



Value creation and value capture in NFT business models: Insights from blockchain-based ventures

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ABSTRACT

This paper sets out to explore how blockchain-based technologies, particularly non-fungible tokens (NFTs), are influencing future business models. Drawing on the relevant literature and a multiple case study of blockchain ventures, we demonstrate how the technology leads to new polyadic mechanisms of value creation and value capture. A clarification of NFTs and related concepts, together with their use values and exchange value determinants, led us to argue that the polyadic mechanisms differ from those in dyadic and triadic business models. Overall, we identify a total of 39 NFT technology affordances that fall into four types: utility, social, financial, and legal affordances. In addition, the NFT business ecosystem is mapped in terms of sources of generativity, mixed-side network effects, and the convergence of complementors within the ecosystem. Finally, this study explores three distinct mechanisms of stakeholder collaboration using NFTs: token distribution and fundraising, polyadic value creation and capture, and smart contract-enabled facilitation of stakeholder interactions. Based on the insights, we discuss the impact of NFTs and blockchain technology on society (illustrated by two cases of NFT ticketing and decentralized apps), and the implications for theory, practice, and policy.

1. Introduction

Non-fungible tokens or NFTs are digital creations used to represent a unique asset, such as a song or a piece of artwork, and are stored on the blockchain, a decentralized and distributed database for the transparent storage of transactions between parties in a network (Großmann et al., 2024; Malik et al., 2023; Yilmaz et al., 2023). They have been used by digital art companies to authenticate ownership, monetize digital products, and create new revenue streams (Kumar et al., 2025). Although NFT businesses face challenges such as the risk of criminal exploitation (Manning et al., 2025) or market saturation, declining consumer interest, and difficulty in sustaining long-term value, as exemplified by the closure of some NFT startups, such as Nike-owned RTFKT (Cerqueira, 2024), when the initial excitement about a new technology fades, it becomes an ideal time to evaluate its true value and identify potential new business models that describe the mechanisms by which value can be created and captured (Amit and Zott, 2001; Bowman and Ambrosini, 2000; Brandenburger and Stuart Jr, 1996; Foss and Saebi, 2017; Lepak et al., 2007). According to Teece (2010), the commercial success of novel technologies and whether they help create and capture customer value largely depend on the business model, which

translates technical input into economic output. Thus, as the NFT technology matures, this is the time to explore action potentials associated with the NFT technology (i.e., affordances), beyond the artwork and specific use cases like the metaverse (Gleim et al., 2025; Umar et al., 2022).

NFTs create a dynamic and highly interconnected business ecosystem in which different actors can create and capture value in multiple ways (Wilson et al., 2022). Such emergent ecosystems challenge the management of boundaries and how the actors interact with the external environment through generative mechanisms (Wang et al., 2021). Most notably, compared to traditional business models that are either dyadic (e.g., e-commerce) or triadic (e.g., multi-sided platforms) (Andreassen et al., 2018; Baden-Fuller et al., 2017; Wynstra et al., 2015; Xu et al., 2021), NFTs enable novel “polyadic” relationships. A polyadic relationship is a type of multi-sided relationship that allows for multiple participants to provide value to each other and their customers, and to capture value from multiple paths generated by interconnected parties (Norris et al., 2021; Ritter and Schanz, 2019). Although previous research provides valuable insights into polyadic relationships in contexts such as multisided sharing economy platforms (Ritter and Schanz, 2019), project-based human resource management systems (Keegan and

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Den Hartog, 2019), and sustainable supply chain management practices (Norris et al., 2021), there is a need for research that empirically examines the emerging business models that have such relationships at their core.

Exploring NFT technology affordances (any quality or property of a technology that defines how it can be effectively applied) (Yoo et al., 2012) sheds light on the possible implementation scenarios through which ecosystem complementors can create and capture value. Given this unique opportunity yet prevailing ambiguity of the value of the technology, this paper explores affordances and business models, but also the distinctive value creation and capture mechanisms enabled by NFTs. Building on Bowman and Ambrosini (2000), we focus on two types of value, namely “use value” (a quality or feature perceived by users in relation to their needs) and “exchange value” (monetary amount at the point of sale). To obtain an in-depth understanding of the ways in which businesses and entrepreneurs are tapping into NFT-enabled solutions, we adopted an exploratory multiple-case study design to answer the questions of how NFTs can aid value creation and capture and what affordances, mechanisms, and business models are being developed in this context.

The case studies point to eight use values of NFTs (e.g., *digital content ownership, social status in Web 3.0 environments, or linking digital tokens to physical assets*) and five factors influencing NFTs’ exchange value (e.g., *the digital content’s quality, the digital content’s uniqueness and rarity, or NFT’s attachment to something valuable*). In addition, with the exploration of new business mechanisms enabled by NFTs, we find a new type of business model that incorporates polyadic mechanisms of value creation and capture. This new business model type is defined and compared with the existing types (i.e., dyadic and triadic).

We contribute to theory by expanding the existing business model typologies, which fail to explain how blockchain-based solutions enable new mechanisms for value creation and capture. Blockchain’s technical sophistication has made it difficult to explore its business value and implications (Antsipava et al., 2024; Großmann et al., 2024; Morkunas et al., 2019; Queiroz et al., 2020; Tandon et al., 2021). Tackling this challenge, we identify the utility, social, financial, and legal affordances through empirical analysis to explicitly illustrate the applications of this new business model type. Further, the application of use value and exchange value concepts is relatively new in the blockchain-related business model literature (see Morkunas et al. (2019) for a review), paving the way for future research efforts to understand the business aspects of blockchain implementation across different sectors. The case of NFTs is particularly relevant in bridging these gaps, given the versatility and wide applicability of these assets to the long-lasting issues of digital content creation and management. While previous research on blockchain-based business models has provided valuable insights into several aspects of the domain, such as business model dimensions in designing Web 3.0 platform ecosystems (Schmück et al., 2025), decentralized business models in the financial industry (Chen and Bellavitis, 2020), elements of business models with blockchain at their core (Morkunas et al., 2019), and identification of new blockchain-enabled business model patterns and implementation strategies (Weking et al., 2020), there is a lack of focus on NFT business models, use values, and exchange value determinants that drive new mechanisms, which we argue are “polyadic”. Therefore, the identification of such polyadic mechanisms in NFT business ecosystems advances our theoretical understanding of generativity and how a community of users, commercial actors, and intermediaries interact within a dynamic network to generate and deliver their own offerings.

The rest of the paper is organized as follows. First, we begin by providing a theoretical overview of the concept of value and how it is created and captured through the use values and exchange value determinants in the context of NFTs. This is followed by a clarification of the different types of business models used. The subsequent section analyzes 12 case study examples through content analysis of the data collected, supplemented with insights from interviews. Finally, we

discuss the impact of NFT technology on society and the implications of our findings for theory, practice, and policy.

2. Theoretical background

The theoretical background of the study is based on a value-based perspective of business strategy (Brandenburger and Stuart Jr, 1996; Teece, 2010), drawing on theoretical frameworks related to value creation and value capture (Amit and Zott, 2001; Chesbrough and Rosembloom, 2002; Lepak et al., 2007; Tantalo and Priem, 2016), the distinction between use value and exchange value (Bowman and Ambrosini, 2000; Priem, 2007), and generativity in digital innovation ecosystems (Thomas and Tee, 2022; Wareham et al., 2014; Yoo et al., 2012; Zittrain, 2006). These concepts provide a foundation for understanding how blockchain-based technologies, such as NFTs, are transforming traditional business models with dyadic and triadic business relationships (Andreassen et al., 2018; Baden-Fuller et al., 2017; Massa et al., 2017; Zott et al., 2011) into emerging business models with polyadic value creation and capture mechanisms (Keegan and Den Hartog, 2019; Norris et al., 2021; Ritter and Schanz, 2019). Together, these theoretical lenses guide our analysis of the transition from linear to more complex polyadic value configurations.

2.1. NFTs and value systems in digital innovation ecosystems

Since the genesis of blockchain-based assets such as NFTs, there has been increasing interest in their business applications beyond investment purposes (Chen and Bellavitis, 2020; Großmann et al., 2024), raising the question: How does the technology add practical and strategic value? To address this, we begin by taking a value-based perspective (Fig. 1) when examining value creation and value capture. For customers, value is perceived as the difference between their willingness to pay and the offering’s final price, something which is often called “consumer surplus” or “value for money” (Sweeney and Soutar, 2001). Vice versa, in the buyer-supplier value chain context, value is the difference between buyers’ willingness to pay and suppliers’ “opportunity costs” (losses caused by allocating resources to the focal firm instead of alternatives) (Brandenburger and Stuart Jr, 1996).

Now, in order to understand what influences willingness to pay and the final price, Bowman and Ambrosini (2000) distinguish between two types of values, namely “use value” referring to any specific quality or feature of a new job, task, product, or service that reflects user needs, and “exchange value”, the amount paid by customers for the realization of use values. The delivery of profit depends on the uniqueness and quality of use values perceived by customers (Priem, 2007). The exchange value, on the other hand, is influenced by and can be significantly higher if: (I) it meets customer needs and there is no alternative offering in the market; and (II) suppliers find it difficult to switch over to other buying companies (Bowman and Ambrosini, 2000). Based on this theory of value, we identified NFTs’ use values and exchange values to better understand their underlying mechanisms of value creation and capture.

2.1.1. Use values of NFTs

First, NFTs enable creators of digital content to *certify ownership* and protect legal and regulatory values (Jones, 2021; Liu et al., 2025). For example, the smiley face symbol has been massively used in messaging services, but its inventor is not capturing any of the value. Similarly, memes shared on social media have no return for their creators. NFTs could break these barriers and allow value capture from digital content. A blockchain stores an NFT’s encrypted data, making its exchange history transparent and immutable, allowing the original creator and subsequent transactions to be traced (Concas, 2021). This enables the capture of value throughout the asset’s lifecycle. For example, the creator of the digital artwork “Everyday: The First 5000 Days” receives 10 % each time the attached NFT is traded in the marketplace. Royalties,

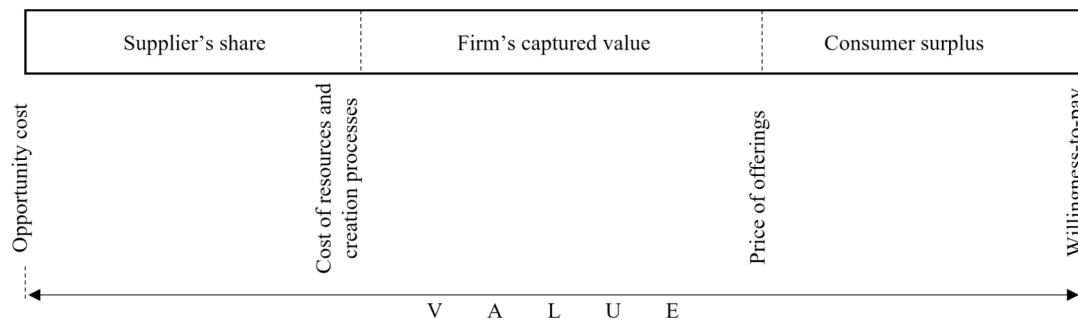


Fig. 1. Understanding value creation and capture from the existing value-based perspective (adapted from Brandenburger and Stuart Jr (1996) and Bowman and Ambrosini (2003)).

as passive income for digital content creators, increase the value of digital content (Fairfield, 2022; Hofstetter et al., 2022). Compared with physical products that, in general, devalue over time, NFTs have the potential to provide the creator with more earnings in the long run.

