LAB University of Applied Sciences

Membership NFTs

Blockchain Technology, opportunities, and implementation of utility based Non-Fungible-Tokens

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Abstract

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Abstract

The purpose of the study is to help companies understand, how blockchain technology, and specifically NFTs, will revolutionize the future of business, as well as to develop a universal NFT implementation strategy. Specifically, the thesis intends to define a basic NFT execution guide for retail-based businesses wanting to implement modern, membership strategies.

In the theoretical part of the thesis the following areas will be covered: how blockchain technology works, what Bitcoin, altcoins and tokens are, what makes NFTs unique, how they can be used and what their risks and challenges are.

In the empirical section of the study both qualitative and quantitative approaches were utilized. As data collecting methods, case studies, research experiments, and questionnaires were used.

The study results indicate that NFTs have the potential to become an essential part of modern society, equivalent to the importance of internet and social media today. Furthermore, the study shows that the overall adoption of NFTs is still in its infancy, and that companies, embracing this disruptive technology early, will potentially be rewarded significantly in the future.

Keywords

Blockchain Technology, Distributed Ledger Technology (DLT), Bitcoin, cryptocurrencies, Non-Fungible-Tokens (NFTs), utility NFTs, membership clubs

Contents

1 Introduction

1.1 Background

Crypto. Blockchain. Bitcoin. The Metaverse. NFTs…

These terms have all gathered a lot of mainstream media attention over the recent years. Be it the stories of investors becoming overnight millionaires, to the fraudulent scammers, hackers and money laundering criminals, trying to stay anonymous. Be it the promise of a freer more decentralised world with equal financial accessibility for everyone, to the worries of a dystopian future where the government loses all control over the economy. Be it the belief that creators finally have true digital ownership and the chance to really profit from their intellectual property, to joking about the fact that some people are buying jpegs for tens of millions of dollars. Be it for good or bad, cryptocurrencies and blockchain technology have gripped public attention countless times over the last decade. By now it is fair to assume, this disruptive technology is here to stay.

The similarities to the wacky early days of the internet are undeniable. The thought of purchasing something over the internet used to sound just as crazy as today's idea of owning property or assets in a virtual reality. It is hard to dispute the statement that the future of humanity will inevitably be intertwined and dependent on blockchain technology, similar to how today's society is currently dependent on the internet. (Vaynerchuk 2021.)

If this turns out to be true, the most likely scenario will be, like with the internet today, most of its users will have no real clue how the underlying technology works, but rather be dependent on third party intermediaries for a more user-friendly experience. Considering that these original third party intermediaries of the internet are now some of the biggest companies in the world - sometimes referred to as *Big Tech* or *FAANG (Facebook/Meta, Apple, Amazon, Netflix & Alphabet/Google)* - and that nearly all of these companies are currently investing heavily into the development of their blockchain, crypto and augmented reality departments, it is safe to say some more in-depth knowledge of the space could prove to be a very profitable use of time for any organisation or individual. (Hoffmann 2022.)

1.2 Objectives and Delimitations

Since the words crypto, blockchain, tokens and coins, all get used so freely and often synonymously, one tends to overlook how many different unique sectors already exist under the crypto umbrella. To clearly differentiate these subsectors, often requires a lot more technical knowledge and nuance then one might think.

For example, coins and tokens can be categorised by their function, such as:

- payment coins - digital currencies to facilitate transactions and the storing of value
- stablecoins - asset backed or algorithmically pegged tokens
- smart contracts - programmable money
- tokens – derivative digital assets built on the blockchain of another cryptocurrency
- Non-Fungible-Tokens – certificates of digital ownership.

There are numerous other ways to categorised blockchains, such as on a more technical base, e.g., by their scaling solutions or their consensus mechanisms. (Hoffmann 2022; Cryptopedia 2022.)

This thesis aims to first explain the basics of blockchain technology, then briefly describe the different subsectors in the crypto space and finally dive deep into the Non-Fungible-Token (NFT) realm. The goal is to understand what differentiates NFTs from the rest of crypto, what opportunities and limitations they possess and what the challenges of an NFT implementation are. The thesis will thoroughly investigate the utility NFTs can provide and how one can capitalise on this utility.

The main NFT utility this study explores, is how Non-Fungible-Tokens will revolutionise the future of membership clubs and subscription business models. It will discuss what new membership strategies can be derived from this technology and aims to be a generalised implementation handbook for companies wishing to integrate modern membership clubs into their business, with the help of blockchain technology. By the end of this report, the reader will understand:

- what blockchains, cryptocurrencies and tokens are
- what makes NFTs unique and how they will revolutionise modern businesses
- how companies can capitalise on NFTs, specifically retail-based businesses wanting to implement modern membership strategies.

To help illustrate the challenges in the NFT implementation process, this thesis will conduct experiments, analyse questionnaires, and refer to real-world case studies of successful projects. However, this study does not unpack the detailed cryptography and programming behind blockchains, but more the conceptual understanding of it. Therefore, this thesis does not entail a single line of code. This study analyses the technology based on financial, legal, economic, psychological, and sociological terms, rather than by the approach a computer

scientist might take. Hence, this thesis is not intended as a manual for developers, but rather addresses the audience interested in the business utility of blockchains and NFTs.

Blockchain technology emerged from the vision of creating permissionless, peer-to-peer networks, yet in reality, accessing the benefits of crypto is often gated by excessive amounts of complex technical terms and industry knowledge. The whole study is essentially an investigative process, shedding a light onto the blockchain space, with the goal of successfully creating an advanced plan/guidebook on the implementations of membership NFTs for modern businesses.

1.3 Structure

There are five chapters in this thesis. The first chapter is an introduction chapter, and is intended to describe the background, the relevance, the research questions, and the objectives and delimitations of the thesis topic. This chapter will also define the theoretical framework of the study and explain the research methodology. The first chapter is finished by determining the thesis structure.

The second chapter has the intended purpose of laying the foundational knowledge required to understand blockchain technology. This chapter will start by defining the terminology, origin, and history of blockchain and cryptocurrencies. The first half of the second chapter will concentrate on understanding Bitcoin, while the second half of this chapter will focus on the alternative crypto coins and tokens. The goal of the chapter is for the reader to be able to understand and differentiate between the various blockchain sectors. This chapter is particularly important, as it describes the theoretical framework that is necessary to be able to follow the rest of the paper.

The third chapter solely focuses on the Non-Fungible-Token (NFT) sector. This chapter first covers the definition, fundamentals, and origin of NFTs, whilst describing the most pivotal projects in the history of NFTs. The chapter then describes and analyzes the different NFT subsectors and use cases, as well as the adoption of this new technology.

The fourth chapter is the empirical part of the thesis, in which experiment data is collected and analysed. This chapter brings all the theoretical knowledge of the previous chapters together, to create a basic, universal guide for companies interested in implementing NFTs in their business, particularly as a membership strategy. This chapter also discusses the risks and challenges of NFTs, from the perspective of a company wanting to utilize them,

but also the risks and challenges that might stunt the broader NFT adoption. The fourth chapter is also the chapter where most of the research questions are answered.

The fifth and final chapter is the a brief summary of the whole thesis and the conclusion of the study.

2 Blockchain Technology

2.1 Terminology

Before advancing in this thesis, it is important to acknowledge the confusing nature of the terms *blockchain*, *Bitcoin* and many other crypto currencies, as they often carry multiple meanings (Swan 2015, 9).

The term *Bitcoin* for example can be used to either describe the concepts of the underlying blockchain technology, the specific network protocol, or the cryptocurrency as a unit of exchange itself *(*Swan 2015, 9).

An appropriate analogy for this is:

> *It is as if PayPal has called the Internet "PayPal", upon which the PayPal protocol was run, to transfer the PayPal currency (Swan 2015, 9).*

During the process of understanding the technology of blockchain it will become gradually clearer what exactly is being referred to with each term in its specific context.

2.2 Origin and History

The origin of blockchain technology stems from Bitcoin. Its concept was first invented in the aftermath of the Global Financial Crisis with the publishing of a white paper called *Bitcoin: A Peer-to-Peer Electronic Cash System (2008)* by the pseudo-anonymous person or entity under the alias of Satoshi Nakamoto. The nine-page document, first published on a mailing list for cryptographers, describes the operational details of the new technology concisely. It explains how a decentralized electronic cash system can validate transactions and issues new currency safely without going through the financial system or relying on a central authority. (Antonopoulos 2015, 3.)

Bitcoin officially launched on January 9, 2009, making it the first crypto currency to exist. In April of 2011, the still unknown Satoshi Nakamoto withdrew from the public leaving the network and its open-source code in the hands of any programmers, developers or users willing to maintain and improve the protocol. However, no one, including Nakamoto, exerts control over the fully transparent system that instead is governed by mathematical principles and democratic concepts. (Antonopoulos 2015, 4; Swan 2015, 9.)

As Bitcoin.org (2022), the leading independent open-source website representing the Bitcoin network, puts it:

> *Bitcoin is controlled by all Bitcoin users around the world. Developers are improving the software but they can't force a change in the rules of the Bitcoin protocol because all users are free to choose what software they use. In order to stay compatible with each other, all users need to use software complying with the same rules. Bitcoin can only work decently with a complete consensus between all users. Therefore, all users and developers have strong incentives to adopt and protect this consensus.*

Since the launch of Bitcoin in 2009, it has seen exponential growth in transaction volume, clearing value, market capitalization and participants using and maintaining the network. It has even received formal national recognition as legal tender in the country of El Salvador (Jagtiani & McDonald 2021).

The main function of Bitcoin is to enable decentralized trustless transactions, yet how it enables this is the underlying technology and concept that allows all other blockchain based applications to function. Understanding how Bitcoin works is the groundworks of understanding the technology of blockchain as a whole and all its variations.

2.3 Bitcoin

In the original white paper published by Satoshi Nakamoto (2008), he describes the problem that all commerce and financial activity on the Internet requires a trusted third party. He argues this is inherently inefficient, as the *cost of mediation increases transaction costs*. This increased cost makes it financially nonsensical to send *casual* smaller transactions amounts. In addition, Satoshi (2008) states another reason the current financial system is dependent on third parties is to prohibit non-reversable electronic transactions. This is beneficial as a means of combatting fraudulent transactions, yet negatively effects the sellers of *nonreversible services.* This would not be the case if no trust was required whilst conducting digital settlements.

Nakamoto (2008, 1.) therefore defines his aimed for Bitcoin as follows:

> *What is needed is an electronic payment system based on cryptographic proof instead of trust, allowing any two willing parties to transact directly with each other without the need for a trusted third party.*

He follows by stating that by making transactions *computationally impractical to reverse,* it inheritably protects sellers. Simultaneously, buyers can easily be protected by the incorporation of a simple *routine escrow mechanism.* (Nakamoto 2008, 1.)

During his quest to achieve this goal Satoshi Nakamoto (2008) came about inventing blockchain technology and named his protocol Bitcoin.

The computer scientist, Andreas M. Antonopoulos, who is one of the most well-known figures in bitcoin and highly respected by the blockchain community, tries to briefly describe the functioning of the Bitcoin protocol in his best-selling book, Mastering Bitcoin (2015), as follows:

> *Bitcoin is a distributed, peer-to-peer system. As such there is no "central" server or point of control. Bitcoins are created through a process called "mining", which involves competing to find solutions to a mathematical problem while processing bitcoin transactions. [...] Essentially, bitcoin mining decentralizes the currency-issuance and clearing functions of a central bank and replaces the need for any central bank with this global competition. (*Antonopoulos 2015, 1-2.)

By breaking down this synopsis and elaborating on each individual point in bite sized chunks, one can fully decipher and clearly understand how this new technology works.

2.3.1 A Peer-to-Peer System

Bitcoin is a distributed, peer-to-peer system. As such there is no "central" server or point of control (Antonopoulos 2015, 3-4).

With the term *peer-to-peer* Nakamoto (2008) implies extinguishing the need for middlemen in transaction between unknown parties. In a practical sense, this means using cryptography to shift the role of ledger-keeping away from financial institutions (third parties) to a decentralized network of autonomous computers. By doing so the issue of guaranteeing trust between two parties is outside the control of any one person. (Vigna 2015, 5.)

The challenge in applying correct ledger-keeping in a trustless *peer-to-peer* system is verifying that the assets are authentic, and the transactions amounts legitimate. What makes this challenging with digital assets is that they are inherently easy to counterfeit. Duplicating a document or a jpeg an infinite number of times only requires the simple technique of resaving or copying and pasting that digital information, repeatedly. (Swan 2015, 2.)

This problem is known as *The Double-Spending Problem* and until blockchain cryptography there was no other way of undoubtably verifying digital record-keeping without an accredited

third party. Financial institutions can guarantee legitimate transactions with legitimate assets since they hold the funds of their users on their behalf. Therefore, they also have the power to approve or decline any illegitimate transaction requests by their users. This traditional system makes banks the quasi gatekeepers between its users and their personal funds. In addition to these *gatekeepers* having their own incentives, they are also all highly dependent on the regulatory, fiscal, and monetary decisions made by governments and central banks. Having *financial gatekeepers* might be beneficial in hindering fraudulent transactions, like *double spending* funds that don't exist, yet this also gives financial intermediaries and with them governments an immense amount of power which can be misused. This misusage of power by financial institutions and governments, be it on purpose or out of ignorance, can be seen numerous times in human history. Some notable recent examples are the hyperinflation of the Zimbabwean Dollar in 2007, the Global Financial Crisis of 2008 and the Greek Debt Crisis of 2015. (Vigna 2015, 15-16; Johnston 2021.)

Before his disappearance, Satoshi Nakamoto (2010) himself stated the following on a cryptography forum:

> *The root problem with conventional currency is all the trust that's required to make it work. The central bank must be trusted not to debase the currency, but the history of fiat currencies is full of breaches of that trust.*

By solving the double-spend problem through the implementation of a distributed public ledger, also known as *Distributed-Ledger-Technology,* Satoshi has successfully managed to create a trustless peer-to-peer currency (Swan 2015, 2).

2.3.2 Distributed-Ledger-Technology

Instead of using the traditional accounting approach of the banking sector, where all ledger entries are concealed in private databases, the blockchain itself is one large public database which anyone can access. Each cryptocurrency is hosted by its own blockchain and therefore acts as the original medium of exchange within the record-keeping system of its own public ledger. (Swan 2015, 2.)

To inspect any transaction on the public ledger (the blockchain) one can simply use Internet sites called *Block explorers*, such as www.Blockchain.info for the Bitcoin chain. (Swan 2015, 2.)

To use the public ledger of Bitcoin, which means to make a peer-to-peer Bitcoin transaction, one needs to create a *digital address* with a *private key*, and then install a *wallet software*. The *digital address,* sometimes also referred to with their hash value, *public keys*, are the details that one party requires to be able to send another party cryptocurrency, i.e., Bitcoin. This address is the blockchain equivalent of *bank details* in the traditional fiat financial system. The *private key* is a cryptographic secret phrase which is required to send any digital currencies associated with the public address that key represents. The *private key* resembles the login details required for online banking, yet there is no centralized account. The final ingredient to use Bitcoin, besides internet access and a computer/smartphone, is a *wallet software*. The *wallet software* is the computer software and user interface face required to a manage your Bitcoin activity. A digital wallet does not actually store any digital currencies, but instead stores sets of public and private keys which enable the user to access the location on the blockchain where his/her assets are stored. The software wallet, unlike its analogue counterpart, is used to communicate with the blockchain rather than store any valuable assets itself. (Swan 2015, 3.)

A popular software wallet for Bitcoin would i.e., be Exodus (www.exodus.com).

To still ensure user privacy on a public ledger Nakamoto (2008) devised keeping the public adresses or keys of all user independent of any physical identities. This only works as long as no person, publicly identifies themselves as having control over a particlar public adress. Once this information is public knowledge, anyone can track all previous and future transactions of that specific adress and link it to that person. Doing so it is possible to follow the transaction trail and decrypt where all the funds of that person originate and eventually end up. Figure 1 clearly depics how this differs from the traditional banking system, where the bank keeps all financial activity behind closed doors. Keeping your financial privacy in the *New Privacy Model,* the distributed ledger model, is now a matter of personal responsibility rather than relying on the soundness of financial intermediaries. (Nakamoto 2008.)

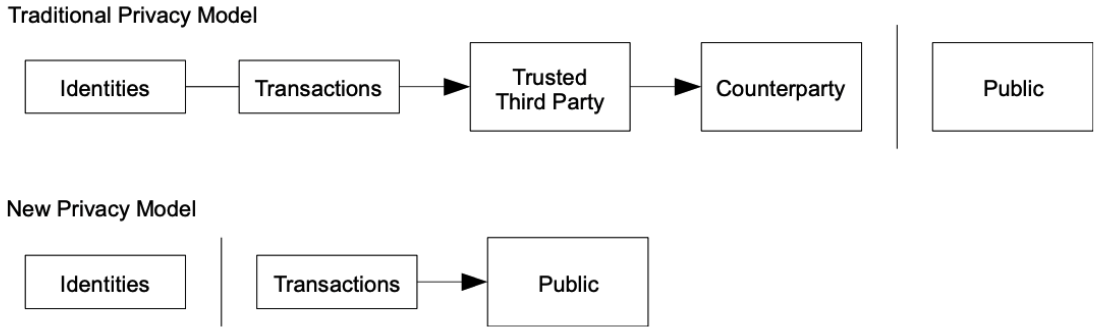


Figure 1. Privacy Models (Nakamoto 2008, 6)

Since the Bitcoin blockchain is one large public ledger, anyone holding a private key has the password and the right to move any coins, that according to the public ledger, have last been sent to the public address which that key has access to. This means all crypto assets are stored on the blockchain itself and who owns the private keys locating that asset, also owns the asset. This is where the classic phrase in crypto finds its meaning:

Not your keys, not your coins (Antonopoulos 2015).

Nakamoto (2008) solves the double-spend problem of digital cash with a peer-to-peer network using a public ledger. Yet this system only works if one assumes all network participants, also referred to as *nodes*, are honest and have no malicious intents. In practice this is of course unrealistic. That is why a blockchain requires the incorporation of an additional incentive structure that makes it economically and financially more rewarding for nodes to act honestly that fraudulently within the network.

Nakamoto (2008) satisfies this need to incentivize and guarantee network honesty with the establishment of *miners* and the *Proof-of-Work* algorithm within the network.

2.3.3 Mining and Proof-of-Work

Bitcoins are created through a process called "mining", which involves competing to find solutions to a mathematical problem while processing bitcoin transactions (Antonopoulos 2015, 3-4).

Bitcoin *mining* or *miners* validate the public ledger by securing the network of any fraudulent transactions. They are who confirm no double-spending of Bitcoins has occurred. Miners do this by providing their computational processing power to the bitcoin network in return for the chance of winning Bitcoin rewards. This consensus algorithm Nakamoto (2008) invented is called *Proof-of-Work*. The intent of this algorithm is to make it obviously more rewarding to validate transactions honestly than fraudulently, because as long as half of the participants in the Bitcoin system are honest the protocol can function flawlessly and trust free. (Nakamoto 2008.)

