link references off-chain.

The second issue is that currently NFT-based assets are designed to not interface with data and systems outside the blockchain. Currently, blockchain does not dynamically pull in or push data out to any external system as part of its built-in functionality, and this has the effect of making blockchain an isolated network. Technical solutions for this include new middleware blockchain ‘oracles’ that are currently being developed to allow transactions between blockchain and off-chain systems including data providers, enterprise backends, Internet of Things (IoT) devices, and signatures. This means that NFTs can move from relatively static entities to more dynamic assets. An example of this is the emergence of the ‘perpetual’ smart contract, which would automatically ‘re-mint’ a limited-edition digital soccer collectible card if the oracle informed it that a sport player markedly improved their performance and personal game statistics (Chainlink, 2020). Another example is the development of perpetually updating game assets that can be traded in or outside the game, and that change dynamically over time.

A third issue is ongoing security of ownership of NFTs. There have been instances where pre-existing digital art has been stolen, minted as an NFT, and placed on open NFT marketplaces for sale (Purtill, 2021). This has created difficulties for NFT market traders in locating the original owner of the NFT, and presented related difficulties in assessing the NFTs’ uniqueness, and in understanding how many other copies exist. The chief solution in development involves secure biometric access technology aimed at NFT creators and owners (Shilina, 2021).

Currently, managers should consider implications of these key technical issues to ensure NFT shortcomings have available and cost-effective solutions. This includes monitoring further development and application of available security solutions such as biometrics, to ensure each NFT owner retains asset control and that provenance is provable. Once widespread biometrics are in use, it is expected that the problem of theft and deception related to NFT ownership and trade will ease. Other technical issues that managers should monitor involve long-term storage issue solutions; better technical solutions regarding on-chain/off-chain programming issues; and the widespread availability of automatic and dynamic updating ability relating to the development of blockchain oracles.

6.3.2. Additional issues and risks in the exploitation stage

Other considerations in the exploitation stage are prominent for decision makers and those developing strategies around NFTs. One major problem with NFTs is the issue of environmental sustainability of the underlying proof-of-work process of blockchain mining, which uses huge amounts of energy in the requisite verification processes. According to the [Cambridge Bitcoin Electricity Consumption Index \(2021\)](#), such proof-of-work mining, which is used to verify Bitcoin, consumes more electricity than whole countries including Finland, Kazakhstan, Chile, Belgium, and Austria. This high energy usage and associated environmental impact means that some stakeholders have been unable to countenance working in the NFT space. Recently, the French digital artist Joanie [Lemercier \(2021\)](#) cancelled NFT production and sale of six artworks after calculations revealed that the process would use the same amount of electricity in a mere 10 seconds as his studio used in two years. However, the continuing development and expanding use of new proof-of-stake next-generation verification consensus models require significantly less energy to prove trustworthiness, and thereby substantially reduces the overall energy consumption of the process ([Platt et al., 2021](#)). The proof-of-stake process replaces miners with validators who own larger cryptocurrency holdings and thereby have a proportionally larger influence in transaction validation. Such validators seek reward through staking their own tokens as collateral to support the validation process (Ethereum, 2021).

The volatility of cryptocurrencies is a further prominent issue that affects the underlying value of the *content* of the NFT, and NFT adoption.

Owners of NFTs can experience levels of uncertainty based on the volatile value of the underlying cryptocurrency, particularly if it is a speculative or longer-term investment ([Gural, 2021](#)). Therefore, choices concerning which cryptocurrency and blockchain technologies be used will remain an important consideration.

From the perspective of technical and business intermediaries, risk is also largely present in volatile cryptocurrency and NFT markets, in much the same way as consumers experience it. Technical and business intermediaries may also feel public and internal pressure to mitigate environmental sustainability risks related to NFTs via strategies such as pivoting to carbon-neutral, renewable energy-based sources, and/or purchasing carbon offset credits. Business and technical stakeholders also face risks around copyright, contracts, and legal issues. In addition, ensuring the originating provenance is accurate, and that off-chain information linked to NFT content is properly safeguarded and secure over the long term remain primary concerns for stakeholders. Finally, as [Sherman \(2021\)](#) asserts, the ease with which platforms carrying digital content may disappear can create issues for storage of NFT-linked digital assets and maintenance of longer-term access, which are further considerations for managers.

