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# IU DISCUSSION

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**Business & Management**

Exploring Markets – Non-Fungible Token

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## Exploring Markets – Non-Fungible Token

Daniel Weber

### ABSTRACT:

*„Exploring Markets“ is a paper series discussing niche markets with interesting characteristics. The paper on hand focuses on the market for Non-Fungible Token (NFT) which are transferrable rights of ownership to unique digital assets. NFTs are based on blockchain technology and are traded with cryptocurrencies primarily on specialized marketplaces. In 2021 record breaking auctions of expensive NFTs got mainstream attention, whereas a decreasing trade volume at the start of 2022 might indicate challenges in market adoption for this new technology. The paper discusses specific characteristics of NFTs, use cases and associated problems.*

### KEYWORDS:

*Market Study, NFTs, Non-Fungible Token*

**JEL classification: Z19**

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**Prof. Dr. Daniel Weber** ist Professor für Allgemeine Betriebswirtschaftslehre am Campus Hamburg der IU Internationale Hochschule. Wissenschaftlich beschäftigt er sich vor allem mit Innovationen, Nischenmärkten und aus seiner Sicht interessanten Marktmechanismen.

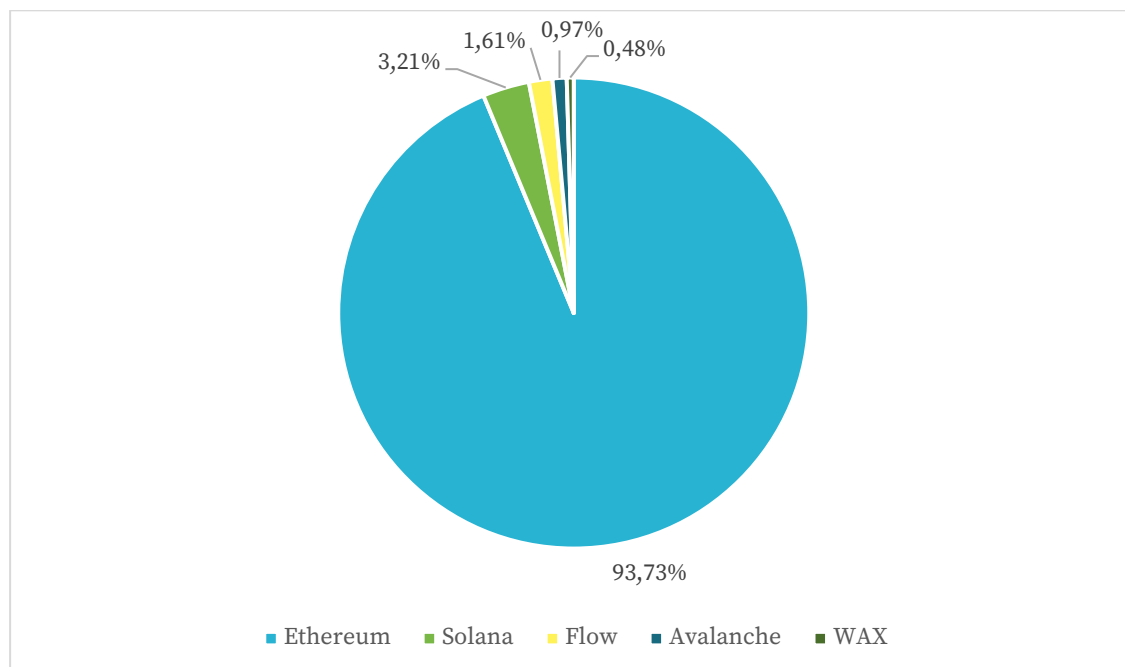
## Introduction

A non-fungible Token (NFT) is at its core a unit of data stored on a blockchain. In comparison to fungible tokens (like cryptocurrency) a non-fungible-token is cryptographically unique and nonreplicable, making it interchangeable with other NFTs. The data on the blockchain stores information about who created the NFT, as well as who previously and currently owns it. This allows for assigning ownership of the “original” of replicable digital objects like images, videos, or audio (Evans 2019).

As of March 2022, most NFTs are created (minted) and traded on the blockchain Ethereum (see Figure 1). Ethereum allows for the building of applications, or smart contracts, which are necessary for NFTs because they enable the assignment of ownership. When someone creates (or “mints”) an NFT, they execute code stored in smart contracts that conform to different technical standards. Each token has a unique identifier that is directly linked to one Ethereum address. NFTs are traded between cryptocurrency wallets, whereas market participants can have multiple wallets (see chapter “wash trading”).

The creation and transaction of NFTs isn’t free, the costs (coined “gas fees”) depend on the amount of traffic on the network and the computation energy taken to execute the transaction (Ethereum, 2022a). As of March 2022, an average sale at the biggest NFT platform Opensea had transaction costs of 13,68 \$ (Etherscan, 2022). For creating an NFT additional costs like account and listing fees apply dependent on the marketplace.