NFTs can represent people’s social status in the online world and share emotional value (Hofstetter et al., 2022). Social media users can link their profile pictures to NFTs that signify their standing in comparison to other users (Chohan and Paschen, 2021). NFTs are registered in a blockchain, and given their anti-piracy effectiveness (Liu et al., 2025), no one else can claim the same identity in the virtual world (Trautman, 2021). Owning a rare and unique NFT can grant its owner a higher social status within the community (Fairfield, 2022). For example, Mike Tyson bought the Cool Cats NFT for his Twitter profile picture, which received around 9000 likes and 1800 retweets (Sniper, 2021). This use value is essential to NFTs as a “signaling” device in the metaverse (Aysan et al., 2024). Similarly to how a Rolex or Porsche might signify status in the real world, NFTs allow signaling in Web 3.0, the third generation of the Internet characterized by decentralized, distributed, and user-centric networks (Chandra, 2022; Schmück et al., 2025).

NFTs can also be used to promote *social values* by encouraging community outreach and engagement. For example, digital content creators release NFTs of their projects in order to generate interest and bring people together to discuss the meanings, myths, symbolism, and narrative behind them (Regner et al., 2019). In the game industry, developers often release visualizations of the in-game characters as NFTs in online marketplaces prior to the launch of the game (Vidal-Tomás, 2022). One example is Illuvium.io, an open-world role-playing, interoperable blockchain game launched in 2024. The developers released the game character NFTs before the launch in the marketplace to help build a larger community and gain attention.

NFTs can serve as a token gating mechanism (Zeilinger, 2024), granting exclusive access or privileges to a designated group of users. For example, after purchasing an NFT, fans can communicate directly with their favorite artist. Event organizers can also use NFTs for registration and identification of attendees. NFTs can even be used to issue digital passports, which grant access to virtual worlds. Additionally, the freemium model can be used with NFTs, where basic services are provided for free but premium features are only accessible to those who purchase NFTs (Baker et al., 2022; Houser and Holden, 2022).

Finally, NFTs can be used to generate additional income when attached to physical products, creating an effective physical/virtual interface (Chandra, 2022). This can be done by creating a digital NFT and trading it for a physical asset like a painting, which allows for the transfer of exclusive or fractional ownership rights to the NFT owner (Gleim et al., 2025; Li and Kassem, 2021). Alternatively, the NFT can be used as a separate commodity that can be bought and sold independently from the asset (Lydiate, 2021). This was done with Nike’s NFT sneakers, for example, where the NFT owner may not be the same as the owner of the physical asset. When the asset is traded successfully, it can

result in higher royalties and an increased exchange value. Additionally, NFTs can be used ahead of product launches, so that buyers have access to a limited number of products before the main launch. Adidas has used this method with their “Into the Metaverse” NFT project, and by studying the ratings, likes, and dislikes of each NFT, they can gain valuable insights into what design patterns may be successful in the real world. Ultimately, this has led to the emergence of physical NFTs that tokenize ownership of physical assets such as luxury products (Kim et al., 2025). Table 1 provides an overview of NFT use values with relevant examples from real-world applications.

2.1.2. NFT exchange values and drivers

Value capture in the digital age takes on new meanings and

Table 1
NFT use values.

NFT use values	Value types	Applications	Notable examples
Certify ownership rights of the digital content owner	Legal and regulatory value	Digital art	Mike Winkelmann created an NFT for ownership and trading rights of the Consecutive Days Collection.
Represent the owner’s social status in the online world	Emotional value	Social media	Mike Tyson posted the Cool Cats NFT as his Twitter profile picture.
Facilitate the trading of digital content with more speed and accuracy	Functional value	Marketplaces	Opensea.io (NFT largest marketplace)
Secure the collection and trading of digital content	Functional value	Crypto wallet providers	D’CENT is a hardware wallet with a plug-in device providing safe portable access to crypto assets.
Provide the original owner with royalties for the trading of digital content in the aftermarket	Economic value	Aftermarket trading	Mike Winkelmann receives 10 % each time his NFT-linked artwork is traded in the marketplace.
Provide NFT owners with membership access	Functional value	Fashion industry	Official (theofficialbrand.com) uses NFTs to grant exclusive access to selected fashion items and after-sales services.
Build and grow a virtual community of NFT owners	Social value	Gaming industry	Illuvium.io offers its game character NFTs before the release of the game.
Link virtual assets to physical products	Functional and economic value	Launch of new products	Adidas offers NFT-linked virtual sneakers attached to its physical products.

interpretations since the exchange value of NFTs can fluctuate greatly over time (see Fig. 2), in contrast to physical resources, which eventually lose their value. NFTs can generate a residual exchange value that may grow considerably over time. In traditional business ecosystems, value capture is typically determined by customers (how they perceive the offering's benefits versus competitors) or suppliers (their bargaining power) (Bowman and Ambrosini, 2000). With digital content, however, the residual exchange value is dependent on a wider range of factors, such as the creator's reputation, the community's growth, and its ability to be sustained (Chalmers et al., 2022; Hofstetter et al., 2022; Houser and Holden, 2022; Trautman, 2021).

The exchange value of an NFT is determined by several factors. First, the digital content represented by an NFT can have a significant impact on its value, in terms of rarity, uniqueness, quality, and representativeness of distinct artistic characteristics (Gleim et al., 2025). If it is a unique and high-quality piece of digital art, writing, or other content, it will likely have a higher exchange value (Chohan and Paschen, 2021). Furthermore, if the NFT is attached to a unique asset in a metaverse (a 3D virtual shared world) or to a video game character launching in the future, its exchange value can increase significantly (Murray et al., 2023; Fairfield, 2022). Third, specific affordances of NFT may also influence its exchange value. For example, NFTs providing access to information about sophisticated manufacturing processes are likely to be exchanged at a higher value than a simple JPEG file. Fourth, NFTs are valued based on the reputation of the creator/owner. Famous creators/owners are more likely to have higher-priced NFTs (Trautman, 2021). Last, the buyers may also value the community that supports the creators' team. If the community is active on online platforms, such as social media, it can help draw attention and support to the NFT project (Regner et al., 2019). Table 2 provides an overview of the main factors impacting an NFT exchange value.

Based on these use values and exchange values and building on

Table 2
Factors influencing NFTs' exchange value.

Factors	Effect	Notable examples
The digital content's quality	The higher the quality of the content, the higher the exchange value would be.	'Everydays: the First 5000 Days' NFT represents an artwork that joins 5000 images taken from Day 1 (1 May 2007) to Day 5000 (7 January 2021) into a single digital collage.
The digital content's uniqueness and rarity	The more unique and rare the content, the higher the exchange value would be.	'CryptoPunk #7523' NFT is the only character in the CryptoPunks collection (containing 10,000 NFTs) that wears a face mask, symbolizing the COVID-19 pandemic.
NFT's attachment to something valuable	If an NFT is attached to something valuable, its exchange value is likely to be high.	Axie #1046 NFT which was sold at 300 ETH (around 700 k USD at the time), is attached to an in-game character in Axie Infinity digital game.
NFT's creator/owner	The more famous and well-known the creator/owner, the more expensive the NFT.	The creator of the 'HUMAN ONE' NFT was well-known for his previous highly-priced NFT artwork.
The community supporting the NFT's team of creators	The more engagement that the community members expose, the more likely that the NFTs gain higher exchange value.	The Bored Ape Yacht Club (BAYC) project has an active community of users on social media supporting the release of new NFTs.

Bowman and Ambrosini's (2000) conceptualization of value, we illustrate the new value creation and capture processes using NFTs in Fig. 3. The figure stresses the notion that, particularly new owners of an NFT,

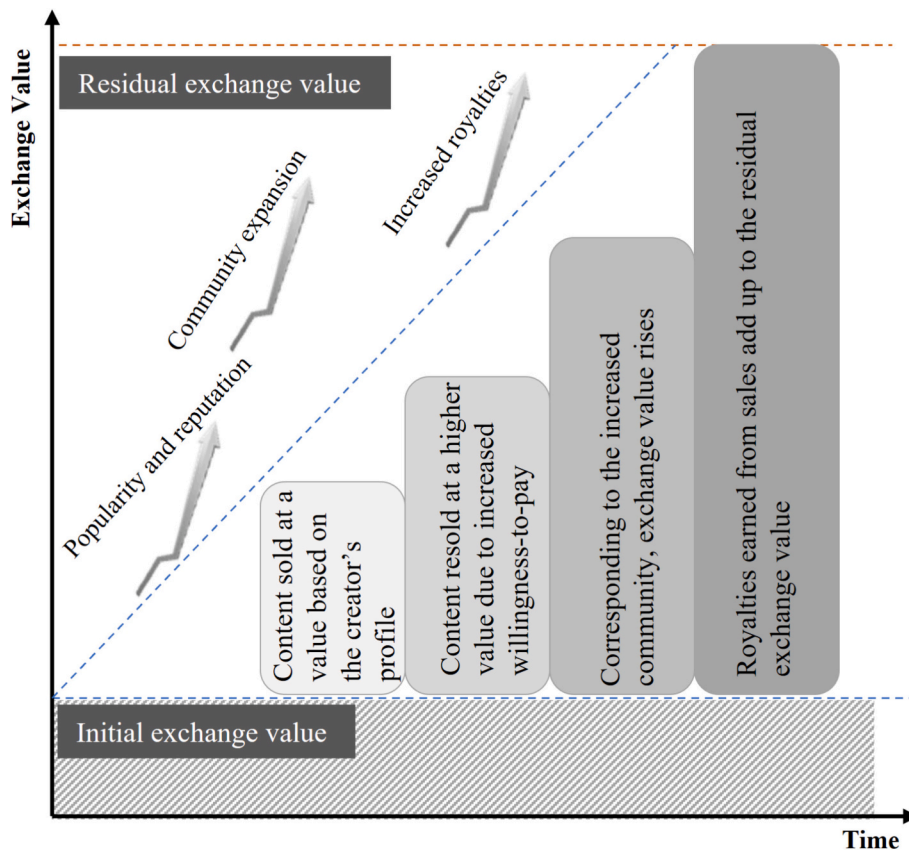


Fig. 2. Proliferating exchange value of digital content as a result of multiple factors.