Proof-of-work functions on a sort of lottery system in which the chance of winning is governed by the amount of processing power provided by each participant, also known as the miner. The basic idea behind this system is that, since there is no central authority within the network, someone new needs to be routinely chosen to update the public ledger, for the collective. Miners are essentially network participant (or nodes), who are volunteering to update the ledger for the whole Bitcoin network. Since this power of authority cannot just

be handed to any network participant randomly and assume that, that participant is an honest node, a cost and reward structure is required. (Antonopoulos 2015, 175.)

The cost a miner accurse is the cost involved in creating high levels of computational processing power, also known as *hash power*. This is generally the cost of the hardware and the cost of electricity required to run that hardware. All miners use this processing power to then solve a complicated mathematical problem, based on a cryptographic hash algorithm, which is broadcasted throughout the Bitcoin network. This problem can practically only be solved by guessing the right answer repeatedly. The first miner to figure out the correct answer is rewarded the right to add the next batch of transactions to the public ledger, the Bitcoin blockchain. Since the answer can only be guessed, the chances of winning this race are in direct correlation with the amount of computing power a miner can generate. More computing power equals more guesses per second. This is also referred to as the *hash rate*. An analogue analogy here would be the lottery system, where the chance of winning the jackpot increases with the amount of lottery tickets purchased. (Antonopoulos 2015, 175.)

In the Bitcoin proof-of-work system, this competition repeats itself approximately every ten minutes. This means that roughly every ten minutes, a new miner is chosen to update the public ledger with a new batch of transactions, also known as a *block*. This new block is then forwarded to the rest of the network for inspection. Once the majority of the network agrees that the miner has validated the batch of transactions in that block correctly, the block is deemed as *confirmed* and officially added to the chain. This whole process happens roughly every ten minutes. The first block of any blockchain – the first batch of transactions ever processed by the network – is referred to as the genesis block. (Antonopoulos 2015, 175.)

Since anyone with a computer can join and exit the bitcoin network and become a miner as they please, the number of miners participating in the network, and with them the amount of processing power generated, can vary greatly. Hence, the mathematical hash problem is adjusted roughly every two weeks to ensure the time it takes to solve the equation, stays at approximately ten minutes. (Nakamoto 2008; Antonopoulos 2015, 175.)

To offset this cost accrued by the miners, the proof-of-work system also rewards each winning miner with an additional amount of newly minted Bitcoins, as well as a small transaction fee from the network participants to incentivize miners to process their transactions first.

> *Essentially, bitcoin mining decentralizes the currency-issuance and clearing functions of a central bank and replaces the need for any central bank with this global competition (Antonopoulos 2015, 2).*

By newly minting bitcoins after every block the protocol not only incentivizes miners to participate in the proof-of-work system, but also holds the function of the central bank by issuing new currency into circulation. These newly minted bitcoin rewards originally started at 50 Bitcoin per new block. The protocol halves these mining rewards every four years, or precisely every 210,000 blocks, making Bitcoin a deflationary currency. These reward halving events are generally referred to as *the halvings.* The current mining rewards, as of 2020 till 2024, stand at 6.25 newly minted Bitcoin per new block. Considering the price appreciation Bitcoin has experienced, this can generally be seen as quite the large once-off reward. Hence, the analogy to a lottery jackpot often finding merit here. Also, the term *Bitcoin mining* itself is an applicable analogy to the mining process of extracting precious metals, as both require work to obtain, and are both affected by the forces of quantitively diminishing future returns. The difference being that metal extraction requires physical work and Bitcoin mining computational work. (Antonopoulos 2015, 175.)

In addition to the amount of newly minted Bitcoin halving every four years, Nakamoto (2008) also hard-coded the maximum money supply of Bitcoin to cap out at 21 million Bitcoin. This is assumed to happen approximately in the year 2140. From then onwards the reward miners receive will solely be reliant on the transaction fees users are willing to pay to successfully confirm their transactions. The deflationary increase in the new money supply of Bitcoin can be seen in Figure 2. (Antonopoulos 2015, 175-176.)

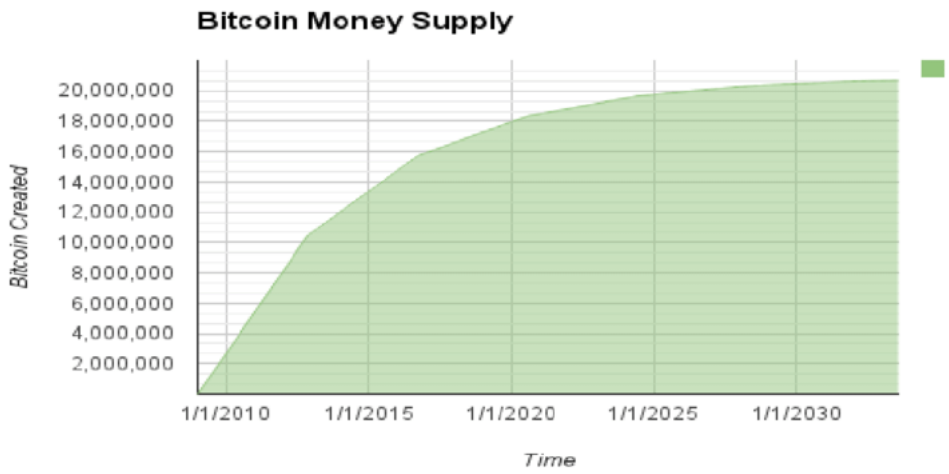


Figure 2. Bitcoin Money Supply (Antonopoulos 2015, 177)

These economic properties of blockchain protocols are referred to as *tokenomics* (Langridge *2021).*

Besides the adjustment of mining difficulty, the secured long-term profitability of miners is generally assured by the assumption that computer processing efficiency, in relation to hardware price, will continuously improve. This is also known as the Moore's Law (Nakamoto 2018, 4). In addition, the continuous price appreciation of Bitcoin, partly due to the decreasing issuance of supply, has diminished the loss of profits incurred by the miners during the previous halving events. (Antonopoulos 2015, 176-177.)

The act of participating as a miner has been so lucrative that the number of bitcoin miners has increased dramatically since the inception of Bitcoin in 2009. This in return has increased the difficulty of the mathematical problem greatly as well. Today, to stand a chance to win a *block,* a miner almost certainly requires specialized computing units, known as ASICs (application-specific integrated circuits), which are produced specifically to maximize mining efficiency. (Antonopoulos 2015, 26.)

It is important to remember that the main purpose of the mining process is not the rewards or currency issuance, but the function of a decentralized clearing house. The incentives of mining laid out in such a way that acting fraudulently is not just non-sensical but even avoidable. Acting fraudulently as a miner is a non-sensical decision, as one would have to incur an immense amount of work and cost by means of hardware, electricity, and time, only to stand the potential chance of eventually winning a block to verify some random group of transactions. In addition, by undermining the network as a fraudulent participant you are simultaneously diminishing the value of the rewards you received on that network. (Antonopoulos 2015, 25-26.)

Besides fraudulent miner behavior being illogical, it also has little effect on a network where most participants are honest actors. Since every new block is double checked by the rest of the community, a fraudulent transaction is picked up almost immediately. If the majority agrees that the last block is fraudulent or it wasn’t that miners turn to validate, they can discard its existence as an invalid *fork* off the main chain and carry on adding new blocks from the last block deemed as honest. A fork refers to the splitting of a single blockchain into multiple chains. This concept is visually depicted in Figure 3. Majority - measured as the combined hash power - rules in Bitcoin. In practice this means the longest chain, which has consumed the most energy (hash power), is always considered the only true and valid blockchain. In addition, the influence of miners is also limited by the fact that they cannot change the underlying code, steal coins, or create extra bitcoin. (Antonopoulos 2015, 179; 99Bitcoins 2018; Caselin 2022.)

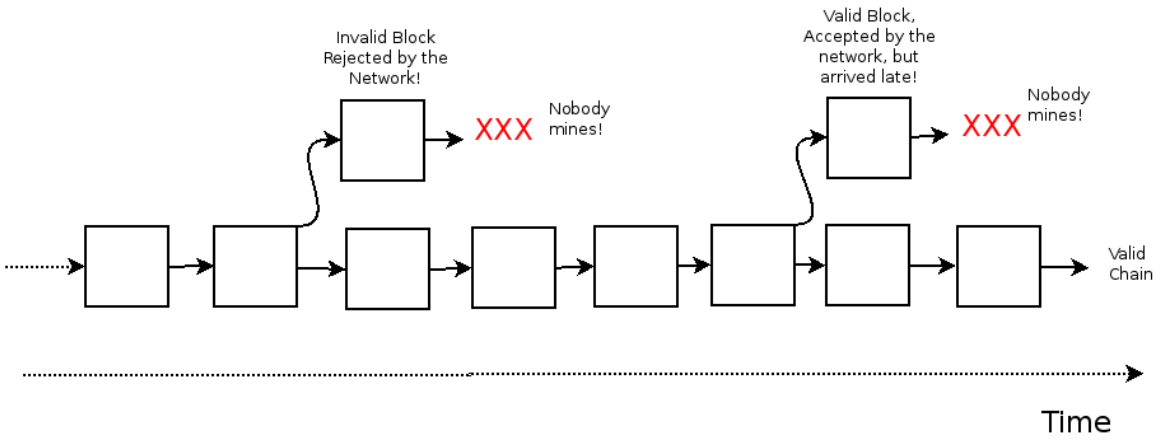


Figure 3. The Chain and Chain Forks (Forkdrop.io 2019)

This decentralized security measure, proof-of-work, might enable trustless peer-to-peer transactions, but also consumes large amounts of energy to maintain. Since the computational processing power required to up-keep the distributed ledger itself, is relatively low, the vast majority of power generated by the Bitcoin network is consumed by the proof-of-work consensus system. (Antonopoulos 2015, 25-26.)

Although Bitcoin is the first blockchain technology it paved the way for numerous alternative blockchains to try and redefine and improve the Bitcoin protocol. These new blockchains are universally referred to as *Altcoins*.

2.4 Altcoins

Altcoins, which is the shortened term for *alternative coins,* is the term used to refer to all blockchains and tokens other than Bitcoin itself. Bitcoin might have been the first blockchain invented, but it wasn't the last. According to CoinMarketCap, as of today (14 April 2022), there are 968 different cryptocurrencies, each with a market capitalization of over 10 million USD. The market capitalization of an asset is calculated by multiplying the circulating supply of that asset by the price of an individual unit. The total amount of different cryptocurrencies, as of March 2022, is estimated to be over 18,000, with most of them having virtually no following or trading volume. The market capitalization and volume traded are two of the best indicators to judge the adoption, confidence, and overall success of a digital asset. (CoinMarketCap 2022; Saylor 2022.)

Even with the introduction of so many new altcoins, the market dominance of Bitcoin still lies at roughly 40%. This means that of the total market capitalization of all cryptocurrencies combined, which as of today (14 April 2022), lies at approximately 2 trillion USD, Bitcoin still

consumes around 40%, or roughly 780 billion USD, of that pie. Figure 4 highlights this. (CoinMarketCap 2022.)

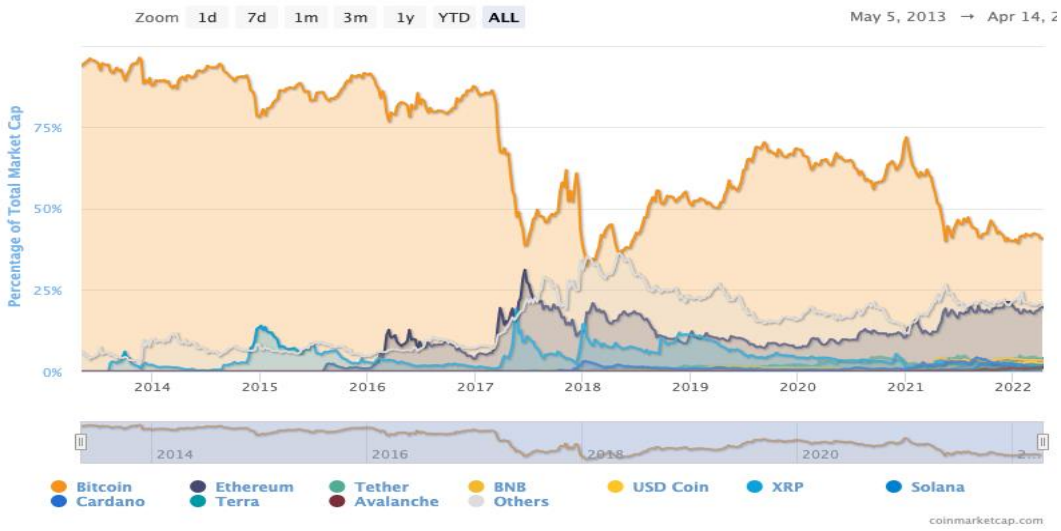


Figure 4. Bitcoin Dominance (CoinMarketCap 2022)

Figure 4, which also depicts the percentual market dominance of the top nine largest altcoins by market cap, clearly shows how the market dominance of Bitcoin has steadily declined over the last nine years. This is not due to the value of Bitcoin decreasing, but rather due to the proportional faster growth seen in the altcoin market. The Altcoin market has grown with an outstanding pace and evolved into numerous totally unique and independent crypto subsectors all aiming to tackle different financial, technological, economical, and social issues. (Saylor 2022.)

Since these subsectors are all unique ecosystems with a variety of differences and similarities between each other, there are multiple different ways to categorized them in a generalized manner. The most obvious categorization strategy is by differentiating various blockchains by their technological differences. The technological differences between blockchains can broadly be distinguished by their *consensus mechanism* and their *scaling solution.* (Saylor 2022.)

2.4.1 Consensus Mechanisms

The consensus mechanism is the fault-tolerant method a blockchain uses to validate new cryptocurrency transactions in a permissionless, decentralized manner. The consensus mechanism of a blockchain can be viewed as the backbone of a blockchain and is the best technical measure of how decentralized and secure it is. It is therefore important to analyze

the barrier of entry required to participate in a consensus mechanism. Only when the participation of a consensus mechanism is permissionless can it truly be considered decentralized. The consensus mechanism for Bitcoin is the proof-of-work consensus protocol, where the processing power of miners is used to determine the next block validator. Although proof-of-work is the most used consensus mechanism and has proven its validity for more than a decade, it is still routinely criticized due to its high energy consumption. This has led to the development of numerous other consensus algorithms, with the most notable being *proof-of-stake*. (Ethereum 2022.)

Proof-of-stake doesn't require miners to provide their energy consuming computational power to stand a chance to validate a new block, but instead requires network participants to lock up their personal capital on the protocol. In the proof-of-stake consensus model network participants that wish to earn rewards by validating blocks are called validators, not miners. Validators, lock up their personal capital on the network in exchange for cryptocurrency rewards. The process of locking up capital to validate transactions is called *staking.* As with the mining system in Bitcoin, where the more processing power a miner provides directly translates in them having a higher chance of winning the mining reward, the more capital locked up in the proof-of-stake model, also directly increases the chances of being chosen to validate a new block. If most of the network participants deem that the chosen validator recorded all transactions honestly, the validator is rewarded with cryptocurrency. If the validator is deemed to have acted fraudulently, they may lose some or all their staked capital as a penalty. The staking rewards and penalties can vary greatly depending on the underlying protocol design of the blockchain in question. (Ethereum 2022; Napoletano & Curry 2022.)

Proof-of-stake has proven to be more energy efficient, yet the protocol implementation is often criticized to potentially be more vulnerable to network attacks when compared to proof-of-work. Another argument critics of proof-of-stake often mention, is that the wealthier a validator is, the more network influence they have. This is technically true and also the case with Bitcoin, as more capital can also buy a miner more processing power. Since in theory participation is permissionless, meaning there is no barrier of entry to become a miner or validator, outsized network influence can always be combated with an increase of new network participants joining the consensus mechanism. In practice there are some barriers, like the necessary computing equipment (ASICs) when mining in proof-of-work, or minimal capital requirements to become a validator in proof-of-stake. These barriers are often circumvented by pooling capital together between multiple network participants into so called mining- or staking pools. This can also be beneficial when splitting rewards, as pool participants can rely on a more consistent yield out of a pool than the more

unpredictable reward schedule when mining/staking individually. (Napoletano & Curry 2022.)

Proof-of-stake has been gaining more and more popularity, with over 80 cryptocurrencies using the proof-of-stake consensus mechanism as of April 2022. The second largest cryptocurrency by market capitalization, Ethereum, is also currently in the process of transitioning its blockchain from a proof-of-work to a proof-of-stake model. There are numerous other consensus models being developed and deployed, such as *proof-of-authority* or *proof-of-storage*, yet their total market share is almost neglectable relative to that of the proof-of-work and proof-of-stake protocols. (Ethereum 2022; Napoletano & Curry 2022.)

Besides their consensus mechanism blockchains can also be categorized by the method they used to tackle excessive network growth, also known as their *scaling solution*.

2.4.2 Scaling Solutions

Categorizing blockchains by their scaling solutions is another technical way of differentiating cryptocurrencies. It is based on the technical challenge blockchains face when their network size and with them their transaction volumes, exceed the capacities of their original design.

Even the original blockchain, Bitcoin, is burdened by a maximum transaction volume which lies at only around 4.6 transactions per second or 2,759 per block. To put this into perspective to other traditional payment networks, VISA (2022) claims to be able to process around 2,400 transactions per second. (Ethereum 2022.)

The *blockchain trilemma* suggest that there is a tradeoff between security, decentralization, and scalability within the protocol design of any blockchain. Decentralization and security were often the original focal points of many of the first blockchain designs, yet with the growing mainstream adoption of crypto the lack of their scalability is now proving to be one of the largest challenges for blockchain technology. (Takyar 2022.)

The blockchain where this is most evident is Ethereum. The Ethereum network is the second largest cryptocurrency by market capitalization and has seen an extreme growth in network usage due to their invention of the *smart contract (*what a smart contract is will be discussed in a later chapter). This new blockchain feature has led to the mass adoption and success of Ethereum, yet simultaneously resulted in the mass congestion of its network. This network congestion can at times become so extreme that the network fee, also known as *gas fee,* go into the hundreds of dollars (US) per transaction. Gas fees are the equivalent to the transaction fees bitcoin miners receive to process a transaction. The higher fee a

network participant is willing to pay the quicker their transaction will get processed, since miners or validators are financially incentivized to process those transactions first. When network usage is extremely high, the congestion forces network participants to pay exuberant high transactions fees for them to even stand a chance to be included in one of the next blocks of transactions. Such high network fees make smaller transactions amount financially illogical and therefore contradicts the original idea of financial inclusion, that crypto and blockchain technology is supposed to stand for. (Ethereum 2022.)

To combat these network congestions and high transaction fees a variety of new scaling solutions are being developed. These solutions are either in the form of totally new blockchains, protocol improvements on older blockchains or a mixed between these two approaches. They can generally be categorized as *Layer 1* or *Layer 2* scaling solutions. (Ethereum 2022.)