**Figure 1: Blockchains used for NFT Transactions (March 2022)**

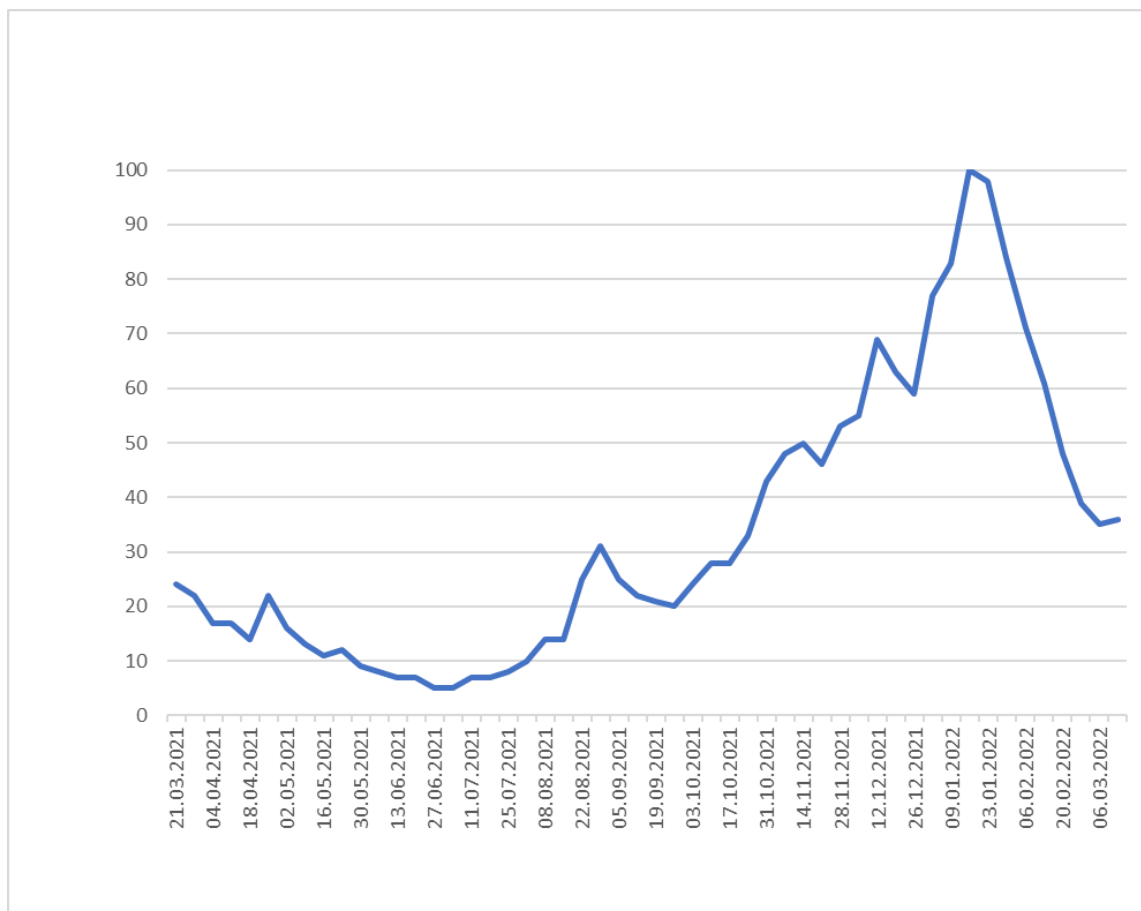


Source: data from cryptoslam.com, retrieved on March 18th, 2022

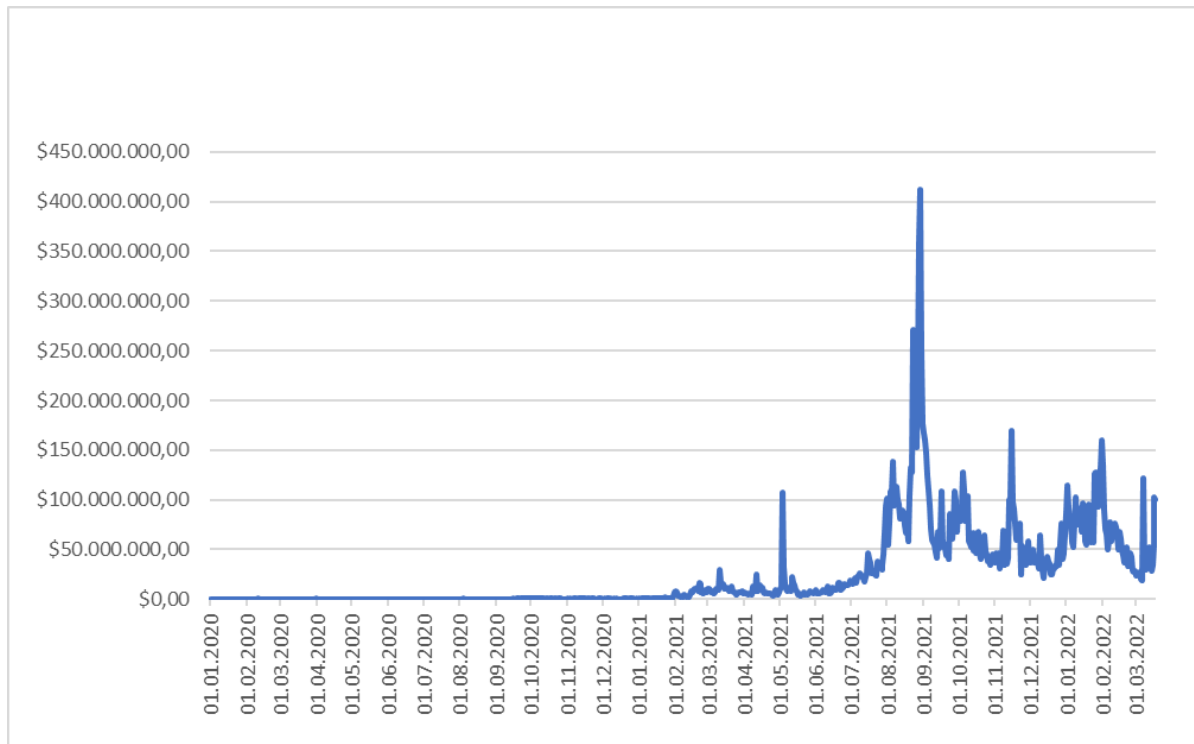
High volume trades of NFTs for digital art and collectibles popularized NFTs mid 2021 and led to a boom of NFT projects leading to a trade volume of over 2 billion \$ and nearly 2 million active wallets in 2021 (Nonfungible, 2022). As of March 2022, Google trend (see figure 2) and sales volume data (see figure 3) suggest that the interest in NFTs has significantly cooled down. Gartner Inc. described a common path