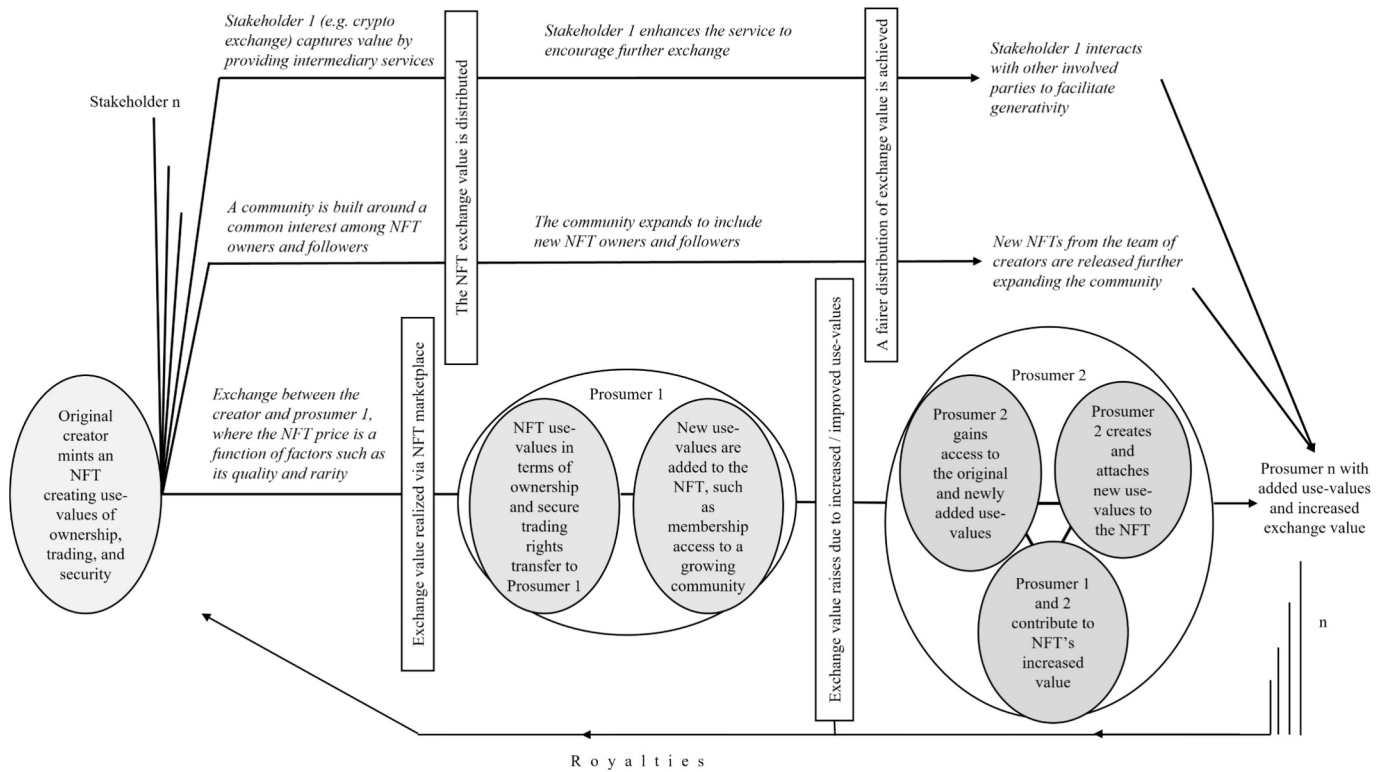


Fig. 3. NFT-enabled pathways of value creation and capture.

can create new use values, and this leads to an increase in exchange value due to the abovementioned factors. This is also a reflection of the concept of *generativity* and the capacity of the NFT ecosystem to generate, evolve, or build new outputs, structures, or behaviors without requiring input from the original creators (Thomas and Tee, 2022; Wareham et al., 2014). This generative network encourages more independent members to participate and interact in the ecosystem. The reason for this mechanism is that NFTs promote generativity and innovation, leading to multiple pathways through which all the involved stakeholders, including the prosumers (consumers who are also producers), create and capture new value (Bohnsack et al., 2021).

Now that the use values and exchange values of NFTs have been analyzed, it is important to understand the business models associated with them.

2.2. Emerging business models: Dyadic, triadic vs. polyadic relationships

Business models explain how value is created for stakeholders and how it is captured by the provider (Amit and Zott, 2001; Massa et al., 2017). Although the business model literature has been considered subject to “conceptual ambiguity and disjointed research efforts” (Foss and Saebi, 2017, p. 221), the proposed typologies have provided valuable guidance. Drawing upon a typology established by a body of studies (e.g., Andreassen et al., 2018; Baden-Fuller et al., 2017), this work recognizes two primary types of business models: the dyadic or multidivisional model (M-model), which focuses on the direct exchange of value between buyers and suppliers, and the triadic or platform-based model (T-model), which involves intermediaries to facilitate this exchange. Dyadic business models include (1) dyadic products and (2) dyadic solutions, depending on whether the supplier delivers a tangible product or a comprehensive solution that combines products and services. Triadic business models include (1) triadic matchmaking models, which connect buyers and sellers by facilitating transactions, and (2) triadic multi-sided models, which serve several different user groups simultaneously through a shared platform.

Building on this business model typology, scholars have put forward the idea of *polyadic* relationships, which involve multiple interdependent parties in complex, interconnected networks, characterized by more fluid boundaries and less control over value creation and delivery than dyadic and triadic relationships (Ritter and Schanz, 2019). Polyadic relationships extend beyond the direct and indirect interactions between buyers and suppliers to also include the broader interconnected network of stakeholders, including employees, financial stakeholders, and societal stakeholders (Norris et al., 2021). As shown in Fig. 4, business models with polyadic relationships involve value creators, value capturers, and intermediaries that play different roles in different networks, making their boundaries fluid and dynamic. For example, actor A in Fig. 4 plays an intermediary role in Network 1, while capturing value in Network 2 and creating value in Network 3.

The novel opportunities of value creation and value capture as described in section 2 and depicted in Fig. 3 suggest that NFT-enabled business models do not fit into the existing typology of dyadic and triadic business models. First, because the main actors involved in polyadic relationships, namely the provider (company), prosumers, technical intermediaries, business intermediaries, and complementors, do not fit into dyadic or triadic business models. Here, the relationship between the provider and its prosumers is different from that in dyadic models in the sense that the proliferated value (of NFTs) depends on value co-creation activities of both the provider (NFT creator) and prosumer (NFT buyers). Therefore, unlike the dyadic product business model, prosumers play a key role in the company’s value capture potential. In addition, the interaction between the company and its prosumers continues to grow after the purchase of the offering (due to the digital nature of the offering), different from the dyadic solution business model.

Second, compared to triadic business models, the multiple groups of intermediaries involved in polyadic relationships do more than just connect consumers with suppliers which is the case in triadic matchmaking business models. Here, every stakeholder or complementor is provided with multiple paths of value creation and capture that best fit

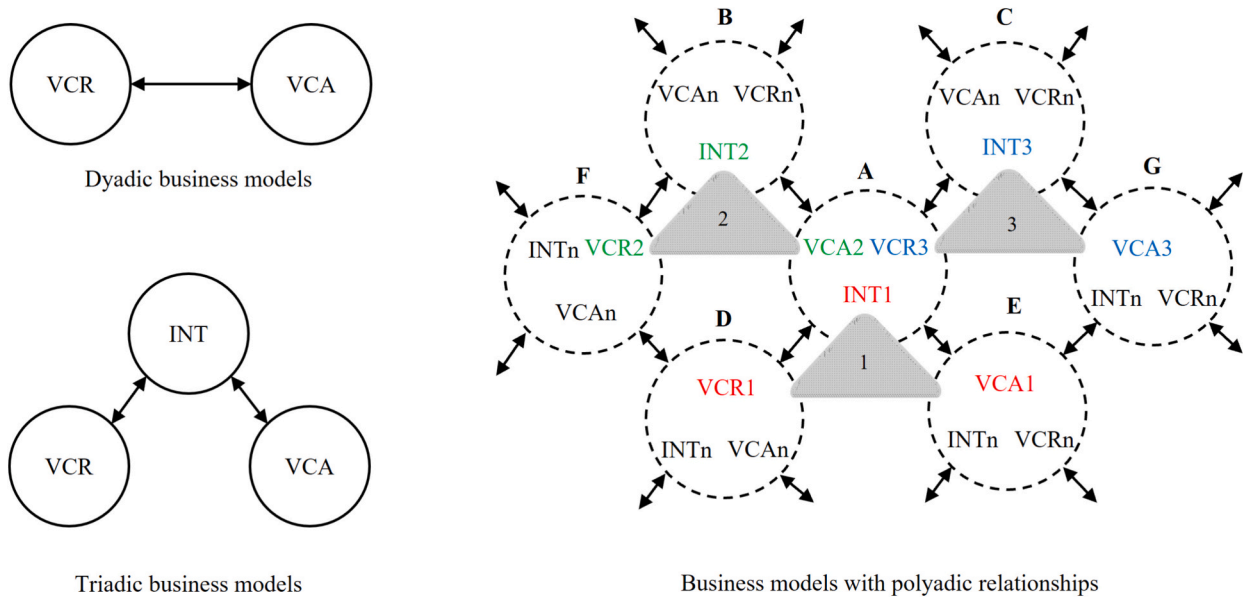


Fig. 4. Dyadic, triadic, and polyadic business models. Notes: VCR: Value creator; VCA: Value capturer; INT: Intermediary; Dashed perimeters indicate fluid boundaries.

their needs and circumstances. Moreover, the interactions among different groups of complementors in polyadic relationships (marketplace organizer, infrastructure provider, cryptocurrency suppliers, and crypto wallet services) are more dynamic than the relationship between consumer beneficiaries and paying-customers in triadic multisided business models. Here, traditional boundaries within the ecosystem are blurred as complementors converge in the creation and capture of value.

Third, polyadic relationships offer different kinds of use and exchange values to the company and its customers than those in dyadic and triadic business models. The incorporation of blockchain technologies into customer relationship management leads to major cost savings due to decreased paperwork. Moreover, the increased accuracy and transparency enabled by smart contracts attract more customers to purchase the company’s offerings. No other business model can make consumers as endogenous to the firm as this new business model, given the specific mechanisms designed to generate royalties, provide utility and access, enable collective ownership and secondary markets, and integrate with blockchain-based ecosystems such as DeFi and the metaverse. This new type of business model leverages the capabilities of blockchain technology and Web 3.0 infrastructures (e.g., asset tokenization, smart contracts, automated governance, and interoperability) to create mutual value for businesses, customers, and intermediaries. As the company’s offerings gain market acceptance, value is simultaneously created and shared across the entire stakeholder ecosystem, reinforcing network effects and scalability.

Therefore, we suggest that NFTs enable a new type of business model that accommodates polyadic relationships. Compared with existing business models, there is only a limited potential for value capture over time, while this new business model opens the possibility of achieving greater value from the same offering in the long run. The new polyadic business model provides customers with the opportunity to co-create proliferated value with the original creator/company. Thus, there is no clear-cut boundary between the company and its customers as in the case of dyadic or triadic business models. Also, since NFTs are based on blockchain technology, there are no hierarchies, but rather decentralized systems that promote free flows of information within transparent digital ecosystems. Table 3 summarizes the comparison of the new business model with existing dyadic and triadic business models.

To gain insight into this emerging business model, we will be exploring how businesses make use of its novel opportunities and

Table 3
Emerging business models compared to existing dyadic and triadic business model types.

	Dyadic business models	Triadic business models	Business models with polyadic relationships
Ecosystem members	Company and customers	Company, customers, and third parties (matchmakers, customer beneficiaries, and paying-customers)	Company, customers, intermediaries (technical and business), and community that create a network effect and contribute to generativity over time
Use values	Consumers obtain value during (with the help of the provider) and after purchase	Consumers obtain value with the help of third parties	Consumers obtain value by gaining access to specific resources that enable superior value creation and capture
Exchange value	Exchange value does not proliferate over time	Exchange value proliferates over time for the intermediary only	Exchange value proliferates over time for all parties involved through multiple cascading paths
Value creation	Develop products or services to meet consumer needs	Connect consumers with providers and other ecosystem members	Generate value through distributed and decentralized business operations and processes
Value capture	Sale of products or services	Charge commission for facilitating the interaction among ecosystem members	- Sale and trade of digital assets - Earning royalties - Utility and access - Collective ownership and secondary markets - Integration with new Web 3.0 ecosystems such as DeFi and metaverse

seeking to uncover the underlying mechanisms. In doing so, we will be looking at the opportunities and challenges posed by NFTs, the business ecosystem surrounding NFTs, as well as how ownership, governance, and competition will be affected by them. We will be basing our research methodology on these questions, taking into account the specific geographical context of Portugal, where an open and increasingly growing market of NFTs is gaining attention from investors worldwide (Sergio and Wedemeier, 2025).