A *Layer 1* (L1) solution refers to improving the actual core protocol of a blockchain. This can mean inventing and starting a whole new blockchain with a new protocol or improving the protocol code of an older more established blockchain. The benefit of improving an older blockchain is the network effect acquired by already having a large community of users/nodes who use and secure the network. The challenge is that there is an increased security risk when merging an old chain into the protocol of a new updated chain. This is not the case if one just starts a whole new blockchain from scratch. The three most popular *Layer 1* scaling solutions in development are: *Hard Forks, Segregated Witness* solutions and *Sharding.* (Takyar 2022; Ethereum 2022.)

A Hard Forks scaling solution means modifying the blockchains network properties in a structural or fundamental way, i.e., changing the underlying source code to increase the number of transactions per block or decrease the amount of time required to create a block. A hard fork is the prerequisite of implementing a Layer 1 scaling solution. This can either be done as a *planned hard fork or contentious hard fork.* In a *planned hard fork,* the overall community decides in advance that their chain will require an update at some specified point in the future, resulting in the death of the old chain. In a *contentious hard fork,* the old chain diverges into two chains due to a community disagreement around the protocol. This splitting of the chain into two chains is visually represented in Figure 5. The fork of the chain supported by the minority of nodes is usually required to rebrand the chain and its community. (Takyar 2022.)

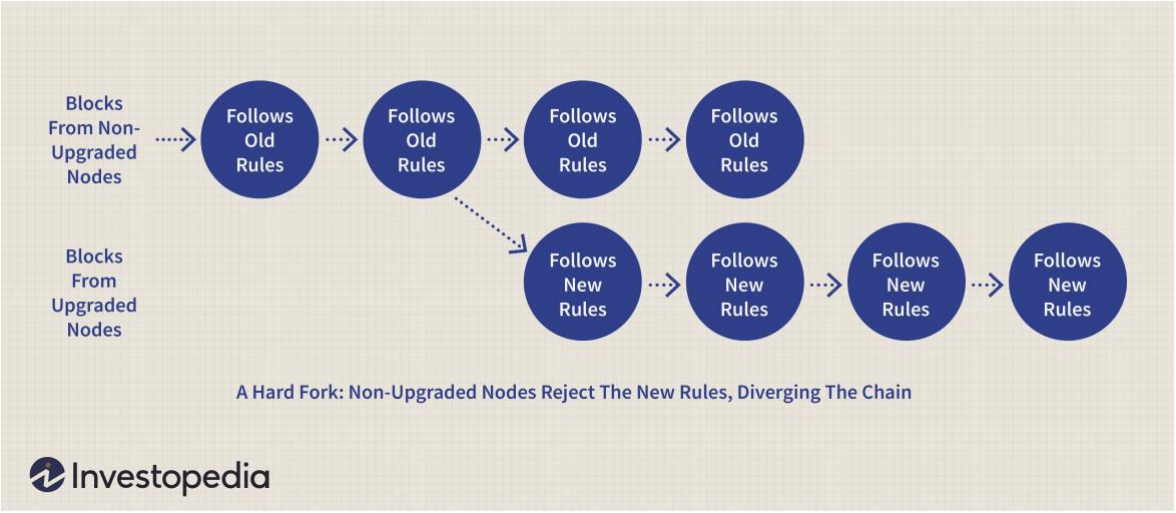


Figure 5. A Hard Fork (Bang 2019)

This was the case with *Bitcoin Cash*, where in 2017 a small minority of the Bitcoin community decided they wanted to increase the Bitcoin block size from 1MB to 8MB (and eventually to 32MB), as a means of increasing its transaction throughput. The adoption of Bitcoin Cash has been relatively low in comparison to the original Bitcoin. This can be attributed to the view that the lower overall mining power required to process Bitcoin Cash transactions is seen to negatively impact the security of the protocol. A similar community dispute also led to the splitting of the Ethereum chain in 2016, creating *Ethereum Classic*. (Rodeck & Curry 2022; Takyar 2022.)

A *Segregated Witness* scaling solution is a Layer 1 solution which instead of changing the protocol itself, focuses on improving the structure of data storage. This solution aims at decreasing the required storage size of the transactions, allowing for more transactions to fit into one block, rather than changing the nature of the block itself. (Takyar 2022.)

Another well-known Layer 1 scaling solution is *Sharding*. Sharding is a scaling technique that aims on breaking down a blockchain from being a single large chain of data to serval smaller chains, *shards*, running in parallel. This system improves the transaction efficiency by splitting the processing work over several different channels, yet this also arguably increases the protocols vulnerability by increasing the number of weak spots the network may have. Ethereum is the most notable blockchain currently in the development of implementing a sharding solution. The Ethereum developer community aims to launch and merge this new version of the chain, known as Ethereum 2.0, by the end of 2022. According to them Ethereum will then have tackled all three challenges of the blockchain trilemma, extinguishing the need of a tradeoff between security, decentralization, and scalability, as shown in Figure 6. (Ethereum.org, 2022; Dwyer 2022; Takyar 2022.)

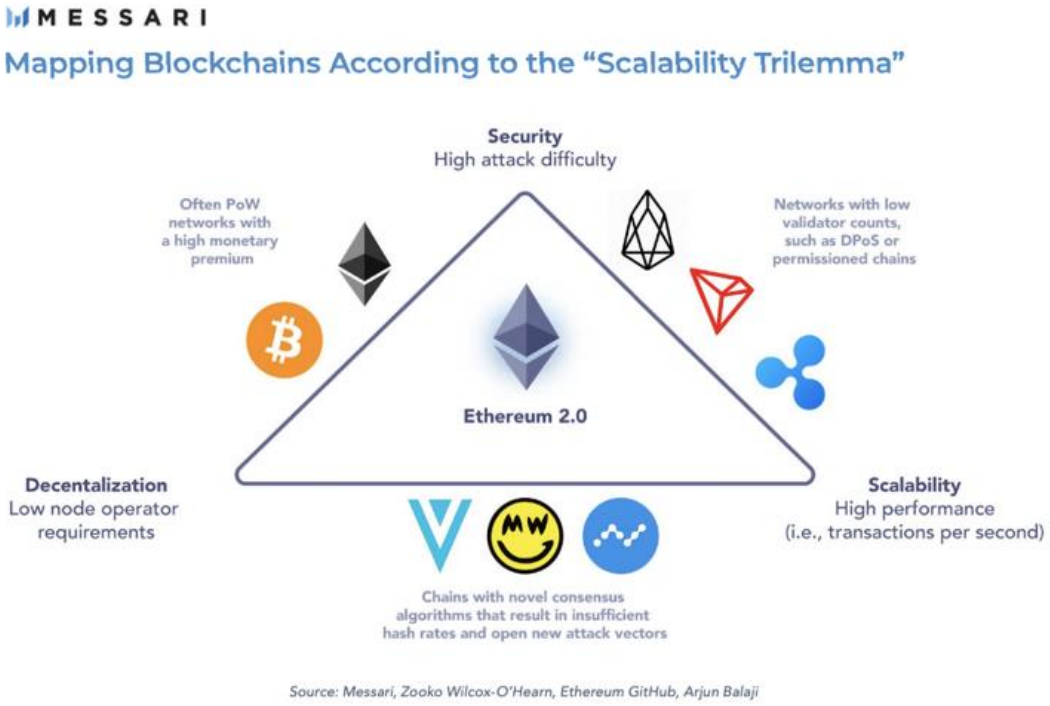


Figure 6. Mapping the Scalability Trilemma (Messari 2022)

Alternatively, to modifying the main protocol of a blockchain, there has been an increased effort and success in developing scaling solutions that run on top of the original blockchain. These scaling solutions are referred to as *Layer 2* scaling solutions, or off-chain solutions, as they leave the underling primary protocol layer unchanged. The basic concept is to offload transaction volume from the main blockchain onto additional application software, elevating the congestion off the main layer. The challenge here remains is to still maintain the security and decentralization of the underling Layer 1 blockchain. (Takyar 2022.)

There are several ways of implementing a Layer 2 solution, such as with *Sidechains*, Plasma Chains, *ZK Rollup*s or *State Channels.* They all use different approaches of increasing scalability while trying to maintain the decentralization and security of the base chain. (Dwyer 2022; Takyar 2022.)

Some popular examples of Layer 2 solutions are the *Bitcoin Lightning Network,* built on Bitcoin, and *Polygon/MATIC*, *Starkware or Arbritrum* built on top of Ethereum. Bitcoin and Ethereum represent the Layer 1 here, where as the *Lightning Network, Polygon/MATIC, Starkware* and *Arbritrum* represent *the Layer 2 scaling solutions.* Since Ethereum is currently the Layer 1 impacted the most by its scalability issues, this is also the chain on which most of the Layer 2 solutions are being developed. Besides the technical challenges of implementing this second layer of protocol code, receiving the support of the base layer community is also very important for its adoption. (Dwyer 2022.)

There are also cryptocurrencies that are referred to as *Layer 0* blockchains with their purposes being interoperability by connecting various Layer 1 chains together. The most popular example of a Layer 0 blockchain is *Polkadot*, which describes itself as *the Internet of blockchain.* (Polkadot 2022; Dwyer 2022.)

Besides these technical differences it is common to categorize altcoins by their practical use cases. The following chapter highlights the historic development of altcoins and distinguishes them by their functionality.

2.4.3 Payment and Value Coins

The original vision Nakamoto (2008) had for Bitcoin was for it to be *electronic cash* or the *currency of the internet*. This vision has arguably not necessarily come to fruition. Its low transaction throughput and high price volatility has led to an overall low adoption in using Bitcoin as a day to day means of exchange. Instead, Bitcoin has found a large audience in its use case as a store of value. Its deflationary properties, high security, incorruptibility, and convenient transportability has led to a lot of investors speculating on Bitcoin as the new store of value asset. Bitcoin is therefore often referred to as *digital gold* or the *digital reserve asset*. Also, governments often treat and regulate the digital asset as either a security, a commodity, or a property, and besides El Salvador no other nation has recognized Bitcoin as a currency (legal tender). (Jagtiani & McDonald 2021.)

The lack of use of Bitcoin as electronic cash spurred the creation of the first altcoins. The second crypto currency, and first altcoin, to launch was a fork of Bitcoin called Litecoin. The new coin was developed by Charlie Lee, an old Google employee, in 2001. Litecoin is almost an identical copy of the opensource code of Bitcoin, with some minor improvement in the software to increase its scalability, making it more viable to be used as a currency. Following Litecoin came the emergence of other altcoins aiming to tackle the challenge of becoming the best currency for the internet. Each of these new digital currencies pushing slightly different narratives, with many of them developing some very promising Bitcoin alternatives and improvements in privacy or scalability. (Litecoin 2022; Saylor 2022.)

It is important to note that, although many blockchain developments are conducted as community-driven, open-source software projects, there are also an equal number of private blockchain projects created by businesses or entities for either commercial or enterprise use cases. Even many of the traditionally developed, opensource blockchain projects are still highly dependent on their founders and original developers. Besides their influence as community leaders, being involved in the founding days of a blockchain often results in them

holding an overproportionate amount of the circulating coin supply, as well as the necessary infrastructure required to exert large amount of control over the consensus mechanism. This is theoretically also the case with Bitcoin, as Satoshi Nakamoto is estimated to have mined over one million of the earliest Bitcoins. Considering the value of one Bitcoin today this would make Satoshi Nakamoto one of the richest humans in the world (assuming the alias is representative of only one person). The transparency of blockchain allows for the public to see that Nakamoto has not made a single transaction with those first bitcoins in over a decade. This fact in combination with the unknown identity of Nakamoto and the withdrawal of his online presence in 2011, lead many enthusiasts of Bitcoin to argue its superiority over altcoins. Due to an emergence of many scam coins, most altcoin communities of today prefer founders not to be anonymous, as this makes it easier to hold founders accountable incase their project is a fraud or fails. (Redman 2021.)

In some cases, the seriousness of development teams is intentionally questionable, such as is the case with the invention of *Dogecoin* in 2013. The coin, which opted to hold the popular Shiba Innu dog meme as its emblem, was created to mock the concepts of altcoins and blockchains in general. It is now considered to be the first so called *Memecoin,* which refers to a class of blockchains whose main purpose is for amusement within internet culture. This is not to be mistaken with the term *Shitcoin,* which refers to all coins which an individual views as meaningless or lacking value in the crypto ecosystem (Frankenfield 2021). (Binance Academy 2022.)

2.4.4 Stablecoins and Central Bank Digital Currencies

The year 2013 was also the year in which the first *Stablecoin,* by the name of Tether, was invented. A stablecoin is an altcoin whose price is pegged to a specific commodity, currency, or other asset. This means the coin aims to consistently mirror the price of that specific underlying asset as accurately as possible. In the case of Tether, also known as USDT, the price of one coin is almost always exactly equal to one US dollar. This act of pegging a specific asset price to a coin is done by the issuer, e.g., Tether, managing the collateral they hold in their reserve accordingly. The issuer must hold an appropriate amount of collateral to back each stablecoin they issue. The types of assets held as collateral, varies between different stablecoin issuers. The use for stablecoins is mainly for network participants who want to transact in a more familiar currency or use an asset with a more stable price, whilst still benefiting on the instant processing, security, and privacy of cryptocurrencies. They are very popular with traders, as stablecoins give them a stable currency to store their crypto trading profits in. Stablecoins can also be pegged to commodities, like gold, silver and oil.

Alternatively, there are also *securities tokens*, which have their price pegged to securities like publicly traded stocks or bonds. These security tokens are also known as *synthetics,* as their price represent the value of a real-world asset in the form of a digital synthetic coin. Their use case is also mainly attributable to traders and investors, which want to forgo high transaction and brokerage fees incurred on legacy platforms, whilst simultaneously capitalizing on the additional privacy and security benefits offered the crypto alternatives. (Ethereum 2022; Hayes 2022.)

As with Tether, most of these issuers of stablecoins have originally been private enterprises functioning on a for-profit basis. This speaks against the decentralized and transparent nature of the original crypto ideology and hence has often resulted in industry disagreements or controversy. Tether itself has often been accused of not having sufficient funds or too risky assets in their reserve to back the market value of their whole USDT supply. Nevertheless, as of April 2022, Tether is still the third largest cryptocurrency by market capitalization (CoinMarketCap 2022). USDC is ranked as the fifth largest cryptocurrency and has steadly been gaining more and more market share due to a their more transparent reporting of their collateral holdings (CoinMarketCap 2022). Their collateral is entirely comprised of a mix of cash and short-term U.S. Treasury bonds. (Ethereum 2022; Hayes 2022; CoinMarketCap 2022.)

Also gaining in popularity are *algorithmic stablecoins,* which back their coins with computer code rather than collateral. These stable coins maintain their peg using various complicated, autonomous, decentralized mechanisms and incentive structures to control the circulating supply of the coin. Although they are free of the risk of mismanagement by a central authority, they carry the alternative risk of holding faulty code or miscalculations in their economic models. As of April 2022, TerraUSD (UST), one of the first algorithmic stable coins, has quickly moved up to be the 13th largest cryptocurrency by market capitalization (CoinMarketCap 2022). (Ethereum 2022; Hayes 2022.)

Due to the increasing adoption of stablecoins many government authorities around the world have criticized their existence as undermining some of the major roles of government, specifically the issuance of the currency by central banks. This has not just led to a variety of stablecoin regulations, but also encouraged states around the globe to develop their own stable coins as alternatives, called *Central Bank Digital Currencies* or *CBDCs.* As of April 2022, there are over 90 countries involved in developing CBDCs with 16 of those having already launched a pilot or a finished product, as seen in Image 1. The largest economy to have successfully launched a CBDC prototype is the People's Republic of China, with its Digital Yuan. The governing communist party has already received a lot of international

criticism for using the technology as a further means of monitoring and controlling their population. (Parker 2022; Atlantic Council 2022.)

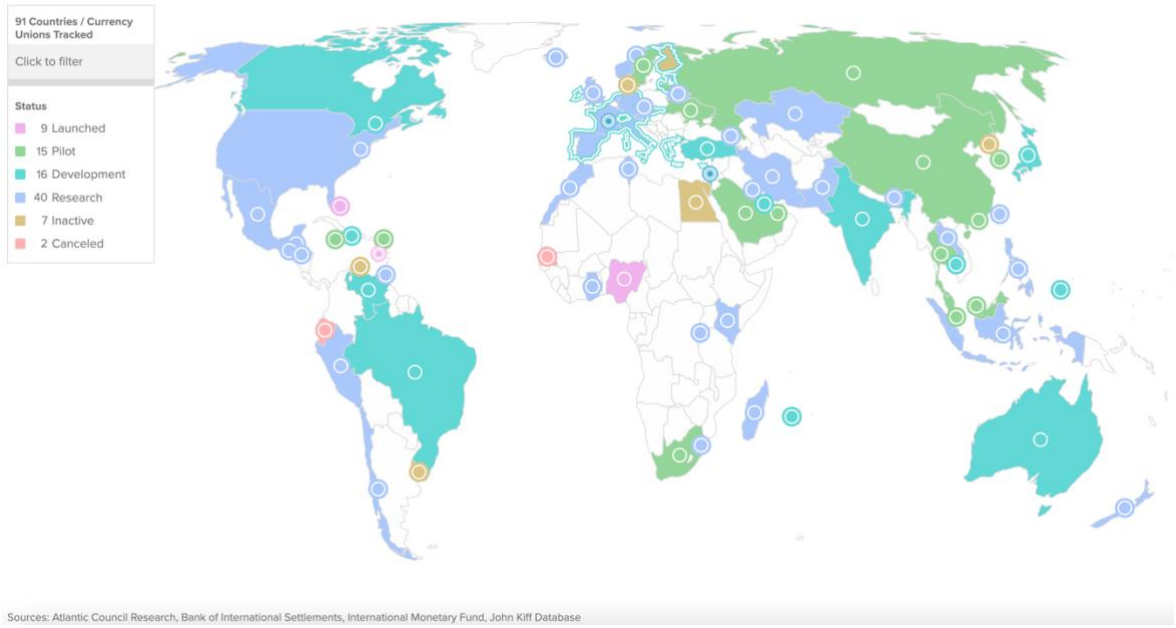


Image 1. Central Bank Digital Currency Map (Atlantic Council 2022)

2.4.5 Smart Contracts, Ethereum and Ethereum Killers

Up until the invention of Ethereum, the utility of blockchain technology was limited to only providing a trust-less means of exchange. This changed when in 2013 a 20-year-old, Vitalik Buterin, published the *Ethereum Whitepaper*. With this paper Buterin (2013) introduced the concept of *The World Computer,* also known as the *Ethereum Virtual Machine* or *EVM*. Instead of using blockchain to just be a decentralised ledger system, the idea was to use the new technology to build the first decentralised supercomputer of the internet. Buterin accomplished this in 2014 by creating *Smart Contracts*. *Smart contracts* are computer protocols that incorporate logical statements into transactions. Normally code is run on a server somewhere and one is required to trust the integrity of that person or entity running the server. Ethereum, with its distributed database and its smart contracts, acts as one big server, giving the control of this *world computer* to everyone and no one at the same time. (Ethereum 2022.)