for new technologies that leads from an “Innovation Trigger” to a “Peak of Inflated Expectations” through a “Valley of Disillusionment” to a “Plateau of Productivity” (Gartner, 2021). Gartner Inc. placed NFTs on the Peak of Inflated Expectations in their assessment of upcoming technologies in August 2021 (ibid). The current downfall of interest in NFTs raises the question if a “Plateau of Productivity” will be reached or if a long-term market adaption of NFTs is unlikely. The paper on hand critical evaluates the status quo of NFT adaption for different use cases and a discusses problems obstructing this adaption.

**Figure 2: Google Trend for „NFT” 2021-2022**



Source: data from trends.google.de , retrieved on March 18th, 2022

**Figure 3: NFT Sales in US \$ 2020-2022**

Source: data from nonfungible.com, retrieved on March 18th, 2022

## Use Cases

### VALUE PROPOSITION AND MARKET OVERVIEW

Most of the NFTs that are currently minted and sold are NFTs for digital objects that can still be copied indefinitely, most of the time with a simple right click (like a digital image or a tweet) and typically NFTs don't convey copyright ownership of the work. So, the value of an NFT must be based either on the social value the proof of ownership conveys or there must be added benefits to this proof of ownership like access to exclusive events for example.

The potential social value a NFT can create is interesting as it incentivizes the NFT owner to encourage others to use and popularize it, because popularity increases the value of ownership. Digital goods historically struggle with copyright issues because they are at their core public goods for which their owners must enforce exclusivity to profit. NFTs could potentially create a new way to generate value for authors of digital work. Brian Frye, Professor at University of Kentucky College of Law, even makes a case for copyright becoming obsolete:

*“Essentially, NFTs allow authors to profit from creating works of authorship without having to control their use. If the potential profit from selling NFTs alone is large enough to encourage authors to create works, then authors don't need copyright anymore. And if authors don't need copyright, no one does. In theory, NFTs could finally make copyright obsolete.” (Frye, 2021, p. 2).*

NFTs are mined and traded for different use cases with the most popular being art & collectables, gaming, and digital items in the metaverse (Nonfungible, 2022). As of March 2022, the market

capitalization of NFTs is just above 10 billion \$ which is a steep decline in comparison to its peak of 23 billion \$ in 2021 (Coinmarketcap, 2022). The daily sales volume is around 65 million \$ with just above 20.000 daily sales (ibid). The following chapter give an overview as well as a brief history of the adaption of NFTs for different use cases, in particular for art & collectables, the metaverse, and games.

## **ART & COLLECTABLES**

The cryptographical uniqueness of NFTs can make them valuable as a collectable item. Incentives to collect things can stem from simple investment motives to the psychological drive to complete things (Danet, Katriel, 1989) or to maintain or achieve status in a social group (Belk, 1995). The first prominent examples of NFTs that got mainstream attention were the digital artwork “EVERYDAYS: THE FIRST 5000 DAYS” created by the artist Beeple, which sold for over 69 million Dollar at Christie’s (Christie’s, 2021) and Jack Dorsey’s (CEO of Twitter) first Tweet that sold for over 2,9 million \$ on the Valuable platform (Valuables, 2022) both in March 2021. Even before those transactions, NFT collectables started off and dominated the NFT market, beginning with the trading of CryptoKitties in 2017. CryptoKitties are unique collectable digital images of virtual cats and were the only NFTs that had relevance in terms of trade volume for almost two years (Nadini et al. 2021). Another noteworthy pioneer NFT project is CryptoPunks which was also launched in 2017 by the software company Larva Labs and is based on 10.000 pixel art images with randomly generated features. CryptoPunks helped to establish the at the time technical standard (ERC-721) for NFTs traded with Ethereum and are predecessors of the most traded art collection of 2021, the Bored Ape Yacht Club, which has seen a trade volume of around 1,06 billion \$ in that period (nonfungible 2022).

NFT art & collectables are sold on specialized online platforms such as Open Sea, Art Blocks, Rarible, SuperRare or Nifty Gateway or in traditional art galleries like christies’s and sotheby’s which quickly adopted to the trend and launched their own NFT marketplaces. Some platforms found new ways to build a community around digital art and compensate artist, such as the Museum of Crypto Art, which gives artist coins of their own cryptocurrency (MOCA COIN) in exchange for their art, holders of MOCA COIN can then vote on the curatorship of the museum (Museum of Crypto Art, 2022).

In Interviews conducted with art advisors and art collectors of NFT art Bsteh (2021) identifies several advantages of NFT art which include a high degree of independence from established institutions, the possibility to build a brand and loyal communities on digital network platforms and the possibility to include an ongoing re-sale percentage in the smart contract of a NFT which enables the artist to benefit of secondary market sales of his/her artwork. Possible drawbacks include dependence of new institutions like NFT marketplaces and blockchains as well as the high volatility of cryptocurrencies. Artists also face the risk that their original art is tokenized and stolen by a third party (Yeo, 2021).