7. Conclusion

7.1. Summary and future development

NFTs represent a case of radical innovation with the scope potentially to disrupt a range of industries ([Chen, 2018](#)). Specifically, early development of NFTs has helped forge markets and promote new ways to organize, consume, move, program, and store digital information. Despite being a relatively new phenomenon, there has been a corresponding rapid increase in the application of NFTs.

While still at a relatively early adoption stage, NFT development to date has been characterized by moving beyond stages of legacy and into exploration, with ongoing movement toward an exploitation stage. Disruption to industry from NFTs is evidenced—and is likely to escalate—in industries such as art, sport, legal, escrow, ticketing, digital collectibles, games, and crypto-technical spheres ([Chen, 2018](#)). Beyond these industries, prescient commentators are pointing to future NFT disruptions to property, vehicle ([Bowden & Jones, 2021](#)), and financial markets because of disruptive and innovative products such

as NFT Bonds (Harsono, 2021; Larios-Hernández, 2017) and expansive augmented and virtual reality technology, and immersive digital worlds (Browne, 2021).

Further, the embedding of NFTs into non-digital, material consumer items is enhancing both the owner and community experiences of physical items and associated digital representation. For example, NFTs are being embedded into physical or real-world items such as bags, jewelry, clothing, event tickets, and shoes. Nike's submitted patent for NFT-supported 'Cryptokicks' represents a new concept in sports sneakers, with its use of NFT tokens to help establish authenticity of the shoe (Boag & Rich, 2020). Further, the Nike NFT can be used for consumer purchasing and trading to allow physical shoes to change hands among collectors, and for consumer engagement, and even for gaming applications.

In sum, and in addition to product or asset ownership and trade, NFTs are emerging as a means for businesses to provide access to memberships, clubs, and discounts (De Leon, 2021). NFTs can also facilitate the provision of specialist content for fans willing to spend more on their fandom. An example is the Kings of Leon, a music band that linked NFTs with the release of an album. Successful bidders could receive a 'golden ticket' NFT to access front row seats at concerts and backstage passes, and gain exclusive access to extra audio-visual content like a moving album cover (Hisson, 2021).

7.2. Contribution and future research

This article has introduced NFTs, provided typologies and examples of their use, and identified major implications for managers, including risks and opportunities. Most pertinently, given the very early state of NFT research, we contribute and position NFTs as part of a mapped relational ecosystem of defined NFT stakeholders including creators, content owners, and core and related technical and business intermediaries and consumers including investors and speculators. Further, we have positioned the ecosystem and the opportunities presented by NFTs as a nascent example of radical innovation that has promoted commercialization of novel ideas in new markets, and fostered value creation in associated firms and new enterprises (Ahuja & Lampert, 2001; Schumpeter, 1934). NFTs have done so by creating fundamentally new ways to package, transfer, sell, and trade non-fungible digital content.

With organizations beginning to engage more strategically with NFTs, this article outlines

several implications for managers based on some prescient viewpoints. We explore ongoing and future development of NFTs based on an exploration and exploitation framework, matched with radical and disruptive innovation, respectively. NFTs are positioned to disrupt and potentially overthrow specific systemic elements in existing markets, such as property, escrow, and legal industries (Christensen & Raynor, 2003; Schmidt & Druehl, 2008). Managers need to understand some of the current NFT shortcomings related to security, storage issues, on- and off-chain programming, and developing dynamism relating to external data sources. We outline developing solutions to these shortcomings, as well as highlight environmental sustainability and cryptocurrency volatility as areas of consideration for managers.

Our article has limitations, which opens avenues of future research. First, given the nature of our study, we suggest future works empirically examine and hypothesize the value of NFT as a new business model using both quantitative and qualitative data. Second, the NFT phenomenon could be explained further using alternate established management theories such as Stakeholder Theory and Agency Theory. Third, given the emerging nature of NFTs and evolving participants, our conceptualization of ecosystem may have limitations to capture the underlying relations and dynamics. Finally, future studies could benefit from advanced text analytics techniques to extract consumer trends and key topics of interest, to further understand the dynamics involved in NFT business. While NFT growth is still emerging, and the underlying value of tethered cryptocurrencies has been highly volatile, it is expected that NFTs will continue to represent and expand as an innovative force in many technological and business enterprises, and continue to be highly popular with creators and consumers.

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