Smart contracts are based on the theory that code is law. They are auto-executing, programmed agreements, that can facilitate, verify, and digitally enforce those agreements. Hence, smart contracts are often described as *programmable money* (Ethereum 2022; Consensys 2022).

The Ethereum Foundation (2022) itself describes smart contracts as follows:

> *Smart contracts are applications that run exactly as programmed without any possibility of downtime, censorship, fraud or third-party interference.*

Since all contracts are stored on a distributed ledger by thousands of computers running the Ethereum blockchain, it makes it impossible to destroy, alter or censor, or avoid the finalized agreements in these smart contracts (Consensys 2022).

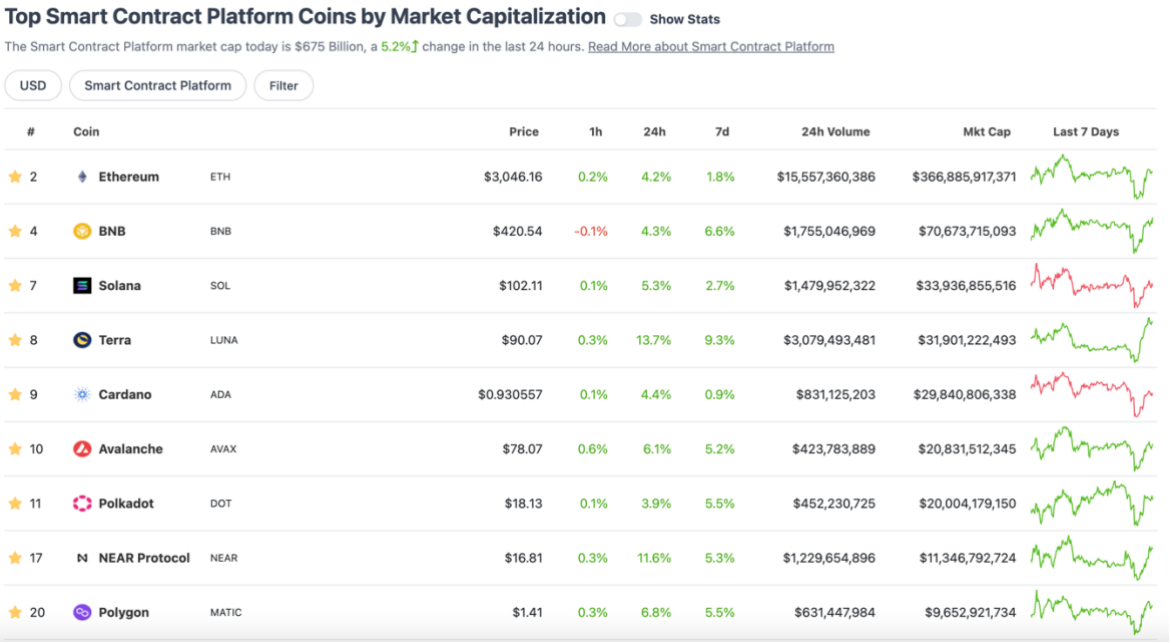
These properties of smart contracts and the fact that Ethereum is *Turing complete,* meaning it is powerful enough to run any computationally complete program*,* allows for the creation of decentralized applications (dApps) and decentralized autonomous organizations (DAOs) using the Ethereum blockchain as their base layer. While Bitcoin is design to solely maximize the security of holding and transferring of value in a decentralized manner, it lacks the ability to process complex commands. The focus of Ethereum lies in being a decentralized, programmable, and versatile computing network, allowing for the creation of a new decentralized internet. This new decentralized internet, which is often referred to as *Web 3.0,* aims to replace the centralized internet by connecting users directly and circumventing the need for online intermediary services, such as those provided by many *Big Tech* firms. Instead of only being able to cut out financial intermediaries, as is the case with Bitcoin, the smart contracts of Ethereum enables the creation of complex decentralised systems, essentially extinguishing the need for all types of centralised intermediaries. Activities that require centralised authorities such as voting, real estate transfers, social networks, streaming services etc., can all in theory be exchanged with decentralized applications and decentralized autonomous organizations. (99Bitcoins 2018; Consensys 2022.)

Ethereum officially launched in 2014 as a community-driven, open-source software project with *Ether* or *ETH* as its native currency. Vitalik Buterin, being one of the five original co-founders, technically has no power over Ethereum. Nevertheless, he is still deeply involved in its further development, and is generally considered to be the public face of the project. Ethereum, like Bitcoin, operates using a proof-of-work consensus algorithm, yet due to its high energy consumption it is currently undergoing the development to change to a proof-of-stake system. This switch to a proof-of-stake consensus algorithm is expected to happen in 2022, although in the past this promise has been postponed numerous times already. (Ethereum 2022.)

Ethereum has simplified the process of launching a blockchain application down to the Ethereum programming language, called *Solidity*. By creating this framework Ethereum gives everyone with a little programming knowledge the ability to write a decentralized

application. In addition, Ethereum created the *ERC-20 (Ethereum Request for Comments) token standard*, which are a set of guidelines for launching a token on Ethereum. A token differs from a coin, since a coin is the currency used to transacting on a Layer 1 blockchain, such as Ether on Ethereum, and a token is a derivative digital asset built on that primary blockchain (Ledger 2022). To simplify it, a coin uses its own blockchain while a token is built using the infrastructure of another blockchain. It is important to note that this definition is not false proof, as some digital assets struggle to definitively be categorized under one of these terms. For example, stablecoins, despite their name, are usually actually tokens. Conventionally tokens and coins are also often used falsely as synonyms. (Ethereum 2022.)

The ease of which a developer can build a decentralized application and launch a token, has led to the mass adoption of Ethereum, ranking it as the second largest crypto currency by market capitalization. This high rate of adoption has also led to high amounts of network congestion. As mentioned previously, in addition to Ethereum changing their consensus mechanism, they are also currently undergoing the development to improve their scalability by switching their chain to a *sharding* model. The long timeframe required for this development process and the high demand for a smart contract platform has resulted in the creation of numerous alternative blockchains competing to satisfy this demand. These new Layer 1 smart contract blockchains, also known as *Ethereum killers*, have accomplished similar, if not better, functionality as Ethereum, whilst also often solving the scalability issues. These Ethereum killers and *Layer 2* scaling solutions for Ethereum have been some of the fastest growing blockchain projects over the last few years. This is clearly shown by Figure 7, which depicts the nine smart contract platforms (including Ethereum) that rank in the overall top 20 cryptocurrencies by market capitalization (19 April 2022). (Ethereum 2022; Saylor 2022.)



Top Smart Contract Platform Coins by Market Capitalization Show Stats

The Smart Contract Platform market cap today is $675 Billion, a 5.2%↑ change in the last 24 hours. Read More about Smart Contract Platform

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#	Coin		Price	1h	24h	7d	24h Volume	Mkt Cap	Last 7 Days
2	Ethereum	ETH	$3,046.16	0.2%	4.2%	1.8%	$15,557,360,386	$366,885,917,371	
4	BNB	BNB	$420.54	-0.1%	4.3%	6.6%	$1,755,046,969	$70,673,715,093	
7	Solana	SOL	$102.11	0.1%	5.3%	2.7%	$1,479,952,322	$33,936,855,516	
8	Terra	LUNA	$90.07	0.3%	13.7%	9.3%	$3,079,493,481	$31,901,222,493	
9	Cardano	ADA	$0.930557	0.1%	4.4%	0.9%	$831,125,203	$29,840,806,338	
10	Avalanche	AVAX	$78.07	0.6%	6.1%	5.2%	$423,783,889	$20,831,512,345	
11	Polkadot	DOT	$18.13	0.1%	3.9%	5.5%	$452,230,725	$20,004,179,150	
17	NEAR Protocol	NEAR	$16.81	0.3%	11.6%	5.3%	$1,229,654,896	$11,346,792,724	
20	Polygon	MATIC	$1.41	0.3%	6.8%	5.5%	$631,447,984	$9,652,921,734	

Figure 7. Top Smart Contract Platforms by Market Capitalization (Coingecko 19 April 2022)

Nevertheless, due to Ethereum having the first mover advantage, the largest network and the most infrastructure, it almost unanimously considered to still be the safest most decentralized platform, with its market capitalization also reflecting this. As mentioned in the Scaling Solutions chapter the blockchain trilemma states that there is a sacrifice to be made when trying to achieve scalability. Deciding between which platform really is the best smart contract alternative overall is still highly debated and often based on individual opinions. The success or failure of Ethereum 2.0 is expected to be a deciding factor in this debate. (Saylor 2022.)

As all these Ethereum Killer platforms create their own unique ecosystems, many industry professionals are betting on a so called, *multi-chain future*. This refers to a future where most of these Layer 1 smart contract ecosystems will thrive simultaneously and rely on so called *bridges* to provide *cross-chain interoperability*. These bridges are often separate blockchains themselves, with the sole purpose of bridging tokens and information from one blockchain ecosystem to another. (Saylor 2022; Ethereum 2022.)

An accurate analogy of this would be the phone network providers of today. Phone users choose their network provider depending on the phone contract that best fits their needs. Just because one person uses the Vodafone network and another person that of Deutsche Telekom, does not mean they cannot call one another. This same concept can apply to people using the services of different blockchains if adequate bridging functionalities are seamlessly integrated. Using bridging functions is currently still a very manual and technical process and is not always possible between all chains. (Saylor 2022.)

All these smart contract ecosystems have enabled the creation of hundreds of decentralized applications and with them the deployment of hundreds of application specific tokens. These tokens can differ greatly in their creation and intended functionality.

2.4.6 Types of Tokens

Tokens are the digital representations of a particular asset or utility in a blockchain. All tokens can be called altcoins, but they are different to coins by residing on top of another blockchain and not being native to the base blockchain on which they reside. (Ethereum 2022.)

Fungible tokens can roughly be differentiated as transactional, platform, governance, security, or utility tokens. These subcategories are based on several things, including their code, their applicational usage, and their extra functionalities. In addition, many tokens can fall under more than one of these categories. (MakerDAO 2020.)

Since tokens are tradable, a common reason a application launches their own in-house token is for the token to be used as the means of exchange within the application. The benefit of using an application specific token, rather than the coin of the underling Layer 1 blockchain, is that the application itself can determine the tokenomics governing their token. Depending on the intended purpose of the token, it is advantageous to optimise factors such as the issuance, supply, fees, inflation etc. of the digital asset. These transactional tokens can utilise the properties of Layer 2 applications and have near zero transaction fees. This is possible by applications not recording every individual transaction on the primary blockchain immediately, but instead only updating the summarised net balances in delayed intervals. This results in less transaction/gas fees to the miners/validators, yet also provides less security than transacting on the base layer directly. Especially since several Ethereum alternatives have already accomplished near zero transaction fees, many applications offer additional value propositions for their tokens to make them more desirable. (MakerDAO 2020.)

A yield bearing *platform token* is a common way of adding additional value to a token. A platform token, also known as an *equity token,* is the crypto equivalent of owning equity in a public company. A yield baring platform token is like a traditional stock which also offers a dividend to its shareholders. The founders of an application can issue and sell tokens to investors, and in return promise them a piece of the success of the protocol. This can either only mean the potential appreciation of that token, or in addition, reward holders with extra token interest. This extra yield is normally paid out in that same native token. To be eligible

for these interest payments often requires holders to *stake* their tokens on the application. Staking means depositing their assets in vaults or pools within the platform. This not only proves that the holders really own the tokens, but it also serves as a means of decreasing the token supply in circulation, which stabilises the token price. Lock-up periods are also commonly incentivised with additional interest, to accentuate this effect. (MakerDAO 2020; Saylor 2022.)

Platform tokens are also the most common means of raising capital to fund the early developments of new applications. This can be done in a so-called *Initial Coin Offering* (ICO). An ICO is the crypto equivalent to an IPO, Initial Public Offering, which is when a company goes public, and its stock is freely traded on the stock exchange. ICOs were very popular in 2017, allowing developers with an application idea to raise large amounts of capital with little struggle. This easy of raising capital attracted a lot of fraudulent founders making use of the unregulated aspect of crypto markets. These scammers would either pitch fake promising dApp ideas and run away with the raised capital, or keep large amounts of the initial token supply to themselves, only to dump their holdings on the market later, after hyping up the token valuation. This act of pumping and dumping tokens is what the crypto community calls a *rug pull.* The *ICO boom*, is largely considered to be one of the key contributing factors to the large growth of the 2017 crypto bull market, as well as the market crash that followed. (Frankenfield 2022.)

To distribute some of the power away from the founders and early developers, many Layer 2 applications started incorporating the feature of governance tokens into their protocol. This can either be a separate token or part of the platform token. A governance token ads democracy into the protocol by adding a voting power to each token. The way an application implements this government structure can differ a lot. In its simplest form the voting power of a holder is proportional to the amounts of coins in their possession. A token holder can then post a protocol improvement proposal leaving its implementation up for a community vote. The analogue example would be if a public company would put every business decision up to a shareholder vote. An alternative would be allowing the community to govern the project treasury while the founders lead the development, requiring the communities blessing for budget allocations. The government structures are in theory infinite, yet still dependent on the supply distribution of their governing token. These governance tokens are what enable decentralised autonomous organisations (DAOs), yet the tokens can only serve their purpose if the founders distribute enough of their authority to the community. (MakerDAO 2020.)

Tokens are also what is required to create stablecoins. As previously discussed, stablecoins, portray the tokenised version of other types of currencies and commodities. In addition to non-crypto assets, a stablecoin can also represent the coin of a competing blockchain. By holding the peg of a non-native coin, users can still have exposure to their coin of preference whilst using the application or benefits of other chains. This is what is referred to as a *wrapped coin*. I.e., if a user prefers to keep their capital stored in Ether (ETH) but they also want to save on transaction costs, they have the ability to use decentralised applications to swap their Ether (ETH) coins for a *wrapped Ether* tokens *(WETH)* which can be used on another less congested network. This is also how Bitcoin (BTC) can be used on smart contract platforms. Bitcoin itself cannot be used in smart contracts or on decentralised applications, yet the wrapped Bitcoin token (WBTC) can. The analogue example would be simplifying trade by owning a gold certificate, representing the gold one has in the bank, compared to caring a bar of gold around as a means of exchange. (Whiteboard Crypto 2021; Hayes 2022.)

Tokens can also offer further use cases as so called *utility tokens.* The exact functionality of utility tokens, above their transaction value, price appreciation, interest yield, governance rights and tokenisation properties, are very application specific. Utility tokens are not created for direct investment, but instead are to be used to access the unique service a protocol offers. This could be a decentralised storage application, which allocates a proportional amount of on-chain storage to the number of tokens possessed by a user. Besides access, utility tokens can also offer additional benefits to users to who hold more tokens. This can resemble the loyalty programs of *real-world* businesses, such as the miles system offered by airlines. Utility tokens are often used in the DeFi sector of crypto. DeFi, is short for decentralised finance, and refers to all applications offering traditional financial services in a decentralised manner, beyond just the clearing of transactions. A decentralised exchange (DEX*)* might offer lower trading fees, higher yields on saving deposits or lower interest rates for loans, to users who hold a specific amount of their native tokens. (Whiteboard Crypto 2021.)

The newest and technically most unique token class to immerge in the crypto space is the Non-Fungible-Token, also known as an NFT.

3 Non-Fungible-Tokens

3.1 Definition, Origin, and History

Tokens are assets that are built as derivatives on top of other blockchains, originally enabled by the Ethereum blockchain. All previously mentioned tokens have been fungible, meaning they are interchangeable. Like with a dollar bill, one Bitcoin that resides in one wallet does not differ in its value or functionality of a Bitcoin residing in another wallet. They are identical and interchangeable, by design. This is not the same with *Non-Fungible-Tokens (NFTs).* As the name itself implies, these tokens are non-fungible, meaning they differ between each other in their value and functionality. At their core NFTs are unique digital representations of assets, with a digital certificate of ownership. (Larva Labs 2022.)

3.1.1 Colored Coins

The first time the concept of a Non-Fungible-Tokens was mentioned, was in 2012 by Yoni Assia, the co-founder and CEO of the Israeli brokerage company eToro. In the article: *bitcoin 2.X (aka Colored Bitcoin) – initial specs,* Assia (2012) discusses the idea of unique coins, he called C*olored Coins,* built on the framework of the Bitcoin blockchain. Unlike Bitcoins, these *Colored Coins* were supposed to be digitally unique, identifiable, and scarce. In return this should increase their value to *normal* Bitcoins, resembling the effects observed in rare metal coins, often collected in the physical world. C*olored Coins* should essentially be the first in non-replicable, digital collectable. Although the topic of this article was well before its time, it is often considered to be the origin of the concept of Non-Fungible-Tokens as they are known today. (Assia 2012.)

Although Assia (2012) was right about the revolutionary concept of Non-Fungible-Tokens, he was wrong about the blockchain. The Bitcoin chain is not suited to support unique tokens or any foreign tokens for that matter. Only when the Ethereum blockchain and its smart contracts was invented, was it possible to tokenize assets efficiently. This is when in 2017, utilizing the Ethereum ERC-20 token standard, the *CryptoPunks* collection dropped. (Larva Labs 2022.)

3.1.2 CryptoPunks

The CryptoPunks project was created by the founders of Larva Labs, Matt Hall and John Watkinson, two software developers from New York, and is widely considered to be the first official NFT collection to launch. They are also one of the only NFT collections to have

launched on the ERC-20 token standard. The ERC-20 standard was originally designed for the deployment of fungible tokens on the Ethereum network and therefore lacked the suitability for unique non fungible assets. This led the Ethereum team to invent the ERC-721 token standard, which was perfectly developed to track the ownership, metadata, and unique price of every individual token. ERC-721, which also launched in 2017, was therefore the first universal framework for standardized NFT contracts. As of April 2022, the ERC-721 token standard, with some of its modern variations - such as the ERC-1155 standard - are still widely considered the leading industry benchmark for launching non-fungible assets. (Ethereum 2022; Larva Labs 2022.)

The CryptoPunks NFTs themselves are ten thousand unique, algorithmically generated, 24x24 pixel art images, resembling punk cartoon characters. They each possess a unique ensemble of traits and accessories which in combination creates differing rarity between the characters. There are also a few scarcer charters mixed in, such as Apes, Zombies and even the odd Alien. All ten thousand *Punks* were originally given out for free. Anyone possessing an Ethereum wallet and approximately 11 cents USD worth of Ether - to pay for the Ethereum gas fees - was able to claim one. (Larva Labs 2022; Daniels 2022.)

Image 2. CryptoPunks Largest Sales – as of 20 April 2022 (Larva Labs 2022)

Considering that the Punks were originally handed out for free and that artistically speaking the images themselves are basic by default, their valuations as of today (20 April 2022) are nothing but astounding. Image 2. shows the largest purchases made for a CryptoPunk in order of the amount of ETH spent. Notice the equivalent US dollar values at the time of purchase in the brackets and how some buyers paid more in Ethereum, but less in dollar terms. This is due to the high volatility of the price of Ether relative to the US dollar. The value of Punk is proportional to the rarity of the combination of its traits. If one combines the

value of all sales that have accrued over the lifespan of the project, the transaction value nets out at approximately 2 billion USD (as of 20 April 2022). (Larva Labs 2022.)