## **METAVEVERSE**

The word “metaverse” was first used in the novel “Snow Crash” from 1992 by the author Neal Stephenson. It is described as a massive virtual environment in which users interact through digital avatars (Stephenson, 1992). The idea was further flashed out by Ernest Cline, another science fiction author, who wrote the novel “Ready Player One” in 2011, in which digital avatars meet in the online simulation OASIS to play games, shop for digital items, or visit virtual events (Cline, 2011). Since then,



applications of virtual worlds like Second Life, Roblox or Fortnite have found real world market success. Many big companies work on their version of the metaverse, the most famous examples are Facebook which rebranded itself as Meta in 2021 and launched “Horizon Worlds” which utilizes their acquisition of Oculus (Oculus, 2022) and Microsoft which is working on a virtual work environment coined Mesh (Microsoft, 2022). However, currently these virtual economies have closed centralized economies with their own currency and digital assets. NFTs allow for transferable digital assets between platforms and enable decentralized governance and participation (Lee et al., 2021), but at this point it is unclear if the major players in the industry are going in the direction of an open metaverse, which would require a consensus on technical standards and some form of decentralized economy. A cooperation of Sony and Microsoft that allowed for cross-platform gaming showed that cooperation is possible and beneficial for all participants, whereas Epic’s antitrust lawsuit against Apple’s platform fees in 2021 exemplifies that there are still major divergent interests among the relevant established market participants (VentureBeat, 2021).

Nevertheless, with the increasing interest in art and collectable NFTs, NFT-based metaverse companies entered the market. The most successful companies include: The Sandbox, Decentraland, CryptoVoxels and Somium Space (Nonfungible, 2022). The concept of virtual real estate first got public attention when virtual property adjacent to Hip Hop Artist Snoop Dogg’s Sandbox estate sold for 450.000\$ in Ethereum (Irwin, 2021). Another noteworthy event was a 2022 Superbowl commercial from the brewery Molson Coors that advertised their virtual “Meta Lite Bar” in Decentraland where visitors could interact with each other, play music on the Jukebox or buy NFTs like a Meta Lite T-Shirt for their avatar (Alcántara, 2021). Other companies that bought virtual real estate in Decentraland include JPMorgan Chase, Sotheby’s, Samsung Electronics and Prager Metis (ibid).

The trade volume of metaverse-NFTs gained traction in February 2021 with daily sales frequently above 100.000 \$ and peaking at over 18 million \$ in November 2021, as with other NFTs the market cooled down to currently around 1,4 million \$ daily in March 2022.

## **GAMES**

When it comes to utilization of NFTs for video gaming there is a perceivable difference between the success of games that are built around NFTs, often from small gaming studios, and the integration of NFTs in existing gaming franchises and triple A games. Whereas there are some prominent examples that the former can be profitable, the latter is met with resistance from the gaming customer base.

There is an argument to be made that the aforementioned CryptoKitties was also the first successful NFT gaming project as it entails a gamification mechanism that allows for the “breeding” of CryptoKitties (CryptoKitties, 2022) which was later adopted by other popular NFT based games like Axie Infinity, Gods Unchained and Star Atlas. The “play to earn” element of these games made them especially popular in Asian countries, which e.g., led to a growing number of communities in the Philippines making a living out of playing Axie Infinity (which was itself developed by a Vietnamese start-up) during the Covid crisis (Callon-Butler, 2021). The success of these type of games however will only be sustainable, when they move away from being self-contained circular economies by attracting enough not-profit seeking customers. This can be exemplified by Axie Infinity which has a 200\$-1.000\$ buy-in to start playing (dependent on the price of three “axis” necessary to play) and a customer base

that is predominantly located in poor regions of the world most likely with a profit motive to play the game: play-to-earn will only be profitable for the individual gamer if the number of players joining remains larger than the numbers of current players, which essentially constitutes a pyramid scheme (for a detailed analysis see Coinmonks, 2021). Despite this structural flaws, Game NFTs have amassed over 4,5 billion \$ trading volume in 2021 and raised over 4 billion \$ in Venture Capital (Herrera, 2021).

For established gaming studios the adaption of NFTs has been difficult. Ubisoft became the first major game developer to announce the launch of NFTs with Ubisoft Digits, a project that is as of March 2022 still in its beta stage. The idea behind Ubisoft Digits is to allow for purchased or earned game items, that are traditionally bound to a game account, to be sold directly to other players and potentially be used across different Ubisoft games (Ubisoft, 2022). This would increase the incentive for players to collect rare items and would Ubisoft profit from royalties of secondary market sales. Ubisoft's plans were poorly received in the gaming community which is already critical of microtransactions, leading to a now infamous interview with Nicolas Pouard, Vice President at Ubisoft's Strategic Innovation Lab, where he stated on the question what gamers are missing about NFTs:

*„I think gamers don't get what a digital secondary market can bring to them. For now, because of the current situation and context of NFTs, gamers really believe it's first destroying the planet, and second just a tool for speculation. But what we [at Ubisoft] are seeing first is the end game. The end game is about giving players the opportunity to resell their items once they're finished with them or they're finished playing the game itself. So, it's really, for them. It's really beneficial. But they don't get it for now.“ (Stead, 2022).*