3. Methodology

A qualitative design was chosen for its ability to explore the multi-faceted and dynamic nature of NFT-enabled business models and polyadic value creation and capture mechanisms, allowing for deeper understanding, flexibility, and contextual insights (Bouncken et al., 2021). Further, following Gerring’s (2004) seven case study selection criteria, this study adopted a case study research design to: (1) prioritize descriptive rather than strictly causal inferences; (2) ensure depth in understanding polyadic inter-firm relationships in emerging business models; (3) improve internal case comparability among our sample blockchain ventures; (4) focus on causal mechanisms of value creation and capture rather than statistical size effects; (5) explore invariant (deterministic) rather than probabilistic causal relationships; (6) accommodate the exploratory nature of this research to support theory generation; and (7) capture meaningful differences within cases rather than broad generalizations across a large number of cases. We have observed multiple cases adhering to the notion that the use of multiple rather than single cases helps achieve triangulation, which increases confidence and accuracy of data analysis (Stake, 2006). Finally, in terms of methodological reasoning, this research follows an abductive approach to theory generation by observing and confirming anomalies (new types of business models and the polyadic inter-firm relationships within them, and complex business ecosystems that cannot be adequately explained by existing theories) and generating and evaluating plausible explanations for these anomalies (Sætre and Van de Ven,

2021). Accordingly, while informed by existing theories on NFT use values, exchange value determinants, and polyadic relationships in emerging business models, the study also accommodates new insights to emerge from empirical analysis.

In terms of the stages of the research process (Fig. 5), following Darlington and Scott’s (2020) qualitative research guide, after developing the research question and consequently a literature review on NFTs, their use values, exchange value drivers, and emerging business models, we identified a sample of blockchain companies based in Portugal for the empirical study. The context of Portugal is important given its crypto tax-friendly environment and legal approval for self-executing or smart contracts in Portuguese law (Decree-Law No. 7/2004), providing legal comfort for individuals and businesses implementing blockchain-based solutions (Moreira et al., 2019).

Sampling included a combination of two purposeful sampling methods: intensity sampling and snowball sampling. First, intensity sampling was used to identify “excellent or rich examples of the phenomenon of interest, but not highly unusual cases” (Patton, 2014, p. 234). We defined intense cases as blockchain-based businesses actively utilizing NFTs in their value creation and capture mechanisms. These cases were identified through industry reports, NFT business databases, and expert recommendations (Farquhar, 2012).

In the second stage, snowball sampling was employed to improve the selection process. We asked executives, investors, and industry experts to recommend additional Portuguese blockchain ventures that fit our criteria. To ensure a diverse and representative sample, we carefully followed recommendations based on business model relevance, technological adoption, and operational maturity (Noy, 2008). To further refine the selection, we consulted several experts in blockchain business strategy and NFT applications. Their role was to validate the suitability of the selected intense cases, ensuring a well-rounded sample covering the key players in the Portuguese blockchain industry.

As shown in Table 4, our final sample included 12 businesses located in Portugal, of varying sizes (startups, SMEs, and established firms) and different operational stages (early-stage, growth-stage, and mature

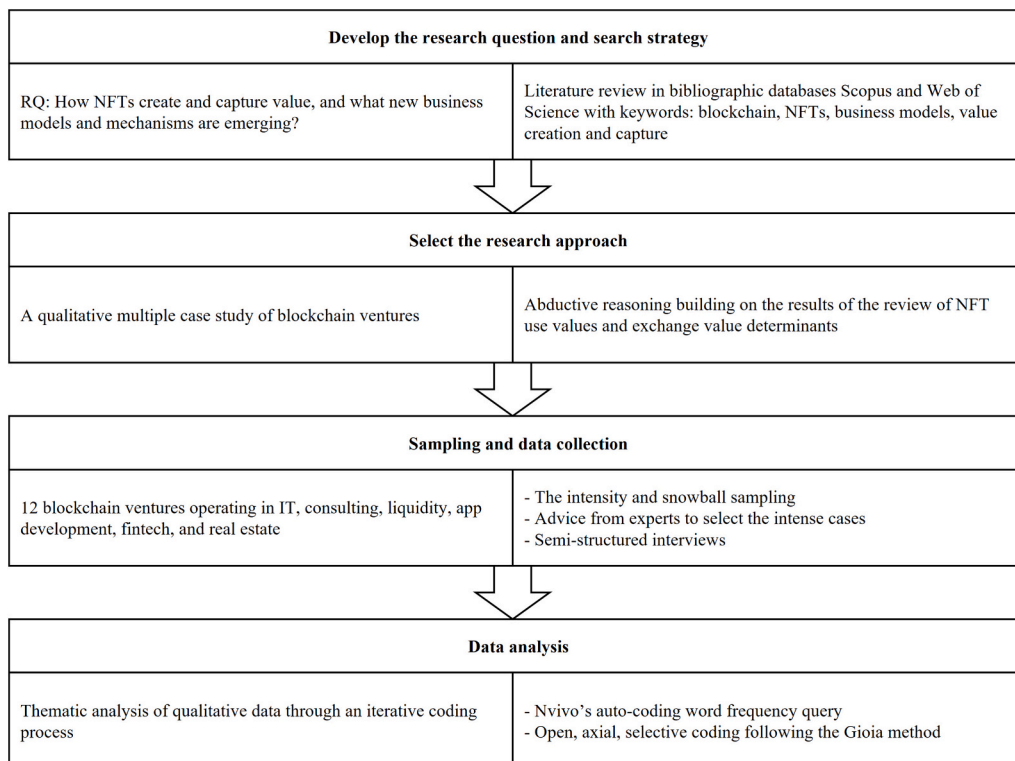


Fig. 5. A visual representation of the methods, tools, and progress through the research stages.

Table 4
Sample profile.

Interviewee No.	Position/ Responsibilities	Company Area	Company Size (N of employees)	Interview duration
1	Blockchain and digital assets analyzer	IT services and consulting	Large (above 250)	60 min
2	Product development manager	Business consulting services	Small (below 50)	63 min
3	Market and portfolio manager	Cryptocurrency liquidity solutions - digital asset management	Large	41 min
4	Business developer manager	Blockchain infrastructure provider	Medium (50–250)	44 min
5	Sales Executive	Decentralized app store	Medium	34 min
6	Vice-President	Association of blockchain entities	Small	42 min
7	Chief marketing officer	Digital payment services	Medium	33 min
8	Director	Luxury real estate agency	Small	36 min
9	Account manager	Financial services	Large	43 min
10	Entrepreneur/ Investor	Investment	Small	31 min
11	Business developer manager	Fintech	Medium	25 min
12	Entrepreneur	Decentralized finance	Small	27 min

businesses). These businesses operated across diverse industries, including IT management and consulting, liquidity services, app development, Fintech, and real estate. While case study findings are primarily applicable within their specific contexts, the careful selection of representative cases in this study strengthened the potential for theoretical generalization (Creswell, 1998).

For data collection, we developed an interview guide with open-ended questions focused on the business applications of NFTs and how they differ from traditional business models. Next, we conducted 12 in-depth, semi-structured interviews in 2022 and 2023 with representatives of the 12 selected blockchain ventures. The questions were refined over the data collection process based on the feedback from participants. Further, follow-up questions and probes were made to bring more clarity to the statements. Carried out in English, and lasting from 25 min to more than one hour, all 12 interviews were conducted face-to-face, tape-recorded, and then transcribed. We continued interviewing until a theoretical saturation indicated by data replication or redundancy was achieved (Bowen, 2008). The codebook was in place after the first interview and was continually updated thereafter. Focusing on the overarching themes as the main criteria for saturation (Guest et al., 2006), we stopped data collection when the last interviews produced little change to the overarching themes in the codebook.

The next step was data analysis, which we began by organizing all the transcripts into a single structure and style (to enable the auto-coding function in NVivo) and then imported them into the software to set off the data analysis process. We used the NVivo 12 Qualitative Software Package to code and classify data. First, the Word Frequency query in NVivo's auto-coding allowed us to identify the most common words mentioned by interviewees (See Appendix A), which were used for detecting relevant segments of text for further coding. The transcripts were coded through the three-step coding process: open, axial, and selective coding (Strauss and Corbin, 1998) and further processed

according to the Gioia Methodology (Gioia et al., 2013). Therefore, as can be seen in Appendix B, we started with an open coding to extract key concepts as 1st order codes from auto-coded segments of text. This was followed by axial coding, trying to identify the relationships between the initial 1st order (informant-centered) codes and classify them into 2nd order (theory-centered) themes. Eventually, the selective coding led us to further refine the data by creating aggregate dimensions for further categorizing the identified 2nd order themes. The data structure was improved over the course of coding in an iterative back-and-forth process between empirical analysis and theoretical development (Magnani and Gioia, 2023), allowing us to organize the results section thematically around the core concepts of technology affordances, ecosystems, and value creation and capture mechanisms. Overall, the coding generated 75 codes under 10 themes and 11 subthemes. In the following section, we describe our findings from 12 interviews with selected blockchain venture informants.

4. Results

The findings are presented thematically to reflect the core dimensions that emerged from the review and data analysis, allowing for a clearer presentation of key findings and their interrelationships. Accordingly, we begin by explaining the technological affordances of NFTs based on the results of the review of the use and exchange values of NFTs, which led us to ask experts about the real-world use cases and applications of the technology. Next, we explain the structure and dynamics of NFT ecosystems, including sources of generativity, mixed-side network effects, and the convergence of complementors and ecosystems. This is because, when explaining the applications of NFTs, experts have highlighted the role of different actors such as marketplaces and exchange services. Finally, answering the main research question and drawing on theories of polyadic relationships, we arrived at polyadic value creation and capture mechanisms. This section concludes with the societal implications of the technology, illustrated by two cases: ticketing and the app economy.

4.1. NFT technology affordances

4.1.1. Utility affordances

The facilitation of the trading of digital content is the first identified utility affordance of NFTs. As Interviewee 2 emphasized, 'you no longer have banks' fiscal pressure and other cumbersome regulatory procedures'. NFTs also improve the accuracy of digital content trading by avoiding errors and mistakes, thanks to self-executing smart contracts: 'NFTs offer new solutions by the use of smart contracts, which have a broad spectrum of accurate actions with minimum errors' (Interviewee 2). Given its nature and qualities, digital content collection and trading are always subject to security vulnerabilities and privacy breaches. NFTs' stronger security configuration mechanisms minimize these threats: 'The security provided by blockchain technology improves on other initiatives to create digital assets' (Interviewee 3). Key to the functionality of an NFT is also the transparency of its ownership and trading records: 'It is important to have tools like NFTs that can transparently verify processes and procedures' (Interviewee 6). 'When I hear about NFTs, I immediately think of one word: transparency, which is completely lacking in traditional systems' (Interviewee 7).

The second utility affordance of NFTs identified in this study is membership access. NFTs can be used for registration and identification of event attendees: 'I think NFT tickets for sports matches, music concerts, or any other events are quite easy to use and implement. They avoid all the ticketing paperwork used currently for authentication' (Interviewee 1). 'Companies can create lifetime NFTs for ticketing purposes. For example, for a recurring festival, users get an NFT lifetime ticket which they can sell later if they want and the festival organizers receive royalties' (Interviewee 7). Digital content creators can use NFTs for direct communication with users and community members: 'I think

the beauty of web 3.0 solutions like NFTs is that they operate in an ecosystem where you can communicate with fewer frictions than before' (Interviewee 5). According to Interviewee 8, NFTs can be used to grant access to metaverse-like environments: 'Companies airdrop NFTs by which users can get access to metaverses like Sandbox and own properties like land, streets, apartments, or shops.' Lastly, with NFTs, companies can successfully employ the freemium model, providing basic services to all users and premium features exclusively to NFT buyers: 'NFTs open a secondary market where companies get to provide additional offerings to customers' (Interviewee 7).