As of today (20 April 2022) the most a Punk has sold for is 8000 ETH, which at the time of sale was 23.7 million USD, the average sale price of a punk over the last 12 months is 92.43 ETH or roughly 280 thousand USD, and the *floor price* of a CryptoPunk currently lies at 61.95 ETH or roughly 190 thousand USD. (Larva Labs 2022.)

The floor price is the NFT term used to describe the current lowest price at which one can purchase a piece from a specific *collection*. A collection, like with physical art, refers to a group of often similar looking NFTs *dropped* together. A *drop* is the term used for officially launching an NFT collection for purchase on the public market. (Larva Labs 2022.)

Whilst art is inherently hard to value and often dependent on subjective opinions, the value factor of CryptoPunks is obvious. They can clearly derive some value from the historic impotence of being the first art on the blockchain. Although this can justify a reason for CryptoPunks holding some value, their currently large quantitative valuations are still quite baffling. These high valuations might attest to the interest shown in NFTs today, yet this wasn't always the case. For instance, CryptoPunks themselves never received much mainstream attention till 2021.

3.1.3 CryptoKitties

The first NFT project to garner larger media attention was a project called *CryptoKitties*. CryptoKitties is a virtual game built on Ethereum that allows players to purchase, sell, collect and breed digitally animated cats as NFTs. This virtual pet game was also launched in 2017 and was developed by a Canadian studio called Dapper Labs. (Daniels 2022; CryptoKitties 22.)

One of the reasons CryptoKitties received so much attention was due to the fact that it was one of the first projects that attempted to create recreational activities using blockchain technology. The fact that these virtual cats were NFTs, enabled them to hold real financial value, as well as accredit players with undeniable digital ownership of their cats. This attracted large quantities of players, who saw an opportunity to make money trading and breeding these in-game, virtual cats. This is exactly as crazy as it sounds, yet the comical aspect of the game was an additional factor enticing more players form the *meme* and joke-based internet communities to join in on the fun. A meme refers to a joke, often an image,

whose main purpose is for amusement within internet culture (Binance Academy 2022). (Daniels 2022.)

The hype around CryptoKitties resulted in large price appreciation of the cat NFTs, with the famous *Founder Cat #18* selling for 253 ETH, which was 100 thousand USD at the time of sale. As seen in Image 3 the actual floor price of a cat is only a few US dollars (<0.03 ETH), yet depending on the rarity of the attribute combination of a cat, these prices can very quickly inflate into the thousands of dollars. There is an aspect of calculated gambling involved in the game, as a cat owner can pay another cat owner to let their cats breed, in an attempt to increase the odds of creating a rarer, more valuable cat offspring. The inflated NFT prices drew more players to this blockchain game gold rush. The game became so popular that this cat trading frenzy, is broadly accredited to have been one of the original projects leading to the congestion issues of the Ethereum Network. (Daniels 2022; CryptoKitties 2022.)

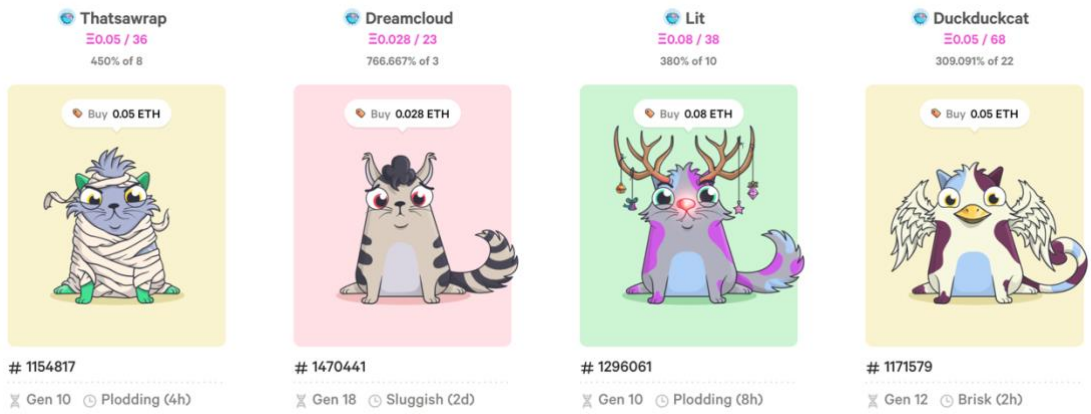

Image 3. CryptoKitties (CryptoKitties 2022)

Although, the hype which infatuated people with CryptoKitties in 2017 has slowed down, the game is still around today, and its developers haven't stopped improving it.

If interested, the game can be played here: https://www.cryptokitties.co/

While silly in theory, CryptoKitties was extremely valuable to the overall NFTs space, as it acted as a proof of concept and brought NFTs to mass attention for the first time. Nevertheless, although NFTs reached the mainstream media, the industry itself didn't see much mainstream adoption, outside of the crypto community itself, until the NFT boom in 2021. Before unpacking the 2021 NFT boom, it is important to understand what the real value proposition of NFTs are and how exactly they function. (Daniels 2022.)

3.2 NFT Fundamentals

A Non-Fungible-Token is a unit of data stored on a digital ledger called a blockchain. Each NFT represents a unique digital item, and thus they are not interchangeable. NFTs can represent digital files such as images, audio, videos, items in video games and other forms of creative work, yet they differ from any other normal jpeg, mp3, mp4 or video game item as they are attached to a unique ownership ID in the form of a Non-Fungible-Token. These NFTs can then prove the undeniable, rightful ownership of the digital data they represent to a single entity. NFTs are essentially digital certificates of ownership, made possible by smart contracts. (Smorenburg 2021, 109.)

3.2.1 Minting

This process of attaching a digital file to an NFT is called *minting.* When an NFT is minted, a unique key is generated, and at the same time the NFT ownership data is stored on the blockchain. This means that only one person, the person who has control over the digital key that unlocks the ownership data on the blockchain, can be the true owner of a specific NFT. Copies of the data represented by an NFT, do not have the unique ID attached to them, making it possible to differentiate the original digital file from its duplicates. This enables the verifiable ownership of the only original version of the data in question. Therefore, by purchasing an NFT, the ownership of a digital key is transferred from the digital wallet of the seller to that of the buyer, which concurrently transfers the ownership of the digital item that key has access to. (Smorenburg 2021; Slance 2022.)

This storing of unique data and their ownership on a the blockchain, is the evolved version of how Nakamoto managed to solve the double-spend problem. Instead of only storing transactions and the ownership of coins on the public ledger, smart contract blockchains, such as Ethereum, now also store unique digital files and their ownership on these public database networks. (Smorenburg 2021.)

At first this might sound unimpressive. Why would one want to prove that someone holds the original file of some data if there are hundreds of copies freely accessible on the internet. The overall appeal and use cases of digital ownership are a lot more spectacular than what meets the eye at first glance. Furthermore, as NFTs are built on programable smart contracts they can offer additional benefits and functionalities. One of these additional functionalities is the NFT *creator royalty* feature. (Smorenburg 2021; Slance 2022.)

3.2.2 NFT Royalties

NFT royalties work similarly to traditional royalties. Analogue to how a recording artist gets paid a royalty percentage every time their song gets played on the radio or each time their record label sells an album, NFT creators can generate similar perpetual revenue streams. The smart contract of an NFT enables the incorporation of a creator royalty fee taken from the secondary market sales. Besides the revenue a NFT creator generates from the initial sale of the NFT, the creator can also receive a percentage of every future sale of that digital asset. (NFT TECH 2021.)

The advantage of an NFT is that in comparison to the traditional royalty system, creators are not dependent on a third party to correctly enforce their contracts since the smart contract does it by default. While an artist must trust the accuracy and honesty of the bookkeeping done by their record company, and except the fact that their record label usually retains most of the revenue income themselves, an NFT creator just needs to trust the integrity of the blockchain. In addition, smart contracts have no expiry date. Therefore, as long as the blockchain and the internet are still in existence the NFT creator will receive his royalty payments on all resails of his intellectual property (IP) for perpetuity. (NFT TECH 2021; Thune 2022.)

Although theoretically the NFT creator can freely decide what percentage of the secondary sales they want to receive, the current industry standard lies at approximately between 5-10%. This seems to be the best range for both the creator and future owners of the NFT. Raising their royalty fees too high would negatively affect the trading of the NFT, as secondary buyers would struggle to make a profit. Disincentivizing the trading of an NFT negatively effects the creator, as the more the NFT ownership changes, the more fees the creator can collect. (Thune 2022.)

Creators also often opt to publish and to sell their work on third party marketplaces. These NFT marketplaces take a small service charge as percentage of each NFT sale, usually ranging between 2.5-5%. Service fees are usually paid by the seller of the NFT, meaning the creator only pays this once during the initial sale of their work. Although using an NFT marketplace is not required, they simplify the NFT creation process and maximize the creators reach, which is particularly important for smaller creators. Some of the most popular NFT marketplaces currently are OpenSea, Rariable, Nifty Gateway and SuperRare, with OpenSea being by far the largest. (Sergeenkov 2022, NFT TECH 2021.)

Properties of blockchain technology and NFTs, such as the perpetual royalty fee feature, are steadily increasing the interest of digital ownership and digital creator IP protection

within the internet. This recent trend is known as the so-called *Web 3.0 revolution*. This new vision of the internet is an evolved version of the World Wide Web that has decentralization and digital ownership at its forefront. (Slance 2022.)

3.2.3 Web 3.0

Web 1.0 refers to the first evolution stage of the World Wide Web. Also called the information economy, Web 1.0 emerged around the year 1990 with the invention of the internet and its primary function was the ability to *READ*. Desktop computers were the only way to access the web and users had to navigate through a disorganized web of lifeless pages, as search engines were not functioning effectively yet. Websites were highly static, meaning they lacked the ability for site visitors to interact with the pages. Web 1.0 saw the early beginnings of e-commerce emerging, yet nothing compared to the online economy that followed. Although heavily centralized around a few servers, Web 1.0. laid out the foundation and infrastructure for the World Wide Web as it is known today. (Slance 2022.)

Web 2.0 emerged from roughly 2004 onward and is also labeled the Platform Economy. The primary functions of Web 2.0 evolved to being *read* and *WRITE*. Web 2.0 made navigating the internet easier with the help of advanced search engines, such as Google and the likes, and saw a major shift towards user generated content. The invention of smart phones and mobile computers made connecting and interacting with each other, as well as content creation much easier. This eventually led to the social media and creator economy. The increasing demand for consuming content of all forms attracted businesses looking for new marketing channels and allowed creators to monetize their followings. This increased content creation and content sharing brought about huge volumes of data and the need to store it. The demand for handling and storing user data, combined with the *always-on-culture* and need for *cloud computing*, allowed *Big Tech* to take a monopoly position in the digital data space. Although these services often come for free or very cheap, there is a price to pay, as one's data is stored on centralized data centers and is essentially property of the platform owners. By accepting the terms and conditions of the platforms, one often legally agrees to the loss of ownership, personal data being sold to third parties and the possibility of freedom of speech censorship on the platform. Since Big Tech are private companies and are able to act as a central authority over personal data streams, privacy concerns are frequently expressed in this current Web 2.0 version of the internet. (Slance 2022.)

Web 3.0, also called the *Token Economy*, refers to the next phase of the World Wide Web with its primary functions being *read, write* and OWN. In this vision of the internet, the Web is owned by users and creators rather than by Big Tech and is fueled by tokens, such as NFTs. Web 3.0 is open, in the sense that it runs on systems developed with open source standards. The network is trustless, as it offers users the freedom to interact privately or publicly without running the risk of an intermediary authority mishandling their data or their privacy. The network is permissionless, as anyone can access the network and interact with each other via seamlessly interoperable, lightning fast, peer-to-peer networks, circumventing the need for consent from a controlling third party organization. (Slance 2022.)

This Web 3.0, token economy, based on ownership and peer-to-peer connections, might sound idealistic and out of a sci-fi utopia, yet with blockchain technology and NFTs the tools already exist to make this possible. There are countless businesses and open-source projects over numerous industries, working relentlessly on protocols and applications striving to make this Web 3.0 vision a reality. To some degree we are arguably already there. Online digital wallets, such as Metamask, function as browser extensions, and already enable access to an array of Web 3.0. Metmask is also the leading wallet used for purchasing, holding and selling NFTs. (Slance 2022.)

Although NFTs play a crucial role in many of these revolutionary Web 3.0 projects, they also function superbly as the technology to enable the breeding of digital cats. As one can see the use cases of NFTs can vary greatly, from transforming the internet and digital economy to creating meaningless digital collectables. The versatility of NFTs is also arguably one of its greatest features and is often accredited as a deciding factor for cryptos broader adoption. (Vaynerchuk 2021.)

3.3 NFT Adoption

3.3.1 Investor Adoption

After the CryptoKitties hype in December 2017, the NFT market, like the larger crypto market, had seen little notable action. The bubble of inflated crypto valuations had burst and led to a long period of miniscule mainstream attention and low numbers of user adoption. This changed with the asset boom that happened in the wake of the coronavirus pandemic.

Although the fears of the virus originally caused record breaking panic selling of assets in all market sectors, globally, these March 2020 panic lows didn't last long. With the combination of government fiscal support, central bank monetary easing (printing money) and the pent-up demand of consumers who were not able to spend their money due to the worldwide lock downs and pandemic restrictions, resulted in a lot of capital finding its way into the public markets. This led to the stark recovery of asset prices around the world, with many asset classes also breaking their historic all-time high valuations. (NonFungible 2022; Vaynerchuk 2021.)

Naturally this also was the case for crypto assets, which profited highly from the overall increase of retail investors. Traditionally most of the enthusiasm in crypto investing has originated from retail investors with an interest in technology, computer science, finance, economics, or internet culture. Alternatively, institutional investors have in the past largely shown hesitancy in investing in this new asset class, yet one can argue that in recent times there have been signs that this narrative is slowly changing. I.e., the electronic vehicle company TESLA adding Bitcoin to their corporate treasury in early 2021 (Ferré 2021). The increased amount of retail investors can broadly be attributed to the worldwide pandemic lockdowns, in which many people were looking for ways to spend their recreational time and money whilst being isolated at home. Many retail investors found their way to cryptocurrencies and so-called *meme stocks* – stocks that gain popularity among retail investors through social media (Hayes 2022) - as their communal nature and internet friendly culture attracted more investors than the more traditional asset classes, which are often largely gated away from non-professional investors. (Vaynerchuk 2021; NonFungible 2022.)

By early 2021 a large part of retail investors eventually branched out beyond their interest in cryptocurrencies and meme stocks and found their way into the digital collectable art and NFT space. As Figure 8 shows, it took until the beginning 2021 for the NFT market to see a noticeable increase in sale volume and asset prices, since the CryptoKitties hype that ended in early 2018. (Vaynerchuk 2021; NonFungible 2022.)

By June 2021 the NFT market exploded, with the number of monthly sales shortly peeking over 5 million transactions by the end of August 2021 and the monthly average sale price per NFT briefly eclipsing 4000 USD in the first days of 2022. According to the Financial Times (2022), by the end of 2021, almost $41 billion was spent on NFTs. Figure 8 also shows that the NFT bubble has largely already burst, with the average monthly price and transaction volume per month, down more than 50% and 80%, respectively, from their

previous highs. Nevertheless, both the NFT valuations and transaction volumes are still well above what they were before 2021. (Vaynerchuk 2021; NonFungible 2022.)

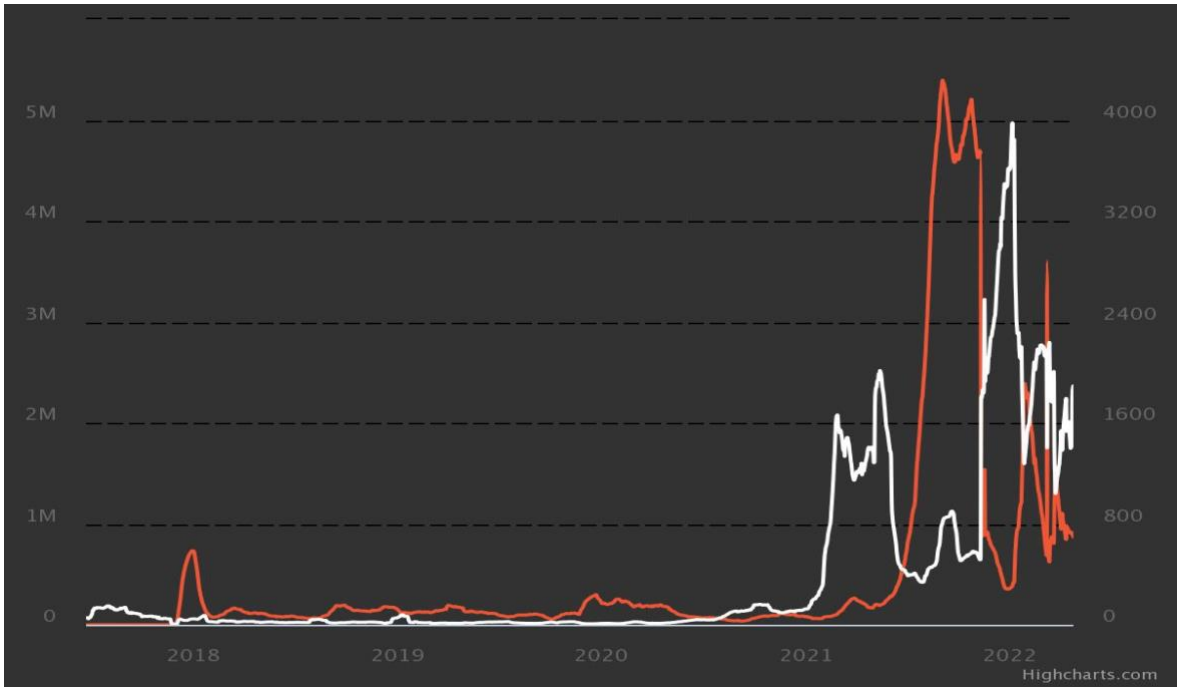

Figure 8. Total number of monthly NFT sales (orange chart + left axis) and the monthly average sale price of an NFT in USD (white chart + right axis) (NonFungible 2022)

3.3.2 Consumer Adoption

Although the retail investors were the ones to reignite the turmoil around NFTs in 2021, the real explosion in token prices and trading volume is accredited to the increased mainstream interest seen outside of the investor community. Investing in crypto was previously only appealing to people who had an interest in finance, technology, economics and investing. To the average individual crypto struggles to spark large amounts of interest due to its technical complexity. (Vaynerchuk 2021.)

NFTs as digital art and virtual collectables are a lot more intuitive to the average consumer than the intricacies of what makes Bitcoin, or other cryptocurrencies, more special than the money in their bank account. Since almost everyone can understand and show interest in art and collecting, compared to the dryer topics of finance, economics, and technology, NFTs open the door to onboard a wide variety of totally new users into the space of crypto. From people who collected marbles, stamps, Pokémon *or* sports cards, to people with an

interest in art, to gamers who are already used to spending money for virtual features in video games, all have a relatable reason to be fascinated by NFTs. (Vaynerchuk 2021.)