The interview made headlines for its last sentence. The popular gaming website ign wrote an article titled “Ubisoft exec says, ‘gamers don’t get it’ when it comes to NFTs” and called the backlash to Ubisoft’s NFT project “brutal” (Leston, 2022). A YouTube video with the announcement that “Tom Clancy’s Ghost Recon Breakpoint” would be the first game to implement cryptocurrency items was downvoted over 40.000 times and even Ubisoft developers were quoted with criticism for NFT integration in their projects (Gach, 2022). This skepticism is in line with the results of a recent survey from the Games Developers Conference (GDC): among 2.700 game developers 70% stated they had no interest in NFT projects, 21 % were “somewhat interested”, 7% were “very interested” and 1% were working on NFT projects (GDC, 2022). In the face of negative public feedback game studios EA, Team17 and GSC Game World have abandoned NFT projects while the developers Square Enix and Zynga announced that NFTs are part of their future strategy (Isaac & Browning, 2022). Epic Games chief executive Tim Sweeney publicly spoke out against integrating NFTs in their games on Twitter:

*„We aren't touching NFTs as the whole field is currently tangled up with an intractable mix of scams, interesting decentralized tech foundations, and scams.“ (Sweeney, 2021)*

The reaction of the major gaming marketplaces is also quite divergent: while the biggest brick and mortar game store chain GameStop announced plans to invest 100 million \$ in its own NFT marketplace (Robertson, 2022), the biggest digital marketplace Steam banned all blockchain games from its platform with its founder Gabe Newell declaring:

*“The things that were being done were super sketchy, and there was some illegal shit that was going on behind the scenes, and you're just like, yeah, this is bad. Blockchains as a technology are a great technology, that the ways in which has been utilized are currently all pretty sketchy. And you sort of want to stay away from that.“ (Robinson, 2022).*

The skepticism of Tim Sweeney and Gabe Newell towards NFTs is no exception and based on serious problems accompanying its technology and value proposition, some of which are discussed in the following chapter.

## Problems

### **WASH TRADING**

NFT trades are made between pseudo anonymous blockchain wallets which do not necessarily need to belong to different market participants. Traders can exploit this to inflate prices and trade volume with self-trades. The Commodity Futures Trading Commission (CFTC) defines it as “Entering into, or purporting to enter into, transactions to give the appearance that purchases and sales have been made, without incurring market risk or changing the trader’s market position” (CFTC, 2022).

An artificially increased trade volume is a metric that can give potential investors the impression that the asset is more in demand than it actually is. Wash trading is illegal for conventional securities and futures in the United States and Europe but so far, no legal action has taken place for wash trading on decentralized cryptocurrency exchanges. This could change due to the prevalence of this manipulative behavior which will most likely attract the attention of governance agencies. A study from Victor and Weintraud (2021) concludes, that more than 30% of all tokens traded on the Ethereum Blockchain have been subject to wash trading activity whereas a study from Le Pennec et al. (2021) states that some cryptocurrency exchanges exaggerate their trade volume by a factor of 25 to 50. A recent example of a NFT marketplace blatantly incentivizing its users to wash trade is LooksRare which established a trading reward model that offered token rewards for trades on its platform that exceeded transaction costs. This has led to high volume trades of royalty-free collections making LooksRare to the biggest rival to the leading NFT marketplace OpenSea. The NFT analytics firm CryptoSlam identified that more than 8,3 billion \$ or about 87% of its trading volume was generated through wash trading (decrypto, 2022).

There is evidence, that most wash trading activities aren’t profitable due to transaction costs, but when they are successful, they make a high profit: An investigation by the blockchain data platform Chainanalysis showed that from 262 identified wash trades, only 110 were profitable but while the unprofitable wash trades made losses of -416.984 \$, the 110 profitable wash trades made a combined profit of 8.458.331 \$ (Chainanalysis, 2022).

### **MONEY LAUNDERING**

Money laundering is defined as a process by which large amount of illegally obtained money, from drug trafficking, terrorist activity or other serious crimes, is given the appearance of having originated from a legitimate source (Kumar, 2012). High value art and collectibles are highly mobile, and prices are subjective making them traditionally prone to money laundering. The ability to trade and transfer NFTs without shipping services and without concern for geographic distance or borders instantaneously make them especially susceptible to launder illicit proceeds of crime (Department of the treasury, 2022). Although transactions are recorded on a public ledger, purchasers can remain anonymous and as discussed earlier the possession of multiple wallets even allows for self-trades.

According to Chainalysis the value sent to NFT marketplaces by identifiable illicit addresses (e.g., scammers, malware operators) is comparatively small with just under 1,4 million \$ in the fourth quarter of 2021 but rising (Chainalysis, 2022). However, this analysis doesn't cover illicit funds that are transferred from fiat currency to a blockchain wallet that has no traceable connection to illegal activities, so the true value of laundered money is most likely significantly higher.