The third utility affordance of NFTs is the possibility of integration with physical products, as pointed out by Interviewee 4 in the case of the real estate sector: 'NFTs bring many opportunities in real estate and stock exchange markets. You can buy a fraction or share of real estate using NFTs.' An NFT can also be attached to a given product to better track and trace its past and present locations along the supply chain. This helps improve inventory management and new product planning and scheduling. Further, NFT custody solutions improve the efficiency of waste management and recycling of production systems.

The fourth identified utility affordance of NFTs is their application in the sharing economy. Both access and ownership rights can be shared in a peer-to-peer manner through users' wallets: 'NFTs can majorly improve the ownership economy because all the ownership issues will be based on people's wallets. In this new ownership form, people will not only own a car, for example. They will own the usage of that car brand too' (Interviewee 4).

4.1.2. Social affordances

Given the early adoption and continual growth of NFTs in digital art, social positioning has been a popular affordance. NFTs are used to promote social standing among peers in a community. As the results indicate, people can use NFTs to prove identity in the virtual world: 'The Bored Ape NFT is a good example of a project targeting big brands and famous people' (Interviewee 8). NFTs allow users to reflect their standing in relation to others in the online world by linking their social media profile pictures to NFTs, for example: 'NFTs bring reputation and brand image to famous people like Madonna, Jimmy Fallon, and Post Malone, same as a kind of statue. It's like you pay \$10,000 for a Gucci shoe. The difference is that most people cannot see that you own that shoe. But with a Bored Ape NFT, everyone can see that you have one' (Interviewee 8).

Another important affordance of NFTs is the ability to build and grow communities. NFTs can be used to reach and attract new users: 'Speaking of NFTs in gaming, the studios are now creating NFT games that are going to be strong as it has a good value proposition for the community of gamers' (Interviewee 2). NFTs also have the potential to activate current community members, fostering their engagement: 'It is important to have users' support. You need to be there every day, encouraging them to use your NFTs' (Interviewee 7). Finally, NFTs help ensure the success of future projects and developments by creating fans' support: 'They (a video game studio) are going to create a new NFT game, a Game-Fi where you can play using NFTs that you bought earlier in the marketplace' (Interviewee 1).

4.1.3. Financial affordances

According to the results, NFTs have the potential to generate additional sources of economic value through secondary sales royalties, sales performance improvement, and fundraising. Selling into the aftermarket, NFTs allow the creators of digital content to benefit from secondary trades after the original issue. As Interviewee 1 points out, this helps expand the value stream for the original creators: 'Take cars as an example. If I sell one car, that's it. I don't make any more value after the sale. Instead, if I sell cars and use NFTs, I can have even more and engage better with people since I have their wallet addresses, for example' (Interviewee 1). With the potential to increase value over time, NFTs provide the original creators with passive sources of income: 'With NFTs,

every time someone watches a video or plays a song, the creator receives royalties very easily and quickly. I think this royalties system will make a huge change' (Interviewee 7).

NFTs can offer a unique set of affordances that can unlock new sources of economic value. For example, creators can use NFTs to sell digital content and benefit from secondary trades and royalties. NFTs can also be attached to physical assets for sales improvement, such as in the real estate sector, as Interviewee 4 points out: 'With NFTs, you can buy a fraction or share of the property. In traditional real estate investment, you have to buy a complete property, invest lots of money beforehand, and maybe ask for a loan with too many barriers and high interest rates. The buyer also has to wait long for someone to pay the whole money for the house.' NFTs also accompany physical products, providing secondary revenue streams. Finally, as highlighted earlier by Interviewee 1 in the case of a new game release, companies can improve the chances of a successful product launch by releasing NFTs beforehand.

NFTs further facilitate large fundraising through Over-The-Counter or OTC trading in which the fundraiser connects directly with the beneficiary without any central exchange or broker. 'If you're buying a house, for example, instead of traditional payment gateway systems used on the checkout process, OTC can be used' (Interviewee 7). NFTs can also be used for crowdfunding practices: 'For example, for scrutinizing the application of funds, the usage of the funds can be recorded by DLT (Distributed Ledger Technology) or things like NFTs' (Interviewee 6). Finally, NFTs can be used as collateral to facilitate loan administration and management: 'We have a service in which anyone can provide NFTs as collateral and get a loan on digital assets' (Interviewee 3).

4.1.4. Legal affordances

Finally, the results reveal that NFTs' legal/regulatory value in terms of tokenized ownership and governance, as well as the protection of intellectual property. NFTs offer a variety of affordances in terms of digital asset ownership, governance, and intellectual property protection. For example, as Interviewee 4 points out, NFTs can facilitate the transferring of valuable physical assets' ownership rights: 'With NFTs, all the ownership issues will be based on owners' wallets. In this new ownership form, people not only own a car, for example, but also the usage of that car brand.' NFTs can also be used for coin voting in decentralized autonomous organizations: 'In some DAOs (decentralized autonomous organizations), NFTs are used as governance tokens for things like ownership purposes, meaning who has the most tokens will have more power' (Interviewee 4). Additionally, NFTs can be used for stock share tokenization as Interviewee 9 points out: 'create an NFT on a blockchain platform and assign a one-to-one correspondence between the NFT and the share' or to monitor and track the allocation of public investment: 'NFTs can be used to scrutinize the application of government funds by taking care of public tenders and avoiding the corruption of European funds' (Interviewee 6). Furthermore, NFTs can reduce bureaucracy in processes: 'NFTs avoid all these papers and everything that you have to sign to make something authentic and then keep it somewhere in some database or print it and keep it somewhere' (Interviewee 4).

In terms of intellectual property, NFTs can also be used to represent identity and background in digital spaces. As Interviewee 4 describes, this can boost the recruitment and selection of human resources: 'Traditionally, companies put job ads and then applicants provide their CVs directly or indirectly through companies like Accenture, which can be very costly. With NFTs, you can have all the records like the position, achievements, awards, and prizes on the blockchain. This is a trustless solution as you can clearly see the applicant's skills and background.' NFTs can also protect the intellectual property rights of digital content creators, as Interviewee 1 points out: 'I think it's important to separate NFTs from the usual stereotype of being just a bunch of JPEGs. It is important to explain NFTs as a technology that can authenticate digital content, something which was not possible before.' Finally, NFTs can be

used to license patents to digital content users. In this way, NFTs offer a range of affordances that can revolutionize many industries.

4.2. NFT ecosystems: Structure and dynamics

Based on our analysis, we find that NFTs evolve around a multi-dimensional and dynamic ecosystem made up of three key constituents: producers, customers, and complementors. These components of the ecosystem interact with each other through cooperation, competition, resource sharing, and complementary products and services in environments such as marketplaces, metaverses, cloud games, and centralized or decentralized social media platforms. Therefore, to better understand NFT ecosystems, we synthesized the codes and aligned them with our literature review findings, arriving at three key themes: sources of the generativity of the technology, mixed-side network effects, and interaction of complementors with the ecosystem.

4.2.1. Sources of generativity of NFT technology

The NFT ecosystem is first characterized by multiple sources of generativity stemming from different types of NFTs and decentralized applications. We find that utility NFTs enable multi-functionality such as providing a verifiable record of ownership and authenticity for digital assets, access to private quality content and membership in private communities, events, or social groups, and decentralized verification of personal or professional identity and credentials. Multimedia NFTs enable interoperability across multiple platforms, such as various public marketplaces or private channels, as well as applications such as social media platforms or virtual environments like metaverses. NFT games promote generativity among ecosystem members, including players, creators, developers, game studios, publishers, and platform providers, through robust, secure, and transparent in-game asset ownership and control mechanisms. In addition, users (players) as “uncoordinated audiences” are offered new revenue streams such as play-to-earn models. Physical NFTs have the potential to increase and sustain the value of physical assets by integrating them with digital elements in sectors such as art and collectibles, real estate, and fashion. Finally, in decentralized social media platforms, NFTs can be used as a source of generativity to improve content authenticity and monetization, as well as proof of user engagement. All of these sources of generativity facilitate interaction among members of the ecosystem. For example, digital art, music, and media NFTs allow artists to become producers of NFTs, avoid intermediaries, and sell directly to customers, thereby reducing their costs. Interviewee 7 reflects on music and complementary services: ‘I think (with NFTs) the music industry will change and also all the services like festivals will be influenced. For example, for the Coachella music festival, you decide to spend 10,000 euros to get a lifetime ticket, which is a lot, but then you can sell it easily if you want, and Coachella benefits too because they get royalties.’

4.2.2. Mixed-side network effects

The NFT ecosystem includes consumers, but also prosumers, who add value to the ecosystem as more users participate (network effect). Prosumers are individuals or organizations that both produce and consume goods and services. In that sense, they are a hybrid of producers and consumers, and typically have the ability to both create products and services as well as purchase them. In the NFT ecosystem, we find that investors, speculators, asset owners, buyers, gamers, app developers, users, and app stores can all benefit from the dynamics of Web 3.0 and blockchain technology, and they can also become prosumers. The network effects they generate are a mixture of same-side and cross-side network effects. Value increases as more users join the same side of the NFT ecosystem, providing a larger user base for digital asset creators and owners. And the value keeps increasing as more users join the other parts of the ecosystem. As more producers create digital content with NFT-based items, more users are drawn to the ecosystem for unique digital assets. At the same time, as more prosumers engage

with and buy NFT items, more consumers and producers are motivated to participate in the integration of NFTs. For example, in the gaming industry, players can develop in-game digital items such as tools, avatars, and accessories, and developers and app stores can make a profit when the NFTs attached to those items are traded. Prosumers also find it more encouraging to get involved in the development of projects. Interviewee 5 said: ‘There are three customers in the ecosystem: app developers, users, and app stores. Users pay the app developers and part of the money also goes to the app store that supports decentralized apps.’ Interviewee 2 adds: ‘In Web 3.0, rather than a small group of investors or companies, your shareholders are going to be hundreds or thousands of investors who each have a small share.’

4.2.3. Convergence of complementors within the ecosystem

Web 3.0 business ecosystems include major intermediaries and complementors that provide the necessary infrastructure for the effective operation of blockchain-based solutions. According to the results, the key complementors in the NFT business ecosystem include blockchain infrastructure providers, marketplaces, crypto exchanges, wallet providers, and consultancy businesses. First, companies like Ethereum Switzerland GmbH provide the basic systems and services, as well as security and privacy necessary to run blockchain-powered projects: ‘We provide a platform (infrastructure provider) by which you can have a scalable, secure and also fast blockchain-based solution for your projects. It is like you can use our highway to drive your car or a fleet of cars’ (Interviewee 4). Secondly, NFT marketplaces provide services for minting NFTs as well as trading digital assets that are attached to NFTs: ‘NFTs also allow you to interact with other projects, for instance, with digital art collections that you can see on OpenSea, which is a marketplace for NFTs’ (Interviewee 2). Thirdly, wallet providers are in charge of keeping users’ digital assets, like NFTs or cryptocurrencies. As Interviewee 1, for example, mentions, NFT tickets can be kept inside wallets: ‘I can hold this NFT ticket in my wallet and I can just send the ticket to someone else very easily.’ Fourthly, crypto exchanges facilitate the buying of cryptocurrencies that are necessary to purchase NFTs. According to Interviewee 3, Binance and Coinbase are two major crypto exchange service providers in the market. In addition, Interviewee 11 points out the implications of Central Bank Digital Currency (CBDC) and how tokenized assets are being used to facilitate intermediaries in various sectors: ‘One of our clients intends to establish a new blockchain system and is trying to help create CBDCs to be used as tokenized assets in real estate’. Finally, business consultancy services help companies develop new projects using NFTs. As Interviewee 2 mentions, these stakeholders guide the businesses through different stages of the project development process: ‘We provide workshops about how companies can help their customers to invest using NFTs and cryptocurrencies. For example, how they can buy a house using Bitcoin and how to deal with law issues.’