The additional benefit of NFTs, in comparison to its analogue alternatives, are the advantageous properties digital objects possess over physical ones. The act of storing, trading, and transporting digital data is infinitely more efficient than the physical alternatives. Buying, storing, and transporting an expensive physical piece of art is often very costly and logistically challenging. In comparison, an NFT is stored on the blockchain and can be transferred to the next owner almost instantly, for very little cost. All that is required from the NFT owner is that they keep the digital key accessing their NFT safe. (Vaynerchuk 2021; NonFungible 2022.)

Another attractive aspect of NFTs for consumers is that by being able to own all sorts of digital data, they now have the chance to profit on the successes of all types of creators. Previously it was impossible for a gamer to profit on the success of a video game (unless owned by a publicly traded company) or for a fan to capitalize on the future achievements of their favorite actor, musician, or athlete. Instead of just paying, either with their money or their attention, to consume content, fans are now able to not only support their favorite creators but also own some sort of equity in their prosperity. Like a stock in a company, the value of an NFT usually mimics the success of their creator. (Hayward 2021.)

3.3.3 Creator Adoption

This is not only attractive to consumers, but also just as enticing to creators who now have a new way to monetize their work. The current Web 2.0 creator business model is based on the premise of monetizing ones reach through advertisement. This can either mean a creator promoting his own brand, the goods and services of another brand or by allowing the platform hosting the creator to promote third party brands using their reach. Instead of generating revenue by selling the attention of their viewers, readers, and users to advertisement agencies, creators are now able to utilize NFTs to sell their work in the form of equity and receive perpetual royalty percentages from the secondary sales of their intellectual property. (Vaynerchuk 2021; NonFungible 2022.)

This is also a common problem in the traditional art industry, as an artist only makes a one-time profit on the initial sale of their artwork. This is quite the disadvantage for artists, considering that the increasing value of their art doesn't financially benefit the artist in any way, but rather the art dealers reselling their work. Naturally this seems unfair, yet up until the invention of NFTs there was no way for an artist to enforce a similar royalty scheme into

their work. NFT royalties, now enable the creator of the art piece to get rewarded every time a sale of their art piece occurs. (Vaynerchuk 2021.)

This concept empowers artist and creators by providing them with a platform that does not include any middle men (peer-to-peer), allowing them to directly profit from their own intellectual property. As Ezra Klein (2021) from The New York Times puts it:

> *Think about it this way: The internet we have allows for the easy transfer of information. We costlessly swap copies of news articles, music files, video games, pornography, GIFs, tweets and much more. The internet is, famously, good at making information nearly free. But for precisely that reason, it is terrible at making information expensive, which it sometimes needs to be. What the internet is missing, in particular, are ways to verify identity, ownership and authenticity — the exact things that make it possible for creators to get paid for their work.*

NFTs have managed to build a nurturing environment for the welfare of creators, whilst also giving consumers the possibility of ownership and the chance to partake in the success of a creating entity. This new online business model has not only attracted many famous artists and creators but also led to the discovery of new ones.

NFTs enabled an artist called Beeple to gain mass media attention when in March 2021 he sold a single NFT, by the name of *Everydays - The First 5,000 Days,* for 69.3 million USD at an auction hosted by the famous auction house, *Christie's*. This broke the record as the third-largest single sale by any living artist in history. (Christe's 2022; NonFungible 2022.)

Many celebrities have since jumped on the bandwagon trying to capitalize on the new industry while it is hot. From musicians, like Snoop Dogg, Justin Timberland, or Steve Aoki, to athletes, the likes of Shaquille O'Neal or Mike Tyson, from internet stars like Logan Paul to famous investors such as Mark Cuban, from Eduard Snowden to Quentin Tarantino, etc. have all managed to monetize this new Web3 technology. Even, Twitter Inc. founder Jack Dorsey managed to convert his first ever tweet to an NFT and sell it for 2.9 million USD. (Liquid 2022; Thomas 2022b; NonFungible 2022.)

Naturally where the consumers and creators go, the institutions follow. As of April 2022 many large names have already done so.

3.3.4 Institutional Adoption

This recent growth in the NFT market has increased the interest of new and old businesses looking for ways to also capitalize on this new industry.

One of the first larger, legacy companies to successfully jump on the NFT trend was the NBA, with the launch of *NBA Top Shot*. The NBA (National Basketball Association) is the national basketball league of the United States and is one of the largest sports leagues in the world. (Thomas 2022a; NonFungible 2022.)

They were not only one of the first larger brands to drop an NFT collection, but also one of the first non-crypto companies to create their own marketplace and additionally use an alternative blockchain to Ethereum. The platform runs on the *FLOW blockchain,* profiting on the low transaction fees when compared to the gas fees on the Ethereum chain. (NBA Top Shot 2022; Thomas 2022a.)

NBA Top Shot was a joint venture between the NBA and Dapper Labs, the creators of the CryptoKitties, and launched in 2020. The project is ultimately a virtual trading card platform where the cards are clips of in-game NBA highlights. Just like with trading cards, only a limited number of NFTs is created per highlight to create scarcity. This increases the rarity of that specific moments and, results in a heightened financial value. Also, like trading cards, the initial card sale only happens in the form of a pack. A pack holds a set of random NFTs each with a varying rarity. Everyone purchasing a pack has the chance to win a rare NBA highlight which they can sell for a profit on the secondary market. The advantage here compared to the traditional trading card business model, is that Top Shot takes a 5% fee on the resale value on one of their NFTs (Scotto 2021). In contrast, rare original Pokémon cards are still being traded for sometimes millions of USD, yet Pokémon as the brand is unable to realize any of that secondary revenue. In 2021 alone, the NBA Top Shot platform had more than 1.1 million registered users which roughly traded 800 million USD in NFTs. A highlight of a LeBron James alone, sold for more than 230 thousand USD in August of 2021. (NBA Top Shot 2022; Thomas 2022a.)

NBA Top Shot is still not only one of the most successful NFT projects on the market, but they pioneered the way for other legacy brands and institutions to follow. Some honorable mentions of mega corporations trying to monetize their brand names with the help of NFTs are Adidas, Lamborghini, Nike, Coca-Cola, Nike, Louis Vuitton, Samsung, Pepsi, McDonalds, Burger King Ray-Ban and Visa (Gautam 2022; NonFungible 2022). Even Facebook changing its name to Meta is a business play betting on the increased relevance

of the virtual world (the metaverse), which inherently can only function with true digital ownership. (Hayward 2021.)

Although NFTs experience an astounding boom in adoption during 2021, the history innovation and many scientific models, such as the *Technology Adoption Life Cycle,* argue NFTs are still in their early days.

3.3.5 Technology Adoption Lifecycle

The *Technology Adoption Lifecycle* is a model describing customer behavior related to the acceptance of a new technology. The theory was first popularized by researcher Everett Rogers in 1962 with his book *Diffusion of Innovations*. As Figure 9 portrays, the model uses a bell curve (blue) to divide the life cycle of a new technology in five stages: *Innovators, early adopters, early majority, late majority,* and *laggards*. The area below the graph represents the percentual number of customers grouped by their psychological inclination. The yellow graph is the s-curve that depicts the total market share and highlights the rate of growth until the technology reaches full market adoption (100%). (Roger 1962.)

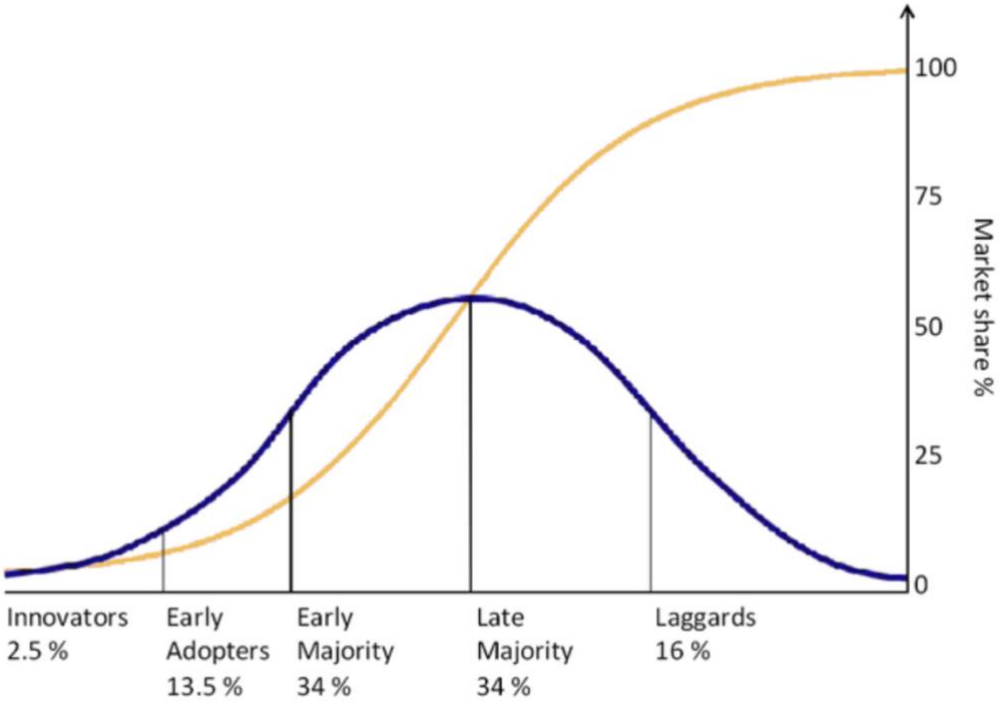

Figure 9. Technology Adoption Lifecycle (Roger 1962)

Although the original 5 stages defined by Roger (1962) have been slightly adapted to fit the modern digital economy, the key denotations of all five stages remain the same. Roger (1995) defines the five stages of consumers as follows:

- Innovators (2.5%): Innovators are the first individuals to adopt an innovation and are best described as *venturesome*. Innovators are willing to take risks, are part of the highest social class, financially well off with little to no liabilities, often young, extremely social and have the closest contact to scientific sources. Their high-risk tolerance also leads them to adopt some technologies which ultimately fail. Their financial resources help absorb these failures. (Rogers 1995, 263-264.)

- *Early Adopters* (13.5%): This is the second fastest category of individuals to adopt an innovation and are best described as *respected*. These individuals hold the highest degree of *opinion leadership* among the other adopter categories, meaning they are very influential individuals in society. Typically, early adopters are also younger in age, have a higher social status, have more financial resources, and are often better educated than late adopters. They are more exclusive with their adoption choices than innovators since their influential position holds more personal risk when promoting a new technology that might fail. A successful choice of adoption will help them maintain a central public communication position and improve their social presence. (Rogers 1995, 264.)

- *Early Majority* (34%) –This category adopts an innovation after a varying degree of time, yet generally they take significantly longer than the innovators and early adopters. In addition to having a slower adoption process, the early majority usually have some sort of contact with early adopters, an above average social status and seldom hold influential and leadership positions in any social system. The Early Majority is best described as *deliberate*. (Rogers 1995, 264-265.)

- *Late Majority* (34%) – Individuals in this category will wait to adopt an innovation until the average member of the society has done so. The Late Majority approach an innovation with a much skepticism and only feel safe to follow suit after most of society has already adopted the innovation. These individuals typically have below average social status, are financial a little worse of, hold very little opinion leadership and often surround themselves with others in the late majority and early majority groups. They are best described as *skeptical.* (Rogers 1995, 265.)

- *Laggards* (16%) – Laggards are the slowest and last to adopt an innovation. Unlike the previous categories, individuals in this category poses little to no opinion leadership. These individuals are typically very conservative, dislike change and tend to be of older age. They are also often likely to have lowest social status, lowest financial status, reduce their contact only to family and close friends and are best described as *traditional*. (Rogers 1995, 265-266.)

While the NFT space saw a large increase in users in 2021, with many influential people and a few large brands accepting the new technology with open arms, the number of people in the world that actually own an NFT is still remarkably low. (Vaynerchuk 2021.)

According to the Financial Times (2022), there were only approximately 360 thousand NFT holders by the end of 2021, with approximately 80% of the market value held by roughly only 9% of the wallets. In comparison, it is estimated that as of 2021 well over 6.2 billion people in the world own a smart phone (Statista 2022). Since everyone with a smart phone can also own an NFT, this roughly calculates the adoption percentage of NFTs at less than 0.00006% (~ 360 thousand / 6.2 billion).

Considering these facts, it is a logical conclusion to deem that the world adoption of NFTs most likely still resides in the *Innovators* stage. Nevertheless, due to the large number of influential people and brands in developed nations already dipping their toes in the NFT space, it is fair to assume that in the larger world economies, NFTs are quickly entering the *Early Adopters* stage. This argument is also supported by the historic trend that new technologies are seeing a faster and faster rate of adoption than previous innovations. This shift can be observed in Figure 10 with the USA. (Osprey Funds 2021.)

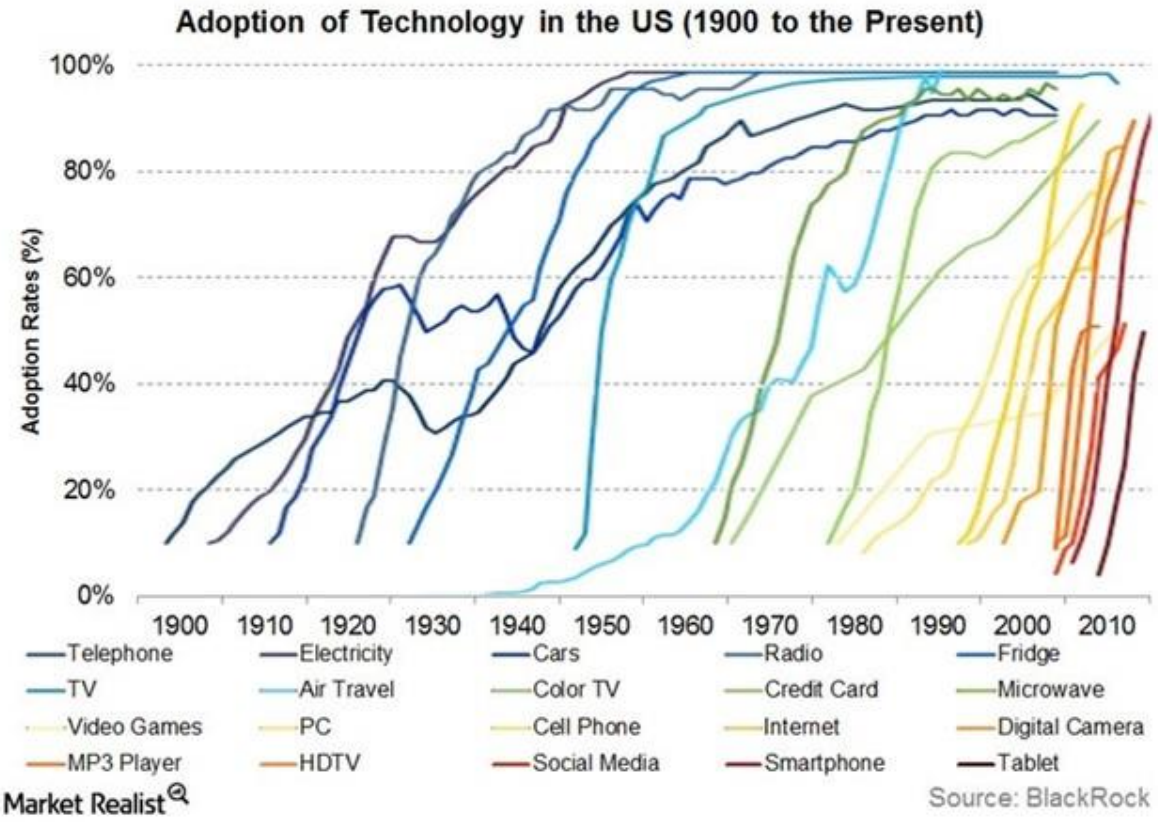

Figure 10. Adoption of Technology in the US: 1900 to the present (Osprey Funds 2021)

Assuming the Technology Adoption Life Cycle theory holds some merit, the potential growth for the NFTs sector has largely not been realized yet. This can further be supported by the steady emergence of new NFT use-cases seen in other industries.

3.4 NFT Use Cases

While first championed by the art and collector communities, digital ownership has proven a useful tool across multiple industries and in many cases has become an important component of their future growth.

3.4.1 NFT Gaming and the Metaverse

One of the leading industries to embrace NFTs is the gaming industry. The seems logical when considering that video game enthusiast are already used to buying virtual in-game accessories. According to a survey done on US based Fortnite gamers in February 2020, respondents had spent more than 100 USD on average on in-game purchases, with roughly 77% of respondents admitting they had made purchases on the free-to-play game (Statista 2020). Fortnight was also the most played game in 2021, beating the runner up with 4 million or 50% more players (Twinfinite 2021). Needless to say, the concept of players being able to truly own and sell their in-game items, was well accepted by the gamer community. (Hayward 2021; Welsh 2022.)

This is confirmed when analyzing the success of CryptoKitties and the newer NFT games that followed, such as Axie Infinity. Axie Infinity quickly became one of the largest NFT projects and a pioneer in the *play-to-earn* gaming industry. A play-to-earn game is the term used to describe games in which players can earn cryptocurrencies as rewards for in-game activities. Axie Infinity was one of the first games to perfect this, allowing for the millions of their players to earn their *Smooth Love Potion (SLP)* tokens by battling their cartoonish, Pokémon-like monsters. These SLP tokens can be changed to real money and have even allowed several players in developing nations to make a living from the game. To combat the high transaction fees, Sky Mavis, the team behind Axie Infinity, even developed their own Ethereum sidechain, called *Ronin*, as well as their own digital wallet with the same name. (Hayward 2021; Axie Infinity 2022.)

Since NFTs permit real digital economies, the concept of a *metaverse* evolved. The metaverse is a term that gained mass popularity in 2021 and was particularly brought into

the limelight when the tech giant, Facebook, changed its name to Meta. The metaverse buzzword itself is broadly understood as a graphically rich, 3D, virtual space, where people can do real world human things, such as work, play, shop, socialize etc. It is estimated to be one of the largest industries of the future, with the potential to create the next generation of Big Tech companies. (Vaynerchuk 2021; Hayward 2021; Welsh 2022.)

Many NFT based companies have managed to front run the space by creating virtual worlds were everything is purchasable as an NFT, even the ground in the game itself. The immersive worlds that have been the most successful are *The Sandbox* and *Decentraland*. In these augmented realities, using the in-game tokens, players can purchase avatars, accessories, equipment, usernames, virtual land, and the material to build customized constructions and experiences on their digital land. They can even monetize their creations by charging other players for visiting or using their constructions/experiences. These constructions/experiences can be user-built games, art galleries, online shops, casinos, virtual concerts etc. The success of these metaverse platforms is vetted by companies and entities such as Adidas, PwC, and Snoop Dogg, in The Sandbox, and Samsung, Prager Metis and JP Morgan, in Decentraland, all buying land in these immersive realities. Some of these entities have already used their virtual land to build stores, office buildings or other online experiences. Although the metaverse idea of people spending their day to day lives in an augmented reality might seem a little futuristic, with the continuous progress seen in virtual/augmented reality hardware and software, this future could be closer than one thinks. This future would also make the value of NFTs feal a lot more tangible. (Hayward 2021; The Sandbox 2022; Decentraland 2022.)