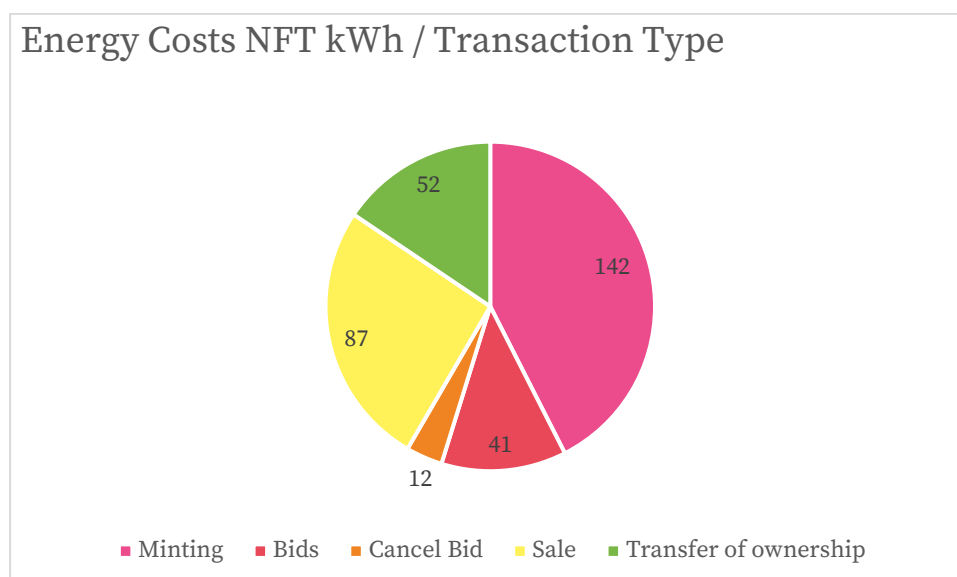
## ECOLOGICAL COST

Currently most peer-to-peer-cryptocurrencies use a form of cryptographic proof called Proof-of-Work (PoW) in which computational effort is used to verify a transaction and add it to a blockchain's public ledger. This mechanism is an effective way to deter denial-of-service attacks and spam but requires a vast amount of computing resources, leading to high energy consumption. The alternative to a Proof-of-Work consensus mechanism is a method called Proof-of-Stake (PoS) in which cryptocurrency owners validate transactions based on the number of coins they offer as collateral. Coin owner who provide "staked" coins are selected randomly to mine new coins, offering an incentive to become a validator but reducing the advantage of single-purpose hardware farms to mine coins.

As stated before, currently over 90% of all NFTs are traded with Ethereum (Cryptoslam, 2022) which uses PoW, leading to a significant negative environmental impact of NFTS.

In a study by Kyle McDonald, it was estimated the total energy use of Ethereum at 40 TWh per year (McDonald 2021) which is in line with similar studies by Gellersdörfer et al. (2021), Krause and Tolaymat (2021). More recent estimations by Alex de Vries are much higher, reaching up to 113 TWh annuarey and 264 kWh for a single Ethereum transaction (De Vries et al., 2021). In an analysis of 79,977 transactions on the SuperRare NFT marketplace by the digital artist Memo Akten (2021) the energy consumption of a single NFT is broken down into different transaction types relevant for creating and selling a NFT, including minting, bidding, cancelling, sales, and transfer of ownership (see figure 4). His analysis stresses the importance to not solely focus on minting when looking at energy costs of NFTs.

**Figure 4: Energy Costs for a single NFT (kWh)**



Source: data from memoakten.medium.com, retrieved on March 15th, 2022

The Ethereum Foundation announced that it would switch to the Proof-of-Stake algorithm with its Eth2-upgrade, which would reduce Ethereum's energy consumption significantly down to 1/10.000<sup>th</sup> of its current energy use (Ethereum, 2022b). The transition has been delayed several times by technical setbacks and is currently announced for Q2 2022 which is met by skepticism from blockchain experts who predict that a full market integration should not be expected until the end of 2023 or start of 2024 (Lange 2021). Until this transition is finalized most NFTs will have a significant negative energy and environmental record.

## Summary and Conclusion

The paper on hand aimed at explaining the basic mechanisms and economics of the current NFT market. It is supposed to provide a base for discussion about NFTs potentials and problems. The following conclusions can be drawn:

- NFTs provide a solution for digital artists to monetize their work without middlemen. Especially the possibility to earn royalties on secondary market sales could have a positive impact for artists and content creators. However, in its short lifespan the idea of NFT art has shifted very quickly from supporting artists who can create a community around their artwork to acquiring a tradeable asset with a value that is fueled by speculation and a “fear of missing out”. A lot of problems the NFT art market faces are not new and widespread in the market of fine art: speculation, wash trading, money laundering, stolen art, and scams. With transactions being recorded on a blockchain, these problems now leave a data trace and just become a lot more transparent. It is very likely that there are going to be stricter governance regulations challenging the pseudo-anonymous nature of the NFT market..
- The popularity of NFT games that are based on “play to earn”-mechanisms especially in poor countries is concerning, as at least those with a buy-in clearly resemble pyramid schemes with a foundation that is already deteriorating. For the gaming market in general it is unclear if NFTs are going to replace traditional centralized downloadable content as there are not many advantages for gaming studios to embrace open economies now, but that could change with increasing market concentration.
- The metaverse has still to emerge in its full form. Some companies have dipped in their toe with some early investments but at this point it is unclear what will be the dominant platform. Recent market leaders like Decentraland and Sandbox will have fierce competition once Microsoft and Meta fully commit to a metaverse strategy. As with the gaming market (and highly connected as Microsoft has bought Activision) it must be seen if the future market leader in this field is going to embrace a decentralized economy based on NFTs.
- Finally, the current power consumption of NFTs is indefensible. With rising energy costs worldwide and increasing public awareness of the importance of sustainable business practices the successful transition of Ethereum to a PoS consensus mechanism might be the single most important aspect to make or break long term NFT adaption.