The architecture and properties of NFT technology drive ecosystem complementors to converge in various aspects. Blockchain infrastructure providers prepare the underlying technology and network (e.g., hosting and cloud services) for marketplaces to enable the creation and trading of NFTs. NFT creators and buyers can become prosumers, converging on marketplaces to mine, list, and trade NFTs. Crypto exchanges and marketplaces converge on the purchase and exchange of cryptocurrencies used to purchase NFTs. The former can develop and promote their own marketplaces, and the latter can issue and release their own tokens and cryptocurrencies. Finally, wallet providers and decentralized applications, such as metaverses and cloud games, converge to store and manage NFTs and associated cryptocurrencies in virtual environments.

4.3. Mechanisms

Our results indicate that NFTs hold powerful potential for creating unique value for customers and capturing a significant portion of the

value obtained otherwise by other market players. Therefore, we placed a focus on the mechanisms by which firms satisfy customers' needs and unlock financial opportunities. These mechanisms help to further characterize the emerging business models that differ from dyadic and triadic ones. The results suggest that the mechanisms are manifested in three categories: 'Advanced token distribution and fundraising', 'Polyadic value creation and capture', and 'Automated and tokenized facilitation processes enabled by smart contracts.'

4.3.1. Advanced token distribution and fundraising

The first emerging mechanism concerns digital asset allocation. With NFTs, providers can offer other ecosystem members the opportunity to purchase unique digital assets early in the project for a limited time. Through this crowdfunding mechanism called the Initial NFT Offering (INO), customers obtain the ownership of an asset, which potentially increases value later alongside the development of the project. As Interviewee 5 points out, INO is of special value for startups that require funds from external investors: 'We created an INO to raise money for the startup. The INO made sense from a business and strategy standpoint because we were competing against a very large rival who was dominant in the market.' As mentioned by Interviewee 6, STOs (security token offerings) also provide customers with the ownership of traditional securities such as stocks, bonds, or options. NFT airdrop is another mechanism in which new NFTs are sent to current customers' wallet addresses, appreciating their support and loyalty. As Interviewee 8 illustrates, this can also encourage customers' further engagement in the offerings: 'They (BAYC) released a second NFT collection, in which you could have a unique Mutant Ape and then they airdropped NFTs to buy things in their metaverse in the form of a game.'

4.3.2. Polyadic value creation and capture

According to the results, NFTs unlock multiple paths of value creation, which develop with the mutual contribution of the provider and prosumer. The results also suggest that these generative mechanisms allow the ecosystem members to use multiple paths to create and capture value. We coin these the Polyadic Value Creation and Capture mechanisms as they do not fit into previously known mechanisms involved in either dyadic or triadic business models. First, NFTs enable passive income through royalties protected by distributed ledger technologies. Interviewee 7 explains this mechanism in the case of event ticketing: 'I believe companies will introduce lifetime NFTs for tickets. Then you spend 10,000 euros, for example, to get a lifetime ticket for a recurring festival and you can sell it so the festival team gets royalties.'

NFTs also enable a new reselling mechanism in which the original creator of a digital/physical offering continues to benefit from each reselling activity, not only by receiving royalties but also through direct interaction with all the buyers. Interviewee 1 illustrates this point in the case of the car industry: 'Traditionally, a car company doesn't have contact with the new owner. However, if they sell cars with NFTs, they can then create more engagement with all buyers through their NFTs and wallet addresses.' NFTs can be used as a loyalty mechanism in which customers gain a reward as a sign of appreciation and gratitude: 'We create a loyalty scheme, in which, in every payment that customers make, they get a percentage of those payments in tokens.' (Interviewee 5). Another polyadic value creation mechanism is the promotion of the buying and selling of NFTs after they have been sold once. Illustrated by Interviewee 1 in the case of event ticketing, this mechanism can lead to increased exchange value: 'With NFTs, football clubs can control the secondary market. Currently, after selling the tickets, they have no idea what's happening with the tickets afterward. People can duplicate tickets or sell them at much higher prices. But with these NFTs, they can create a marketplace where buyers sell tickets if they can't go to the stadium. They can propose a higher price for the tickets or get a royalty. This way, they avoid false tickets, which happen a lot.'

As suggested by the results, the community of users plays a key role in the development of Web 3.0 projects. Therefore, an important NFT-

enabled mechanism is to grow the community before the product release using related NFTs. As mentioned before, this is best illustrated in the gaming sector, where characters and in-game elements can be released through NFTs before the game's official release. In a similar vein, NFT whales (groups or individuals that hold a large amount of highly-priced NFTs) are valuable sources of income and hence must be detected and absorbed. As Interviewee 5 implies, NFTs can be used to further engage the whales: 'In gaming, the majority of income comes from a very small percentage of users, whales. Our job is to convince them to use our solutions by offering them more value by NFTs and cryptos.'

4.3.3. Automated and tokenized facilitation processes enabled by smart contracts

The third mechanism identified focuses on streamlining and securing all value creation and capture processes while reducing the need for intermediaries. First, NFTs can be attached to in-app items, facilitating their purchase and use. Interviewee 8 illustrates this in the case of in-game items used for investment and growth: 'For example, you can buy a piece of the map in the Fortnite game. The cost of that map can be huge and I would pay for it because there are millions of people playing the game every day and by owning the map I can put a Netflix logo in there or rent the space to McDonald's for example.' This also facilitates the patenting and licensing of digital content such as add-on software. The findings also imply that platform businesses struggle to capture value from in-app purchases due to technical challenges and usage barriers. As Interviewee 5 points out, the NFT-enabled in-app purchase mechanism reduces financial frictions (i.e., the stickiness involved in making transactions, such as the delay in adjusting prices or interest rates): 'We provide payment gateways for dApps which reduce payment frictions in making in-app purchases. Now, there are a lot of frictions in payment and our first value proposition is visibility meaning we increase traffic for our customers which they can monetize in two ways: in-app purchases and in-app ads.'

NFTs facilitate joint activities between the creator of digital content and prosumers, such as music collabs, remixes, and fan edits. Similarly, joint investment in large and major projects is greatly facilitated by NFTs: 'In Web 3.0, your shareholders are not going to be a small group of investors or companies. Rather, it's going to be the hundreds or thousands of people that jointly invest in the project and each has a small share.' (Interviewee 2). Computing the track and record of digital assets' exchange history effectively, NFTs facilitate the analysis of users' purchase decision-making. As Interviewee 1 illustrates, this can facilitate business relations in many different areas: 'Users can own tokens in their wallets which represent points from supermarket, gas station, restaurants, etc. So, for example, if I go to a gas station to fill the tank and I need more points in my wallet then I can use tokens I got from the supermarket.'

Finally, NFTs facilitate governance and control mechanisms through algorithmic decision-making. For example, Interviewee 10 illustrates this for the transaction process of company shares in a more democratized and transparent way: 'I see the future financial industry as democratized or at least partially democratized. In this new tokenized share landscape, the infrastructure and process of company share transactions will be completely transformed.' As Interviewee 4 mentions, this especially facilitates the creation and growth of DAOs: 'It is really common for a DAO to have some kind of governance tokens, which are used for ownership and governance purposes so that whoever owns the governance tokens has the power in making decisions.' In a related context, the results indicate that NFTs facilitate control mechanisms through smart contract-enabled automated decision-making: 'Using Snapshot (a decentralized voting system), members can create proposals for organization's decisions that will be made automatically if enough votes are generated (Interviewee 4).' Interviewee 12 describes the automation capabilities of a blockchain protocol in improving the efficiency of financial services: 'Our zero-knowledge smart contract

platform automates administrative tasks in existing financial services, which is especially beneficial for those whose core business consists of exclusively administrative tasks.'

Based on the results, Fig. 6 below illustrates the NFT business ecosystem in which the four types of value are created and captured through polyadic mechanisms.

5. From art to asset: Navigating the impact of NFTs on society

In this section, we discuss the impact of technology on society through two illustrative cases: NFT ticketing and the decentralized app economy. Consistent with previous research (Antsipava et al., 2024; Arora and Kumar, 2022), the results of our analysis suggest that blockchain technology holds the promise of empowering entrepreneurs and small businesses through the decentralization of structures and decision-making. Our findings on utility, social, financial, and legal affordances highlight the decentralized nature of the technology, which facilitates secure and transparent peer-to-peer transactions while reducing the influence of centralized entities, a point noted in previous research as a counter to the potential monopoly power of intermediaries (Chen and Bellavitis, 2020). Our findings align with previous evidence suggesting that barriers to establishing direct and trusted interactions between service providers and consumers have hindered disintermediation (Großmann et al., 2024). This highlights the need for blockchain-based technologies, such as NFTs, that eliminate reliance on costly intermediaries. An illustrative case is the issue of live event ticketing and secondary market transactions in the sports and entertainment industry. In line with previous research (Regner et al., 2019), our findings indicate that despite all the advances in platform technologies, event organizers still rely on e-ticket systems using QR codes, ignoring the fact that no matter how much we invest in new platforms and ticket control systems, they will eventually fail because the underlying infrastructure is highly centralized and hence vulnerable to scalping, fraud, lack of transparency, monopolistic practices, and secondary markets. Recent examples include the sale of 40,000 fake tickets at the Champions League final

between Liverpool and Real Madrid (The New York Times, 2022) or ticket fraud on Coldplay 2022 concert tickets in Portugal (The Portugal News, 2022). Another issue is that due to black market ticket sales and the lack of exchange protocols, there is no safe, transparent, and organized way for buyers who cannot attend the event to resell their tickets. This also poses a serious threat to event organizers, who do not know who is attending the event.

Consistent with previous evidence of the usefulness of NFTs in preventing fraud and improving control over secondary market transactions (Regner et al., 2019), we also find NFT ticketing as a practical solution to these problems. The admission team can mint NFTs and attach them to the event's tickets. They can define the sales and trading regulations in the smart contract to protect buyers and minimize fraud and unfair speculation. In addition, ticket resale is easy and effective through marketplaces such as Opensea, and whenever a ticket is resold in such markets, royalties are paid to the legitimate parties involved in the ticketing process, including the event organizer. Scholars have highlighted the technology's ability to track transaction history thanks to smart contracts (Arora and Kumar, 2022). Similarly, we conclude that the technology allows the organizers to effectively track and record the exchange history of tickets across the chain. This makes it easier to distinguish the original purchaser and legitimate buyers from fraudsters and unfair opportunists. Another problem with traditional ticketing systems is that they are not designed to reflect the memories and special moments of the events (Regner et al., 2019). NFT tickets, on the other hand, are memorable and will be kept in the buyer's wallet at all times. Not least, NFT ticketing systems are relatively less expensive and more sustainable, offering practical benefits to event organizers, attendees, and promoters.