Beyond their virtual utility, NFTs also possess important real-world utilities.

3.4.2 Utility NFTs

Beyond art, collecting, gaming and virtual reality, the real-world utility for NFTs can be quite broad. A few of the most useful functionalities an NFT can offer are:

- Certificates and Documents: NFTs in their purest form are tokenized digital certificates, which means real-world documents issued by institutions can easily benefit from the NFT technology. For example, the certificate proving the graduation of a university degree. A graduation certificate only requires a little photoshop to be forged. If an employer wants to verify that a new applicant really completed the university degree with the marks the applicant claims, he will need to research in the database of the university in question. This would not be necessary if the university

issued their graduation certificate as an NFT on the blockchain. A job site such as LinkedIn could automatically, quickly verify the authenticity of the educational claims of all applicants on their site, exponentially increasing the trust and lowering the workload of recruiters. Other certifications such as driver licenses, IDs, passports, medical and insurance documents can all be stored on a decentralized ledger, simplifying the authentication process, and reducing the administrative load and database upkeep of the issuing institutions. In theory even a physical asset such as real estate can be substituted by an NFT, simplifying prove of ownership and the currently long, complex property transfer process. (Karayaneva 2022; Aderemi 2021.)

- Intellectual Property: As mentioned in the creator adoption chapter, NFTs are ideal for protecting creators by accrediting and rewarding them correctly. Besides art and collectables this also holds true for music, books, patents, and other intellectual properties. NFTs enable creators to go directly to their consumers, cutting out the transactional middlemen, such as record labels, publishers etc. (Klein 2022.)

- Ticketing: NFTs simplify the process of authenticating tickets and have the additional benefit of holding a digital collectable value. Instead of having to post a picture of that concert one was at, one can now additionally hold the memory and bragging value in the form of an NFT. It is not an unlikely scenario that NFTs will start replacing every form of ticket, because it does not just add additional value to the consumer, but also to the seller. Airlines for example could save a lot on database management and administrative work by validating passenger tickets with a quick check if their ID/passport and digital wallet match with the metadata of the ticket minted as an NFT on the blockchain. Consumers could undoubtably prove the validity of their tickets for eternity and collect their flight miles even years after their flights. (Vaynerchuk 2021.)

- Supply Chain Management: By attaching an NFT to every unique production item, NFTs can simplify the long and complex paper trails required in supply chain management. The location, description, history, and future role of an item can all be stored in the metadata of an NFT and updated in real-time on the blockchain, throughout its lifespan. (Elyashiv 2022.)

- Decentralized Finance (DeFi): DeFi platforms have started to incorporate NFTs into their economic models by using them as collateral for loans. Similar to how expensive art collectors can use their art as collateral to get a loan from the bank, NFT owners can now do the same. The benefit is that there is no need to value and

confirm the arts authenticity as that information is freely accessible on the blockchain. In addition, with smart contracts there is no need for debt collectors, because should one default on the loan the transfer of that NFT can happen automatically. (Carnahan 2022.)

- Crowdfunding: Be it equity or non-equity based crowdfunding campaigns involve people providing capital to help reach the campaign goals. This act of participation is something that can be encoded into an NFT and given to all the people that participated in a fundraising campaign. This can either be for a charitable or political cause, or for a business investment. For example, a sport franchise could raise capital for a new stadium by selling VIP season tickets in advance as NFTs. The benefit is that on top of the initial sale capital raised, the NFT royalty feature can bring in additional capital later, through the secondary market trading of their NFTs. (Aderemi 2021.)

Although there are new novel use cases for NFTs emerging nearly every day, it is estimated that almost 90% of the NFT market capitalization still lie in the collectable, art, gaming, and avatar categories. As Figure 11 highlights, the avatar sector alone holds more than 40% of the current market value of NFTs. The avatar classification is the broader term used to categorize the extremely popular PFP, profile picture, NFT market. (Selkis 2022.)

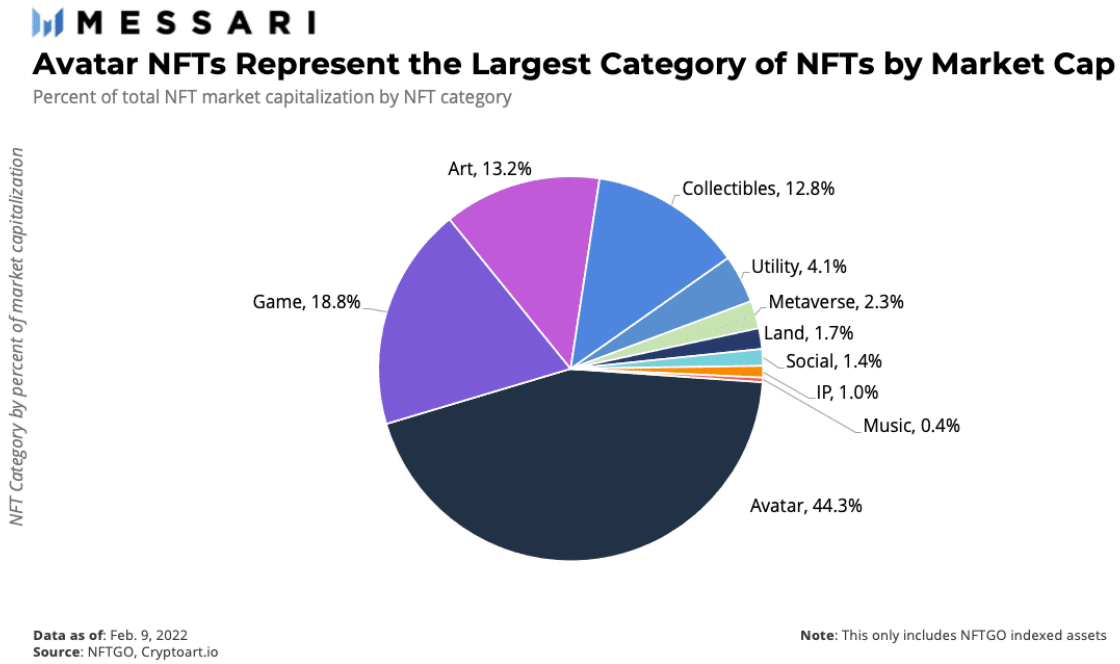

Figure 11. NFT Categories by Market Cap – 9 February 2022 (Selkis 2022)

3.4.3 NFT Profile Pictures (PFPs)

As of April 2022, the top 10 NFT projects ranked by trading volume over the last 30 days, are all avatar NFTs, which are more commonly known as *PFP* NFTs. PFP stands for profile picture. Although there is no concrete definition, a PFP NFT usually referrers to an NFT collection where each NFT depicts a portrait of a unique digital avatar that presents itself as an ideal profile picture for online accounts. When ranked by collection trading volume and NFT value, PFP NFTs are by far the most successful NFT category in the space. They are widely accredited for starting the NFT boom in 2021 and are generally all roughly modeled around the CryptoPunks collection. (CryptoSlam 2022; Mattei 2022.)

During the peak of the NFT craze in August 2021, Shanti Escalante-De Mattei, a journalist at ARTnews, the oldest and most widely circulated art magazine in the world, tries to describe what defines a PFP NFT as follows:

> *PFP projects differ from most NFTs in a few key respects. PFP initiatives tend to involve the drop of thousands of NFTs at once, all algorithmically put together using a fixed set of data. In that way, they can be considered part of a larger series, unlike most NFTs, which exist as one-off digital artworks. PFP NFTs also behave more like traditional collectibles. In combining the thrill of gambling on stocks with the pleasures of creating a digital persona, PFP NFTs could reshape how works made in the medium are bought and made.*

PFPs have redefined the meaning of online virtue signaling. Although social media is supposed to enable digital sharing and embody virtual connection, a large part of social media is fixated around online virtue signaling. A large amount of the photos and videos shared on social media are related to bragging about where one is, who one is with, what one is doing, etc. One can frequently find people sharing their lavish holidays or pictures of them with their sports car. Changing one's profile picture to an expensive PFP NFT is the evolved version of this boasting internet culture. The difference is that previously no one could prove or disprove if a given person actually owns, leased, borrowed, stole, or photoshopped the sportscar in their picture, but when the asset is stored on a publicly distributed ledger, all an owner needs to do is prove they have the key to the wallet that is linked to the NFT. The social media giant Twitter has already simplified this by implementing a featured to publicly verify the authenticity of their premium users, NFT profile pictures. (Barrett 2021.)

Having an exclusive PFP NFT profile picture, is the modern online equivalent of driving an expensive car, owning a pricy watch, or wearing designer clothes, and always keeping the

receipt of purchase, as proof of ownership, at hand. Besides the financial status a PFP can represent, it also holds an association to a specific community. Depending on how a PFP owner wants to represent themselves digitally, they will choose the NFT collection which best fits the values they want to portray. This additional community aspect PFP collections offer is one of the leading factors credited for their success in the NFT market. (Vaynerchuk 2021.)

3.5 Case Study: Board Ape Yacht Club

The prime example of a community driven NFT collection is the *Board Ape Yacht Club* or *BAYC.* Produced by Yuga Labs, The Bored Ape Yacht Club is known to have picked up the baton from the veteran CryptoPunks collection. Like with the CryptoPunks, there are 10,000 original Bored Ape NFTs, each unique due to their different combination of features (Image 4). Besides the scarcity of their feature combination, the Ethereum based, ape NFTs offer additional community benefits to their holders. (Quiroz-Gutierrez 2022.)

Image 4. Board Ape Yacht Club NFTs (Board Ape Yacht Club 2022.)

BAYC has treated its NFT profile pictures as an all-access pass to an exclusive club packed with numerous perks. On the BAYC website they sate:

> *Your Bored Ape doubles as your Yacht Club membership card, and grants access to members-only benefits (Bored Ape Yacht Club 2022).*

Not only does the BAYC offer their holders access to an exclusive community of elites, through private events, experiences, and chat boards, but also gives the NFT owners the right to commercialize their NFT intellectual property (IP) and create a unique brand around each individual character. By handing over all rights of each ape to their holders, Yuga Labs, took true ownership to the next level, allowing the NFT holders to legally monetize their NFT property. They have also frequently airdropped new NFT projects to their holders (for free), with a few of those becoming some of the most successful collections themselves, like the *Mutant Ape Yacht Club* collection. An airdrop is the act of sending coins or tokens to wallet addresses for free, either as a marketing stunt or to reward specific wallets, such as for being an active community member or a collection holder. As of March 2022, they have additionally launched their own fungible token, the ApeCoin, which has also been airdropped to Ape holders. The ApeCoin is supposed to serve as the medium of exchange in the metaverse game their team, Yuga Labs, is currently developing. (Quiroz-Gutierrez 2022; Mcnamara 2022.)

BAYC has been so successful that in March 2022, Yuga Labs, acquired the IP rights of CryptoPunks and Meebits (another successful PFP collection) from Larva Labs, for an undisclosed amount (Kharif & Bloomberg 2022). Like with BAYC, Yuga Labs immediately gave all CryptoPunks and Meebits holders the full legal IP rights to their unique avatars. After this acquisition six of the top 12 NFT collections, when ranked by all-time sale volume, are now part of the BAYC universe, making it by far the most successful NFT project to date (May 2022). Their success is representative of the success for the PFP NFT category overall, yet their additional utility has set them apart from their competition. BAYC NFTs combine the aspects of art and collectability, but most of all they represent a strong community and the chance for advantageous community benefits. By owning an NFT one is automatically a member of an exclusive and useful club. A club that does not just represent a social statement but is also centered around rewarding its members. BAYC have spearheaded the utility PFP NFTs trend and simultaneously reinvented the way membership clubs work. (Vaynerchuk 2021; Quiroz-Gutierrez 2022; Board Ape Yacht Club 2022.)

Many companies are now trying to imitate the success of the BAYC and similar NFT collection, by offering this new membership business model to the loyal customers of their brand.

4 NFT Implementation Guide

By understanding the basics of blockchain technology and the opportunities and trends of NFTs, forward thinking companies can assess how this new technology can benefit their business. The following chapter will discuss the basic technical steps required for a company to successfully implement an NFT strategy, as well as the challenges they might encounter. Aspects such as the marketing, team management and the project launch will not be addressed, as this would exceeds the delimitations of the thesis. The implementation steps will focus on macro level, NFT related, business decisions.

4.1 Implementation Steps

For simplicity and relevance purposes the following chapters will mainly focus on the implementation process of NFT membership strategies applicable to retail-based businesses. As the previous chapters and case studies have highlighted, the most successful NFT collections have been centered around a mixture of community and utility. The membership club business model best embodies community and utility. Companies that are most suitable to capitalize on this membership NFT trend, are businesses which have strong brand followings and the means to offer their customers benefits for their loyalty. Logically, retail-based business models are the most suited to take advantage of this. Nevertheless, many of the steps and challenges discussed in this section can also be relevant to business-to-business companies interested in the NFTs space. (Vaynerchuk 2021.)

4.1.1 Business Model

The actual NFT strategy is obviously dependent on the business model of the company in question. However, if a company sells goods or services, uses a subscription or one-time charge model, requires brick-and-mortar locations or is an online only business, is all irrelevant to the basic level of designing an NFT strategy. The same principles and goals apply to all retail-based businesses.

The NFT strategy must focus on the goal of how a company can utilize their business capacities to offer an additional value proposition to their most loyal customers. The art follows the utility when it comes to membership NFTs. Customers want to join a membership club because it is useful and exclusive. Beneficial and scarce are the key words. Beneficial

comes first, since demand created solely by scarcity is very depended on the customers of the brand in question, and often struggles to muster much interest outside of the most loyal of customers. Luxury brands, whose business model is already highly built around exclusivity and scarcity, will have an advantage here, but for the average retail-based business the rarity of their NFT artwork will not suffice to create much demand. Therefore, an NFT project needs to think about its utility first and the artwork second. (Bleilevens 2021.)

The membership benefits a company can offer are very conditional to their customers, infrastructure, and current business model. The value proposition of the NFT membership strategy can either be built around the already existing business model or be a totally new business venture. This new venture can be financed by utilizing the initial NFT sale as a crowdfunding opportunity. This newly sourced capital can then be used to expand the current capacities of the business. Since this is a promise on future executions of the company, a high level of customer trust in the competences of the brand is required. Similar to how a startup pitches to investors, the company needs to pitch an idea that is worthy enough for their customers to want to invest in. The best way to achieve this trust is by transparency and communication. (Bleilevens 2021; Vaynerchuk 2021.)

For maximum transparency a company should enlighten its customers on the vision and goals of the membership program. The company should define what the benefits are for both the company and the consumer and lay out a realistic, long term, roadmap of how the company plans on achieving this. In addition, the company should encourage a community environment between them and their loyal customers. By utilizing modern communication streams, the company should allow for community input and collaborations, enabling them to create a membership club which is in line with the interests of their customers. A communication platform that is particularly useful in the NFT space is Discord. Discord is the leading messaging and distribution platform between NFT creators and buyers and allows for maximum communication and transparency between both parties. (Bleilevens 2021.)

Theoretically, considering the crowd funding use of NFTs, a company should be able to offer any type of membership benefits. This could be any of the use cases described in the Utility NFTs chapter, as well as any other goods or services a company can offer its customers on a subscription or membership club basis. Depending on their customers, a brand should define these benefits that make the most sense for both parties. The initial sale price of the NFTs and the royalty fee percentage on secondary sales are vital factors to calculate the feasibility and long-term profitability of the business model. The membership NFTs utility should ideally incentivize maximum trading with a constant price appreciation

over time. If the brand manages to continuously create value for its NFT holders this will increase the demand for the NFT and simultaneously increase the price. In return, every time an NFT changes owners, the royalty fee revenue collected by the company will coherently also be higher. However, since the future trading volume and future secondary market price of an NFT collection is almost impossible to accurately predict, a company should not rely on the royalty fee revenue as the base funding for the long-term future of the project. The NFT should rather offer access to exclusive products, services and experiences that still require the customer to make some level of additional purchases, guaranteeing the long-term sustainability of the NFT project. (Vaynerchuk 2021.)

4.1.2 Example Strategies

The analogue example of this is being part of an exclusive country club which requires an annual membership fee, in addition to the country club charging for the food, drinks and other services they offer. In contrast, an NFT membership club could, for example, only require a member to have made a one-time acquisition of a membership NFT. This has the extra benefit that the NFT holder owns a liquid asset with the potential of price appreciation. Logically, this NFT would cost more than any repeating membership fee, yet the fact that the NFT is liquid, makes it desirable if one is not certain one will adequately utilize the membership club benefits. The potential of price appreciation of the digital asset presents an additional advantage, then paying a non-redeemable fee. This is a basic theoretical example, yet the NFT business strategies can be exponentially more complicated. (Vaynerchuk 2021.)

The smart contract component of NFTs allow for a flexible array of implementation strategies. What strategy a company decides to take is fully dependent on their current business model and their future goals. For example, one of the most famous music festivals in the USA, Coachella, has released 10 lifetime festival passes, each holding unique additional benefits. These 10 perpetual tickets were auctioned off to their most loyal fans and netted an initial sale revenue of more than 1.4 million USD. This strategy makes particular sense for a festival business model, since having 10 extra guests attending their annual festival free of charge does not negatively affect their profit margins in any substantial way. Yet the initial capital raised at the NFT sale, plus the future royalty fee revenue of the secondary sales, are material new revenue streams for the business. (Coachella 2022.)

In the case of Coachella, the company decided to utilize their current business model and monetize it in a new way using NFTs. An alternative strategy would be that of the Flyfish Club. The Flyfish Club is the first members-only, private dining club where a membership is purchased as an NFT. Only token-holders can gain access to the New York City based restaurant and various culinary, cultural, and social experiences. The project was founded by famous businessman, Garry Vee, and an array of respected culinary and hospitality veterans. Due to its prominent team the project successfully opted for the NFT crowdfunding tactic, to fund the construction of the project. The club has so far raised more than 14 million USD in the first half of their initial NFT sales and it is anticipated to open in the first half of 2023. They are selling a total of 3035 NFTs, with 385 of those being VIP tickets, for a fixed price of 2.5 ETH and 4.25 ETH respectively. In this specific business model, factors such as the NFT quantity and sale method, are logically more appropriate than the strategy chosen by Coachella. (Flyfish Club 2022.)