## Bibliography:

- Akten, M. (2021). *The unreasonable ecological cost of cryptoart*. Onlinepublikation auf memoakten.medium.com. <https://memoakten.medium.com/analytics-the-unreasonable-ecological-cost-of-cryptoart-72f9066b90d>.
- Belk, R. W. (1995). *Collecting in a Consumer Society*. Routledge.
- Callon, B. (2021). *The NFT Game That Makes Cents for Filipinos During COVID*. Onlinepublikation auf: coindesk.com. <https://www.coindesk.com/markets/2020/08/26/the-nft-game-that-makes-cents-for-filipinos-during-covid>.
- Chainanalysis (2022). *2022-crypto-crime-report-preview-nft-wash-trading-money-laundering*. Onlinepublikation auf blog.chainanalysis.com. <https://blog.chainanalysis.com/reports/2022-crypto-crime-report-preview-nft-wash-trading-money-laundering>.
- Christie's (2021). *Beeple b 1981-1*. Onlinepublikation auf onlineonly.christies.com. <https://onlineonly.christies.com/s/first-open-beeple/beeple-b-1981-1/112924>.
- Cline, E. (2011). *Ready Player One*. Crown Publishers. 2011.
- Coinmarketcap (2022). *NFT*. Onlinepublikation auf coinmarketcap.com. <https://coinmarketcap.com/nft>.
- Coinmonks (2021). *Axie Infinity – a developing world's messiah or the biggest Ponzi Scheme in crypto?* Onlinepublikation auf medium.com. <https://medium.com/coinmonks/axie-infinity-a-developing-worlds-messiah-or-the-biggest-ponzi-scheme-in-crypto-right-now-564ecfb62054>.
- Commodity Futures Trading Commission (CFTC) (2022). CFTC Glossary. Onlinepublikation auf cftc.gov. [https://www.cftc.gov/LearnAndProtect/EducationCenter/CFTCGlossary/glossary\\_wxyz.html](https://www.cftc.gov/LearnAndProtect/EducationCenter/CFTCGlossary/glossary_wxyz.html).
- CryptoKitties (2022). *Cryptokitties*. Onlinepublikation auf cryptokitties.co. <https://www.cryptokitties.co>.
- Cryptoslam (2022). *Blockchains by NFT Sales Volume*. Onlinepublikation auf cryptoslam.io. <https://cryptoslam.io>, abgerufen am 18.03.2022.
- Danet, B., Katriel, T. (1989). No Two Alike: Play and Aesthetics in Collecting. In: *Play & Culture*, 02/03, S. 253-257.
- Decrypto (2022). *NFT Market Cools as Trading on Ethereum and Solana Dips*. Onlinepublikation auf decrypto.co. <https://decrypto.co/94264/nft-market-cools-trading-ethereum-solana>.
- De Vries, A., Gallersdörfer, U., Klaaßen, L. & Stoll, C. (2021). The true costs of digital currencies: Exploring impact beyond energy use. *One Earth* (June 2021), S.786-789.
- Ethereum (2022a). *NFT*. Onlinepublikation auf ethereum.org. <https://ethereum.org/en/nft/>.
- Ethereum (2022b). *Energy Consumption*. Onlinepublikation auf ethereum.org. <https://ethereum.org/en/energy-consumption/>.
- Evans, T.M. (2019). *Cryptokitties, Cryptography and Copyright*. In: *AIPLA QJ*, 47 (2019), S.219-247.

- Frye, L. B. (2021). After Copyright: Pwning NFTs in a Clout Economy. *Journal of Law & the Arts* (Forthcoming). Onlinepublikation auf [papers.ssrn.com](https://papers.ssrn.com/papers.ssrn.com/sol3/papers.cfm?abstract_id=3971240).  
[https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=3971240](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3971240).
- Gach, E. (2022). Ubisoft Devs Don't Understand Company's NFT Push, Either. Onlinepublikation auf [kotaku.com](https://kotaku.com/ubisoft-devs-don-t-understand-company-s-nft-push-eithe-1848215633). <https://kotaku.com/ubisoft-devs-don-t-understand-company-s-nft-push-eithe-1848215633>.
- Gallersdörfer, U., Klaaßen, L., Stoll, C. (2020). Energy Consumption of Cryptocurrencies Beyond Bitcoin. In: *Joule*, 4/9 (Sept.2020), S. 1843-1846.
- Gartner (2021). 3 Themes Surface in the 2021 Hype Cycle for Emerging Technologies. Onlinepublikation auf [gartner.com](https://www.gartner.com/smarterwithgartner/3-themes-surface-in-the-2021-hype-cycle-for-emerging-technologies). <https://www.gartner.com/smarterwithgartner/3-themes-surface-in-the-2021-hype-cycle-for-emerging-technologies>.
- GDC / Game Developers Conference (2022). 2022 State of the Game Industry. Onlinepublikation auf [reg.gdcconf.com](https://reg.gdcconf.com). <https://reg.gdcconf.com/state-of-game-industry-2022>.
- Herrera, P. (2021). BGA Blockchain Game Report 2021. Onlinepublikation auf [dappradar.com](https://dappradar.com/blog/bga-blockchain-game-report-2021).  
<https://dappradar.com/blog/bga-blockchain-game-report-2021>.
- Irvin, K. (2021). Someone Paid \$450K to Be Snoop Dogg's Metaverse Neighbor. Onlinepublikation auf [decrypt.to](https://decrypt.co/87524/someone-paid-450k-snoop-dogg-metaverse-neighbor). <https://decrypt.co/87524/someone-paid-450k-snoop-dogg-metaverse-neighbor>.
- Isaac, M.& Browning, K. (2022). Crypto Enthusiasts Meet Their Match: Angry Gamers. Onlinepublikation auf [nytimes.com](https://www.nytimes.com/2022/01/15/technology/cryptocurrency-nft-gamers.html). <https://www.nytimes.com/2022/01/15/technology/cryptocurrency-nft-gamers.html>
- Krause, M.& Tolaymat, T. (2018). Quantification of energy and carbon costs for mining cryptocurrencies. In: *Nature Sustainability*, 1/11 (Nov.2018), S.711-718.
- Kumar, V. A. (2012). Money Laundering: Concept, Significance, and its Impact. In: *European Journal of Business Management*, 4/2 (2012), S.113-119.
- Lange, G. (2022). Ethereum 2.0: Vitalik Buterin dämpft Hoffnungen auf baldigen Vollzug. Onlinepublikation auf [block-builders.de](https://block-builders.de/ethereum-2-0-vitalik-buterin-daempft-hoffnungen-auf-baldigen-vollzug). <https://block-builders.de/ethereum-2-0-vitalik-buterin-daempft-hoffnungen-auf-baldigen-vollzug>, abgerufen am 16.02.2022.
- Lee, L.-H., Braud, T., Zhou, P., Wang, L., Xu, D., Kumar, A., Bermejo, C., Hui, P. (2021). All One Needs to Know about Metaverse: A Complete Survey on Technological Singularity, Virtual Ecosystem, and Research Agenda. Onlinepublikation auf [arxiv.org](https://arxiv.org/abs/2110.05352). <https://arxiv.org/abs/2110.05352>.
- Le Pennec, G., Fiedler, I., Ante, L. (2021). Wash trading at cryptocurrency exchanges. In: *Finance Research Letters*, 43 (2021).
- Leston, R. (2022). Ubisoft Exec Says 'Gamers Don't Get It' When It Comes To NFTS. Onlinepublikation auf [ing.com](https://www.ign.com/articles/ubisoft-exec-says-gamers-dont-get-it-when-it-comes-to-nfts). <https://www.ign.com/articles/ubisoft-exec-says-gamers-dont-get-it-when-it-comes-to-nfts>.
- Microsoft (2022). Microsoft Mesh. Onlinepublikation auf [microsoft.com](https://www.microsoft.com/en-us/mesh).  
<https://www.microsoft.com/en-us/mesh>.