The second problem is that in the current centralized digital service and business economy, digital content creators and service providers rely heavily on tech giants as intermediaries (Murray et al., 2023), resulting in a significant loss of revenue to these central monopolies (Chen and Bellavitis, 2020). Based on our findings, we present an illustrative case of the current app economy, which is characterized by

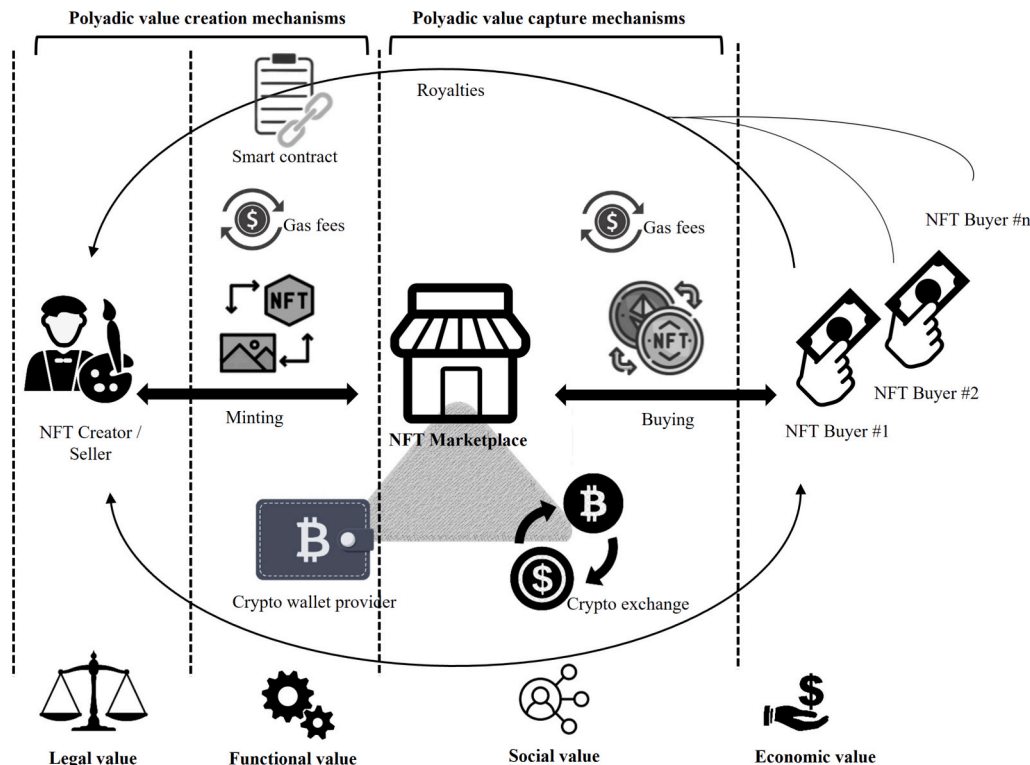


Fig. 6. Polyadic mechanisms of different values in the NFT business ecosystem.

centralization problems (Hsieh and Vergne, 2023). Complementing the existing literature on how emerging digital technologies add value to platform ecosystems (Hein et al., 2020), we find that NFTs have the potential to contribute to a decentralized and distributed app economy, empowering independent app developers and users. The traditional ad-supported app economy is currently centralized around Google's Play Store, Apple's App Store, Samsung Galaxy Store, and Huawei AppGallery. Such centralization increases the gatekeeping power of the tech giants, at a cost to both app developers and users. The former lose their share of ad revenue to all the intermediaries involved, namely RTB platforms (real-time bidding platforms used to buy and sell ad inventory), CPI networks (cost-per-install), ad servers, DSPs (demand-side platforms for automated purchase of advertising), SSPs (supply-side platforms for automated selling of advertising), attribution platforms (to identify and track app installation sources), and app stores (Hsieh and Vergne, 2023). Having all these intermediaries makes developing applications very difficult, time-consuming, and costly. Users also suffer from a centralized app economy, as they become the product of the advertising they are exposed to. In-app ads interrupt the user experience and disrupt the content and flow of information. In addition, the lack of transparency in app approval procedures makes it difficult to know the development team and trust in security and privacy. Given the massive number of apps, the stores do not have the resources for proper audit and control, and hence use algorithms that sometimes fail to detect fraudulent activities and safeguard user data (false positives). Besides, legitimate app developers sometimes lose out because of false negatives.

Also documented in previous studies (Hsieh and Vergne, 2023), the results of this study show that NFTs, powered by blockchain technology, provide a better app management system that enables a direct relationship between developers and users. As such, the app developer's record of transactions is publicly available on the blockchain through smart contracts, and users can evaluate it based on the developer's reputation. Direct monetization allows developers to monetize their apps directly through token sales. Users will be able to sell their access to the app if they are no longer satisfied with its features. In-app purchases become more streamlined, and users can develop in-app items, attach them to NFTs, and sell them on marketplaces, which also provide royalties to the app development team. This helps to reduce friction in creating, ownership, and trading of in-app digital assets.

6. Implications

6.1. Theoretical implications

Our study adds to the business model literature (Massa et al., 2017; Zott et al., 2011) by theorizing the polyadic relationships that firms develop in multi-stakeholder, interconnected, and decentralized digital business ecosystems. We contribute to the understanding of value creation and capture (Andreassen et al., 2018; Bowman and Ambrosini, 2000; Chesbrough and Rosenbloom, 2002; Lepak et al., 2007; Priem, 2007; Tantalo and Priem, 2016) by exploring generative mechanisms through which producers, prosumers, and intermediaries are able to create and capture economic, functional, social, and legal values. We extend the existing business model types (Andreassen et al., 2018; Baden-Fuller et al., 2017) by introducing an emerging business model that provides new dispersed ways of value creation and capture compared to existing business model perspectives that view value and the firms as a 'whole' (Bowman and Ambrosini, 2000). Revenue enhancement opportunities provided by NFTs extend the current business model theories beyond the traditional focus on physical value propositions (Chesbrough and Rosenbloom, 2002).

Contributing to the strategic management literature, the newly identified models of ownership (e.g., tokenized ownership with transparent and immutable history of records), governance (e.g., DAOs with decentralized decision-making), and competition (e.g., collaborative and interoperable networks) provide implications for agency theory,

stakeholder theory, and network theory. In addition, regarding the resource-based view of competitive advantage, we found that NFTs are characterized by utility, social, financial, and legal affordances that make the technology a key source of competitive advantage, not only because the exchange value of NFTs can be cascaded over time, but also because they enable imitable and non-substitutable value creation mechanisms powered by blockchain technology (Arora and Kumar, 2022; Chen and Bellavitis, 2020; Morkunas et al., 2019; Valeonti et al., 2021; Weking et al., 2020).

The third aspect of our theoretical implications relates to the emerging digital business ecosystems. The unique characteristics of NFT business ecosystems identified in terms of generativity, mixed-side network effects, and convergence demonstrate new directions for the development of theories such as stakeholder theory, where decentralized governance and control structures influence the interconnected relationships between a firm and its stakeholders, from customers and communities to suppliers and investors (Donaldson and Preston, 1995). Our analysis of NFT ecosystems is closely aligned with the core principle of stakeholder theory, which emphasizes the creation of value for all stakeholders, not just shareholders (Freeman et al., 2010). Consistent with the theory, the identified polyadic relationships recognize stakeholders as an integral part of the decisions made in the ecosystem. However, rather than the necessity to maintain a balance between the interests of stakeholders (Goodijk, 2002), the identified generative mechanisms allow for the independence of ecosystem participants to create their own desired value without the need to involve intermediaries in value capture.

6.2. Practical implications

The study also helps practitioners make sense of NFT-based business models and highlights potential value capture opportunities for different parties involved in NFT ecosystems. The identified use values of NFTs provide managers with insight into effective sensing of customers' needs. Our findings from interview narratives hint at practical ideas for proactively interacting with customers and engaging them in new product/service development processes. We also highlighted that businesses need to be aware of factors influencing NFTs' exchange value, minimizing the risks and barriers of the transition towards the emerging business models. Although we demonstrated live event ticketing and ad-supported platform development as the two most relevant applications of NFTs, it remains to be seen where the technology will find widespread adoption beyond art.

As the results of our analysis suggest, entrepreneurs and managers who intend to integrate blockchain technologies should be mindful of the associated risks and possible complications and try to minimize them. First, volatility and market risks due to the fluctuations of cryptocurrencies pose a recurring threat to blockchain ventures. Two of the most common possible solutions are (a) using stablecoins, which are price-stable cryptocurrencies that are pegged to fiat money, such as Tether (USDT), which is pegged to the U.S. dollar, and (b) developing and implementing risk management frameworks tailored to the use of tokens that include strategies such as avoiding over-reliance on a particular cryptocurrency in response to market fluctuations. Privacy and security are also key concerns. With hackers and cyberattacks, users are vulnerable to losing the private information of their wallet accounts and the digital assets they own. Therefore, it is important to either use well-known and secure blockchain platforms such as Ethereum, Hyperledger Sawtooth, HyperLedger, EOSIO, Corda, and Tezos, or operate on permissioned blockchains, which are private and require user permission to join, thereby also avoiding the fraud and speculation-related threats of blockchain, such as the crypto pump and dump scheme, where schemers buy a large amount of a given cryptocurrency and then inflate its value to attract buyers (pump), then sell their holding cryptos at a high price (dump) before the value declines. Finally, it is also important to prioritize responsible and ethical practices when

operating on the blockchain. First, practitioners should consider potential negative environmental impacts and use those services and resources that follow environmentally friendly practices, such as blockchain platforms that use more efficient hardware in data centers that require less cooling and reduce CO2 emissions. Second, potential negative social impacts, such as the violation of intellectual property rights and manipulation, should be effectively managed by building transparency and trust with users. Finally, when utilizing blockchain-based technologies, it is important to stay up-to-date on the latest regulations and ensure compliance to mitigate legal risks and protect users' rights. The legal and regulatory framework for blockchain in the European Union (EU policies, 2022) can serve as an example.

6.3. Policy implications

Although NFT technology brings in many practical applications (such as those mentioned above), individuals and businesses using the technology face several challenges that can be mitigated by effective policies to build trust in the system and protect the public interest and consumer data and privacy. The results of our review and data analysis suggest several policy implications. First, trusted intermediaries should be recognized and promoted by regulatory bodies. Policymakers can work closely with intermediaries such as NFT marketplaces, blockchain infrastructure providers, and crypto exchange services to effectively audit transactions and ensure that only valid and verified transactions are executed on the blockchain. This helps ensure authenticity, integrity, and trust, which consequently increases security and reduces the potential for fraud and scams. Lawmakers and regulators can impose several rules on the buying and selling of NFTs, such as anti-money laundering, tax evasion, and know-your-customer requirements to detect illegal uses and prevent crime. Finally, given the unintended consequences of blockchain technology on the environment, such as energy consumption, lawmakers can encourage participants to be transparent about their use of the technology, for example, in their sustainability reports, and promote practices that minimize harmful effects.