- Museum of Crypto Art (2022). *Museum of Crypto Art*. Onlinepublikation auf museumofcryptoart.com. <https://museumofcryptoart.com>.
- Nadini, M., Alessandretti, L., Di Giacinto, F., Martino, M., Aiello, L. M., Baronchelli, A. (2021). Mapping the NFT revolution: market trends, trade networks, and visual features. In: Nature Scientific Reports 11, Nr. 20902 (2021). Onlinepublikation auf nature.com. <https://www.nature.com/articles/s41598-021-00053-8#article-info>.
- Nonfungible (2022). *Market Tracker*. Onlinepublikation auf nonfungible.com. <https://nonfungible.com/market-tracker?segment=art&days=9007199254740991>.
- Oculus (2022). *Oculus Blog*. Onlinepublikation auf oculus.com. <https://www.oculus.com/>.
- Robertson, A. (2022). GameStop is launching its own NFT marketplace. Onlinepublikation auf theverge.com. <https://www.theverge.com/2022/2/3/22914855/gamestop-nft-marketplace-immutable-x-ethereum-announcement>.
- Robinson, M. (2022). Gabe Newell explains why Steam banned NFTs. Onlinepublikation auf eurogamer.net. <https://www.eurogamer.net/articles/2022-02-25-gabe-newell-explains-why-steam-banned-nfts>.
- Stead, C. (2022). Interview: Ubisoft responds to angry NFT Digits and Quartz reaction. Onlinepublikation auf finder.com.au. <https://www.finder.com.au/ubisoft-interview-nfts>.
- Stephenson, Neal (1992): *Snow Crash*. Bantam Books, 1992, New York.
- Sweeney, T. (2021). *Tim Sweeney Twitter*. Onlinepublikation auf twitter.com. [https://twitter.com/TimSweeneyEpic?ref\\_src=twsrc%5Etfw%7Ctwcamp%5Etweetembed%7Ctwterm%5E1442519522875949061%7Ctwgr%5E%7Ctwcon%5Es1\\_&ref\\_url=https%3A%2F%2Fwww.nytimes.com%2F2022%2F01%2F15%2Ftechnology%2Fcryptocurrency-nft-gamers.html](https://twitter.com/TimSweeneyEpic?ref_src=twsrc%5Etfw%7Ctwcamp%5Etweetembed%7Ctwterm%5E1442519522875949061%7Ctwgr%5E%7Ctwcon%5Es1_&ref_url=https%3A%2F%2Fwww.nytimes.com%2F2022%2F01%2F15%2Ftechnology%2Fcryptocurrency-nft-gamers.html).
- The Department of the Treasury (2022). Study of the Facilitation of Money Laundering and Terror Finance Through the Trade in Works of Art. Onlinepublikation auf home.treasury. [https://home.treasury.gov/system/files/136/Treasury\\_Study\\_WoA.pdf](https://home.treasury.gov/system/files/136/Treasury_Study_WoA.pdf).
- Ubisoft (2022): *Ubisoft Quartz*. Onlinepublikation auf quartz.ubisoft.com. <https://quartz.ubisoft.com/welcome>.
- Valuables (2022). *Tweet Auction Jack Dorsey*. Onlinepublikation auf v.cent.to. <https://v.cent.co/tweet/20>.
- Venture Beat (2021). Tim Sweeney: The open metaverse requires companies to have enlightened self-interest. Onlinepublikation auf vulturebeat.com. <https://venturebeat.com/2021/01/27/tim-sweeney-the-open-metaverse-requires-companies-to-have-enlightened-self-interest>.
- Victor, F., Weintraud, A. M. (2021). Detecting and Quantifying Wash Trading on Decentralized Cryptocurrency Exchanges. Onlinepublikation auf arxiv.org. <https://arxiv.org/abs/2102.07001>, abgerufen am 15.03.2022.
- Yeo, A. (2021). Think cryptocurrency is bad? NFTs are even worse. Onlinepublikation auf mashable.com. <https://mashable.com/article/nft-cryptocurrency-bad-environment-art>.