7. Limitations and future research

Our study has several limitations. First, the case studies selected for this research may not fully represent all possible NFT-enabled business models. As a result, the value creation and capture processes identified may not include all relevant mechanisms. Future research could examine additional cases and applications and potentially explore new mechanisms to enrich our understanding of emerging business models. Also, our research did not focus on the use of NFTs in a specific context, which limits its applicability to other potential domains not covered in this research. Therefore, we recommend future research to explore applications to specific scenarios, including the customer journey for digital assets (Yilmaz et al., 2023), new metaverse-enabled retail markets (Yoo et al., 2023), and decentralized digital platforms (Hsieh and Vergne, 2023), among others. In addition, several perspectives are recommended for future research to extend the NFT literature: decentralized finance, or DeFi, utopian and dystopian narratives, gamification, affordability, and governance (Balaji et al., 2023). Our case study with limited cases did not allow us to fully conceptualize the emerging business models with polyadic relationships. Therefore, it is suggested to further clarify and operationalize the business model by exploring the constituent building blocks (Andreassen et al., 2018) and underlying interdependences (de Oliveira and Cortimiglia, 2017). Future research can explore different configuration patterns of the elements of this new business model and how they influence business performance (Massa et al., 2017). More research needs to be undertaken to explore the ways

NFT-based business models differ from blockchain-based ones and the role of blockchain technology in the design (Zott and Amit, 2010) and implementation (Zott and Amit, 2017) of NFT-based business models. Viewing this new business model as an organizational process (Teece, 2020), future research can look into antecedents as well as consequences of the transition towards NFT business models. How NFTs can trigger new business models in different industries, like fashion or real estate, remains a topic of research interest. Further, how can NFTs and blockchain technology contribute to sustainable development in social and environmental aspects? How can governments and public authorities benefit from NFTs?

8. Conclusion

This study explored how blockchain-based technologies, particularly NFTs, are transforming value creation and capture mechanisms in emerging business models. By synthesizing a literature review with multiple case studies of blockchain ventures, we identified a range of use values (from digital ownership to token gating in Web 3.0 communities) and key determinants that drive the exchange value of NFTs. Notably, our findings point to the polyadic relationships between multiple interconnected stakeholders with complex interactions at the core of the innovative business models, offering new possibilities beyond traditional dyadic and triadic frameworks.

The insights derived from real-world applications of the technology in utility (e.g., lifecycle management of physical products), social (e.g., token gating for community building and churn prevention), financial (e.g., omnichannel revenue models), and legal (e.g., tokenized ownership and governance) affordances. We argued that these technology affordances support the implementation of polyadic mechanisms of value creation and capture between multiple stakeholders with multiple roles. We then explored the NFT business ecosystem, explaining how it triggers the sources of generativity of the technology, what mixed-side network effects occur, and how complementors converge with such an ecosystem.

In sum, this work provides the foundation for a deeper understanding of polyadic business models, highlighting their potential to reshape digital innovation ecosystems. We encourage scholars to adopt this emerging business model perspective as a theoretical basis for further exploration in the rapidly evolving and fascinating field of blockchain research.

CRedit authorship contribution statement

Arash Rezazadeh: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **René Bohnsack:** Writing – review & editing, Validation, Supervision, Resources, Methodology, Investigation, Conceptualization.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A

NVivo’s autocoding results.

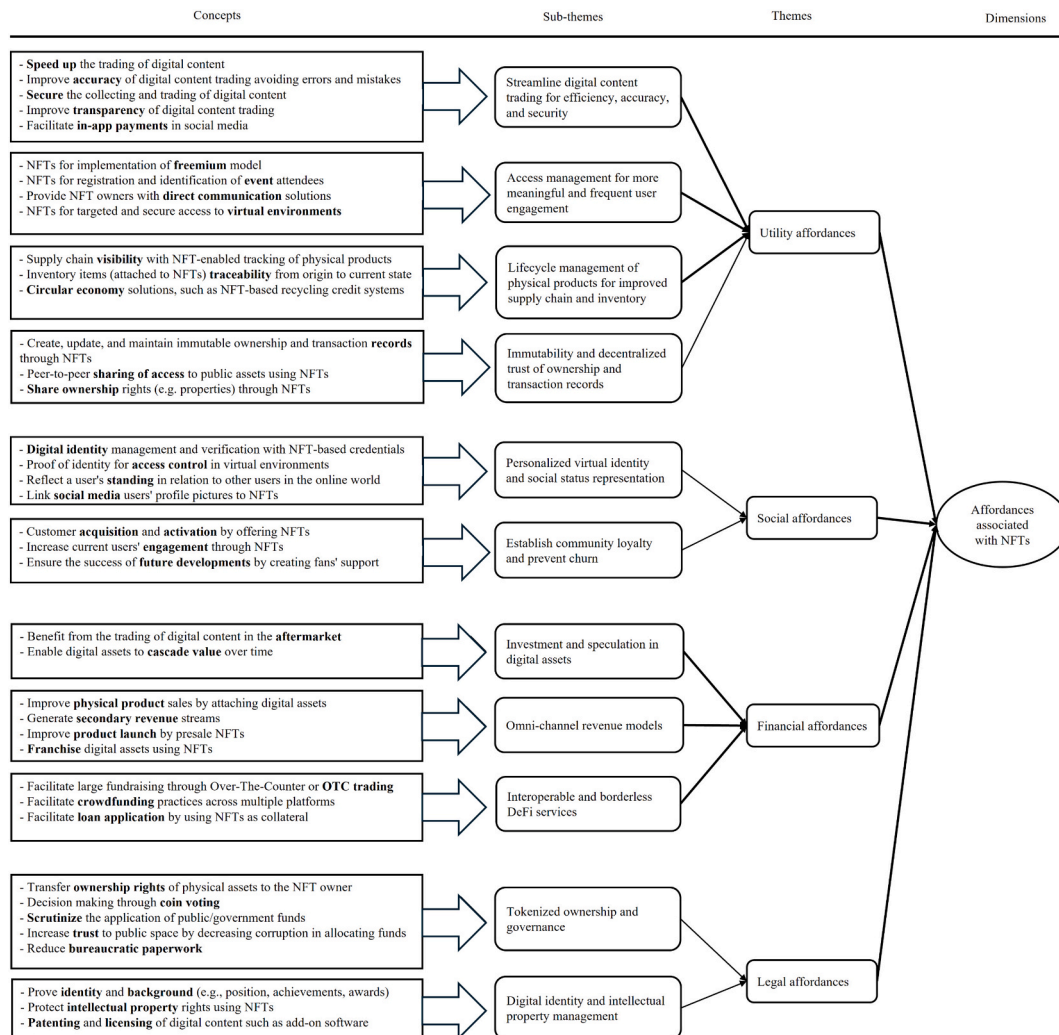
Word frequency query results.

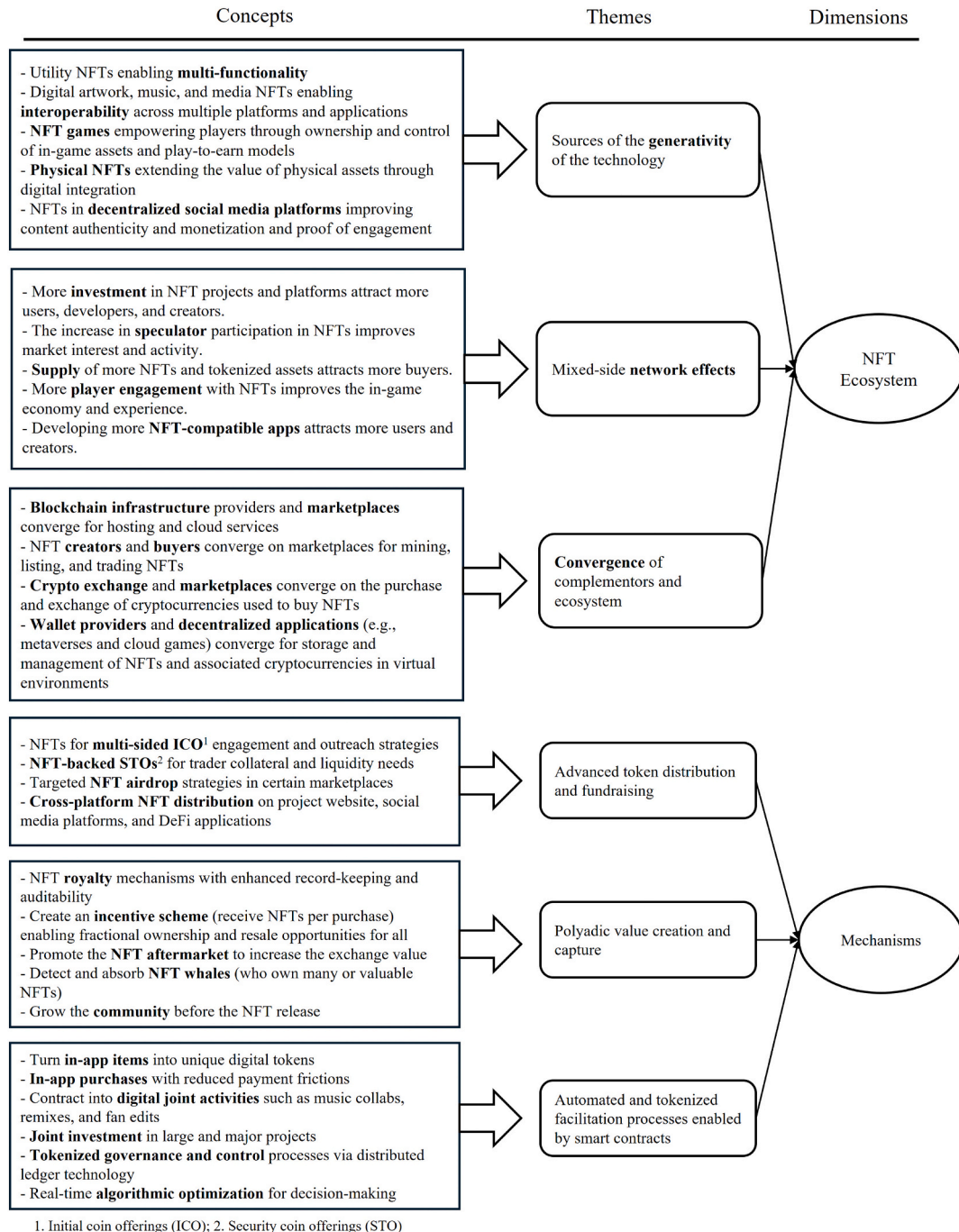
Nodes assigned to each interview question (1st order codes in the initial template)	Most common words mentioned by interviewees *
Interviewee background	blockchain (38**); crypto (9); public (9); funds (7); apps (6); bitcoin (6); startups (6); decentralized finance (5); investors (5)
Products, Customers, Delivery	blockchain (16; gaming (12); users (11); payment (9); businesses (8); crypto (7); market launch (7); platform (7); stores (7); metaverse (5); clients (5)
Challenges and solutions	clients/customers (15); blockchain (14); tokens (13); technology (12); app (11); cryptos (11); money (8); investment (6); mechanisms (6); payment (6); frictions (5); purchase (5)
Ecosystem	people (11); clients/customers (8); companies (8); developers (8); businesses (7); Coinbase (6); partners (5); platform (5); stores (5)
Competition	clients/customers (11); community (9); real (9); money (8); followers (6); strategies (6); startups (5); Binance (5)
DAOs	decision making (24); voting (14); tokens (13); governance (9); executed (6); legal (6); responsible (6); structure (6); budget (5); democratic (5); rewards (5)
NFTs	tokens (29); ticketing (26); gaming (19); buying (18); wallet (11); transparent (9); banking (8); ownership (8); crypto (6); metaverse (6); royalties (6)
Outlook for tokenization	blockchain (24); people (16); tokens (15); quantum computing (9); regulate (9); security (9); bitcoin (5); crypto (5)

Notes
 * Non-relevant words are excluded from the results; for grouping in NVivo, we used the “With stemmed words” option to find stems of words not only the exact word itself.
 ** Frequency of each item in interview transcripts.

Appendix B

Data coding structure following the Gioia Methodology.





Data availability

The data that has been used is confidential.

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