In both the previous examples, their NFTs provide perpetual access, yet this is not necessarily required. Another common strategy is to define a limited usage to the benefits of an NFT. This can either be a specific time frame, with an expiry date, or a maximum capacity of usage, such as a one-time use ticket. Holders of expired NFTs are required to purchase the new NFT collection to regain their membership benefits. Even in this case the expired NFT can hold additional value above just being a collectable. For example, the issuing company can, in an attempt to minimize the value depreciation of an expired NFT, only allow holders of the previous NFT collection to purchase the new one. This means to become a new member a consumer is required to first purchase and hold a token from the old collection, before they are eligible to purchase the new NFT drop which ultimately gives them access to the member benefits. This act of defining specific requirements for a buyer to be eligible to purchase a particular NFT, is what is referred to as *whitelisting*. A whitelist can be used to define the type of members a club wants to accept. By not allowing anyone to freely purchase their NFTs, projects can create additional scarcity for their collections. (Bleilevens 2021; Vaynerchuk 2021.)

As one can see the strategies for implementing an NFT business model are almost infinite and are all conditional to the business in question. Depending on the intended purpose of the NFT collection a company must contemplate decisions such as the utility, quantity, parameters, royalty percentage and the sale mechanism of their NFT. Once this is defined a company can focus on the art. (Vaynerchuk 2021.)

4.1.3 Artwork Design

The NFT design should ideally not only represent the values of the issuing brand, but also be reflective of the utility the NFT holds. Although the artwork style is second to the utility of the token, it is still important from a marketing and brand image perspective. Like with collectable cards, the scarcity of individual designs have proven to be successful value drivers, as well as the collaborations with famous artist. The art is also reliant on the chosen strategy, since factors such as the quantity of NFTs in the collection play a deciding roll. Independent of the chosen business model, there are still only three major art strategies possible. The first is that every NFT in the collection is created from scratch as a totally unique, one-of-a-kind design. The second strategy is also that every NFT is unique, but algorithmically generated based on several reoccurring, predefined traits, and characteristics. The third and final strategy, is the strategy where every NFTs in the collection is visually identical, only differentiating by their unique number IDs. (Bleilevens 2021.)

What type of art a company ultimately decides to use is dependent on how important this is for their customers. Since creating large amounts of unique artworks is time consuming and capital intensive, it only makes sense if there is an adequate additional return on investing in elaborate NFT designs. This is one of the reasons many of the PFP collections, such as the BAYC or the CryptoPunks, opted to design only a few characteristics and combine them algorithmically into thousands of unique characters. Although the uniqueness of an artwork is important, since this generally translates to an elevated valuation of the asset, it is more relevant to consider what the targeted consumers are. A consumer in search of an exclusive PFP to use as a tool for online bragging, does not have the equivalent interest in the NFT design as a consumer who just wants an NFT to access an exclusive restaurant. How the visual NFT design itself is created, be it a photo or a GIF, a 3D or 2D design, a scanned painting, or an algorithmically generated pattern, is ultimately dependent on the brand image the design and marketing teams wish to achieve. (Vaynerchuk 2021.)

4.1.4 Technical Implementation

Once the company has defined its NFT business model, they can focus on the technical questions relevant in the execution process. The two main decisions that need to be established are what blockchain and what marketplace best accomplish the goals of the NFT strategy. When it comes to deciding on what blockchain a company should use for its NFT collection, the deciding factor is assessing where the interest of the targeted

consumers lie. The main consumer values to consider are security, decentralization, transaction costs and environmental impact. Depending on the customer-base of the issuing brand, a chain should be chosen which best fits the importance of each of these customer values. If the customers intend to trade the NFTs a lot, their main interest would be low minting and gas fees. If consumers are very environmentally aware, they would prefer a proof-of-stake chain, such as Solana, over a proof-of-work chain. If security is their prime concern, then the interests of the consumer would be best represented by the largest, oldest, and most decentralized network, Ethereum. The essential question is which of part of the blockchain trilemma, the customer is the most comfortable neglecting. (Bleilevens 2021; Vaynerchuk 2021.)

The Ethereum chain is the main blockchain most NFT projects run on. Although it currently still has a large environmental impact, is rather slow and has some of the highest transaction fees, its network size and longevity has given it the title of the most secure chain. The anticipated release of Ethereum 2.0 should improve these issues. Layer 2 blockchains, such as Polygon have already accomplished low transaction fees on Ethereum sidechains, indirectly furthering the dominance of Ethereum. Nevertheless, the adoption of Ethereum Killers is still growing and will most likely continue to do so until Ethereum 2.0 launches successfully. Another option is for the company to launch their own blockchain, like Axie Infinity has done with Ronin, yet this seems to be a little redundant for an NFT membership strategy. Beside this being very costly and time intensive, it is also frowned upon by the traditional crypto community, as it puts decentralization in the background, essentially defeating the purpose of Web 3.0. (Bleilevens 2021; NFT TECH 2021.)

For an NFT membership strategy the best chain in most cases is still Ethereum. Beside it being the most secure chain, it is also the best accessible for consumers. This is the case since Ethereum is represented on the most exchanges and therefore has the largest total addressable market. For the average membership strategy, a larger addressable market is often substantially more important than low transaction fees. This is the case, since the average membership NFT will most likely possess a relatively low trading volume, meaning the average accrued transaction costs should remain in a proportionally acceptable price range, when compared to the value of the membership NFT itself. In contrast, if the company anticipates their membership NFTs will potentially be subject to high amounts of trading, or the NFT price itself might only be a few multiples above the average Ethereum gas fee, the company should consider an alternative option with cheaper gas fees. Two of the most popular alternative options for membership NFTs are the Polygon and Solana chains. (Vaynerchuk 2021.)

Once a chain is chosen, to the more technical question around the structure of the NFTs becomes important. Since Ethereum is still the leading chain, its NFT token standards are also the most popular. The three most notable ones are the ERC-20, ERC-721 and ERC-1155 token standards. The ERC-20 standard is for designed for fungible tokens and therefore not relevant to NFTs. ERC-721 is for one-of-a-kind tokens, such as for art or personalized tickets. The ERC-1155 is designed for NFTS that are a mixture of fungible and non-fungible. For example, at a concert that sells general pass and VIP passes as NFTs could sell those tickets as two ERC-1155 collections, since both passes are fungible within their own collection but not between the two collections. All other blockchain, besides Ethereum have similar token standards with the equivalent functionality. (Ethereum 2022.)

In combination with deciding the most appropriate chain and token standard, a company should consider what NFT marketplaces support the blockchains and standards in question, and analyze which marketplace is the most accessible for their customers. Figure 12 categorizes the most famous NFT marketplaces based on their intended usage. Figure 12 also shows that many of the large NFT collections, such as NBA Top Shot, CryptoPunks, Axie Infinity and Decentraland, have created their own NFT marketplaces, which are only intended for their users. This is also an option for brands longing to incorporate a membership NFT model in their business, but requires extensive capital investment, as well as additional risks around security and privacy. The benefits are, that the company gains extra control over factors such as the user experience of their clients. The importance of this will be discussed in the next chapter. (NFT TECH 2021.)

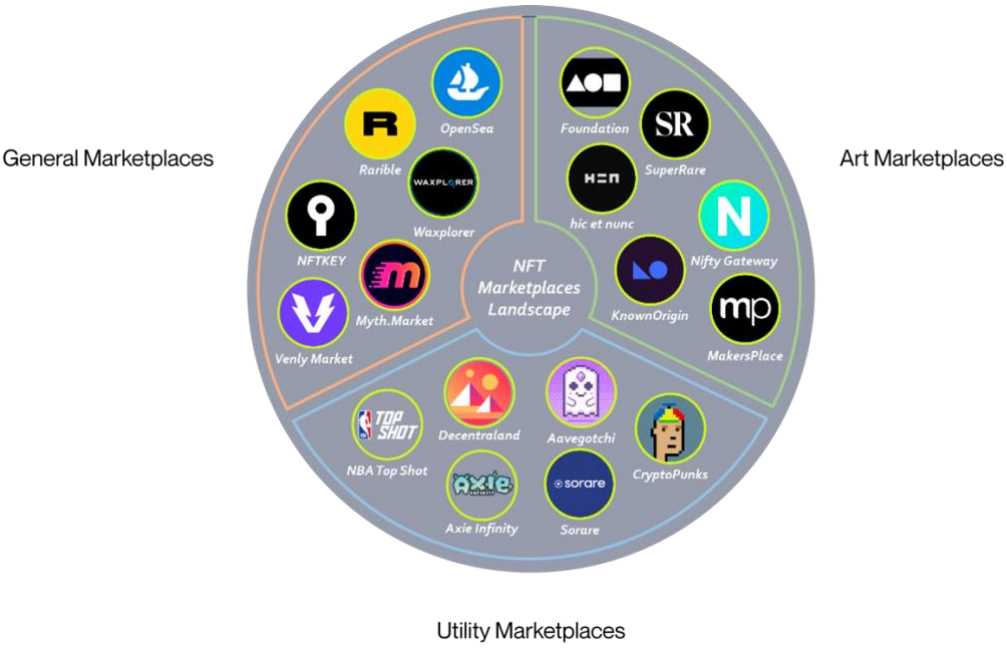

Figure 12. NFT Marketplaces (NFT TECH 2021)

Referring to the examples of the previous chapter, Coachella opted to build their own marketplace, in combination with one of the largest crypto exchanges, FTX. They also opted to use the Solana chain as the base layer of their NFTs. Choosing Solana was an appropriate decision here, since in addition to their 10 lifetime festival passes, Coachella also dropped two additional, larger NFT collections. These other NFTs were sold for as cheap as 60 USD, making it non-sensical to use the Ethereum chain, since the ETH gas fees themselves, regularly cost more than 60 USD. By creating their own in-house NFT marketplace, Coachella was able to leverage its already existing, large following, curate the whole NFT user experience and cut out the extra fees third party marketplaces would have charged. The additional joint venture with FTX meant they were able to acquire some of the best industry know-how and save on hiring additional specialist or consultants. (NFT TECH 2021; Coachella 2022.)

In contrast, the Flyfish club, decided to mint their NFTs on the Ethereum chain and sell them on OpenSea. Choosing the Ethereum chain makes sense in this case, since all the NFTs the Flyfish club sold, were sold for a minimum of a few thousand dollars. Here the security of the digital assets is logically more important than paying a bit more for the transactions. In addition, higher gas fees have the counterintuitive benefit of incentivizing holders to actually utilize the membership benefits, rather than just trying to flip the NFTs for a quick profit. Although increased trading is also beneficial for the creator, due to the increased royalty revenue, keeping the asset price high is more important since that is the ultimate reflection of the success of a project. Choosing OpenSea, the largest NFT marketplace, to list their NFTs, is also logical, considering that the Flyfish club is still in construction and does not already have an existing, loyal customer base, like Coachella. The 2.5% service fee taken by OpenSea on all transactions, is worth the cost as long as it enables the Flyfish club to maximize its reach for potential new members. (NFT TECH 2021; Flyfish Club 2022.)

It is obvious that there are countless other technical challenges a company needs to overcome to successfully launch an NFT project, beside the basic questions of what blockchain and what marketplace they should use. Since covering all these challenges in detail surpasses the delimitations and scope of this thesis, the following chapter will only broadly highlight the largest implementation risks and challenges.

4.2 Risks and Challenges

The challenges a company must face, when wanting to launch an NFT project, especially a membership NFT strategy, are overwhelmingly large. Due to the fact that the technology is so new, much of the infrastructure, guidelines and knowledge is still lacking, both on the side of the consumer and the creator. This makes this process not just challenging but even risky for both parties. Since the distinct challenges a company will encounter are very specific to their business model, the NFT strategy, their geographic location, the customer base, competence of the company and their financial situation, it is almost impossible to cover all possibilities in detail. Nevertheless, the overall challenges that all companies will encounter, can be generalized, under technological challenges, legal challenges, and customer adoption challenges. (Vaynerchuk 2021.)

4.2.1 Technical Challenges

The first technical challenge can already appear if the plan is to release an NFT design with algorithmically generated characteristics. This is still a relatively simple problem since there are an abundance of reliable software that accomplishes the random generation process of traits, such as Chainlink VRF. (Bleilevens 2021; Chainlink 2022.)

Once decided how the NFT artworks will be generated, every company will need to further decide how the artwork will be stored on the blockchain of choice. Since most blockchains are not ideally designed to store large amounts of data in blocks, most blockchains only actually store the necessary data that points to who the owner is and, if required, where the further files are stored. Therefore, if the NFT file is stored on a centralized database, the ownership might be immutable, yet the actual NFT data, such as the visual file of the NFT, can still be deleted. To extinguish this risk, a company should consider using a decentralised database, such as that of the InterPlanetary File System (IPFS), as much as possible. The IPFS is also a peer-to-peer network protocol that stores data in a distributed file system. The more decentralized the data is stored the better, since this cuts out the risk of there being a single point of failure. (Bleilevens 2021; IPFS 2022.)

Integrating the chosen utility of ones NFT, is an even bigger challenge. Depending on the precise intended utility of the NFT a company might even be required to develop new technology or new business procedures. For example, if the NFT is intended to be the access ticket to a membership club, the issuing party needs to exactly define how the verification process will work. Even if the NFT ownership data is freely accessible on the

blockchain, proving that an individual actually is the rightful owner of the wallet in question is the real challenge. Exactly this reason has led many jurisdictions to introduce laws that require crypto service providers, to force their users to link their crypto wallets with their official identification documents. This procedure is referred to as *Know Your Customer* (KYC). NFT membership clubs could also do this, or develop simpler, more user-friendly procedures to accomplish this. (Vaynerchuk 2021; Saylor 2022.)

Besides the technical challenges that already exist when hosting a normal Web 2.0 website, websites that are Web 3.0 compatible, meaning they can connect to digital wallet browser extensions, such as *Metamask* (the most popular online wallet), are even more demanding. By connecting a digital wallet to a WEB 3.0 website, a user is able to use all assets that are attributed to be in the possession of their wallet, on that chain on which the website is build. This can mean using crypto currencies to buy or mint NFTs or use the tokens that are already in possession of that wallet to access specific features on the site. The possibilities are endless and so are the technical challenges and risks associated with safely and ethically deploying functions. (Vaynerchuk 2021; Saylor 2022.)

Other challenges to considered, might be designing the NFT smart contracts in a way that they can be adjusted in the future or tackling the challenges around the initial sale mechanism of the NFTs. The initial sale can become incrementally more challenging when incorporating complex sale mechanisms, such as a Dutch auction or an extensive whitelisting procedure.

The most vital technological challenge and risk is guaranteeing the safety, and privacy of the customers. Complex smart contract should be avoided unless they have been extensively debugged and tested. Any customer data saved by the company should be encrypted and stored as safely as possible. The issuing company should also invest in the appropriate resources to combat hacks and scams, targeting their customers. Consultation and/or hiring of professional blockchain developers and cybersecurity specialists is highly recommended. (Saylor 2022.)

4.2.2 Legal Challenges

The legal challenges are even more specific, since they are not just dependent on the NFT strategy, but also on the jurisdiction in charge of the issuing entity. Besides abiding by all IT and cyber laws that apply in the state in which the company is active, companies should also be aware of two additional large risks. (Saylor 2022.)

The first is the accounting and taxation risks involved in accepting cryptocurrencies as a new means of payment. Here it is important for the company to enquire what the correct accounting procedures and taxation laws for digital asset are, in the jurisdiction in which the company is a tax resident. Although NFTs are most commonly purchased in the coin of the underlying blockchain on which the NFT resides, it might be beneficial for the company to consider accepting stablecoins instead, since this could simplify the accounting process, by limiting the volatile exchange rates. On the other hand, this might result in an increased technical burden, since most NFT marketplaces do not offer stablecoin transactions and therefore would require the company to develop this themselves. (NFT TECH 2021; Saylor 2022.)

Besides the accounting hurdles a company might encounter, a business needs to be even more aware of the security laws governing their jurisdiction. In many countries, some tokens can resemble the definitions of traditional securities and therefore also be required to meet the necessary compliance standards. For example, the Securities and Exchange Commission (SEC), the federal agency in charge of securities in the USA, is already probing if various NFT projects fall under their jurisdiction. Further keeping the largest economy in the world as an example, the USA uses the *Howey test*, to define if an asset is deemed a security. The Howey test states that, if an investment of money is made in a common enterprise, with the expectation of profit, derived from the efforts of others, the asset is considered a security and must abide security laws. Most NFTs represent only a unique asset, with a single owner and are therefore likely not to be considered a security. However, depending on the facts, some NFT use-cases could easily meet the Howey test requirements. For example, NFTs sold for crowdfunding purposes (the proceeds from the presales of digital assets, is intended to fund the development of a non-pre-existing platform) could be argued to be a security. (Gatto et al. 2022; Saylor 2022.)

Although this has led the SEC to argue that they should have authority over these assets, there has still not been a clear decision from the US government on this matter. Alternatively, other countries have already created new government bodies to deal with this new technology. All in all, the whole world is still struggling to regulate and define this new digital asset class and therefore the laws are constantly changing. It is advised that any company wishing to launch a utility NFT collection, seeks adequate legal advice from professionals in the jurisdictions relevant to their company. (Gatto et al. 2022; Saylor 2022.)

4.2.3 Customer Adoption Challenges - Experiment

As was discussed in the NFT Adoption chapter, NFTs as a technology have seen a remarkably quick adoption, especially during the 2021 NFT boom. Nevertheless, the Technology Adoption Lifecycle model by Rogers (1962) argues, that NFT adoption still only resides between the Innovators and Early Adopters stages, meaning the technology is still far from seeing its maximum adoption potential.

Experiment Hypothesis

A common hypothesis is that the difficulty of purchasing an NFT is one of the largest challenges for their further adoption. Purchasing an NFT, is perceived to be a highly technical, non-user-friendly process, that only crypto enthusiast can navigate. To prove how challenging the NFT purchasing process really is and analyze if it can really be accredited for stunting the further adoption of the technology, the thesis has conducted the following experiment. (Vaynerchuk 2021.)

Experiment Objective

The guidelines of the experiment are based on the standards laid out by the Psychology Professor Graham Pluck in his paper *A Guide to Writing Student Psychology Lab Reports* (2014). Using these guidelines, the experiment aims to examine qualitative and quantitative factors of the NFT purchasing process. The main quantitative objective of the experiment is to measure how much time is required for an average first-time NFT buyer to complete an NFT purchase. The resulting measurements of each participant are then compared to factors such as their demographics and previous crypto knowledge. The qualitative data, the experiment inspects, focuses on the subjective opinions of the participants, regarding their experience of trying to purchase an NFT. This data was collected by means of a survey, which all participants were asked to fill out after the completion of the experiment.

Experiment Procedure

The experiment was set up that each contestant, under the oversight of a supervisor, was given the task to purchase a particular NFT, which was specifically made for this experiment. Only participants that claimed that they had never previously purchased, sold, or owned an NFT, were eligible to participate. 10 participants, five male and five female,

from 6 different nationalities, between the ages of 11 and 62, where ultimately chosen. The median age of the participants was just over 32 years. As shown in Figure 13, the experiment demographic was purposely chosen to be more representative of younger people. First, this mitigates the basic, non-crypto related technological hurdles, which are more common with elderly technology users, and second, since NFTs will be more impactful to the future of younger generations, focusing the experiment on them is more relevant to the future adoption of NFTs.

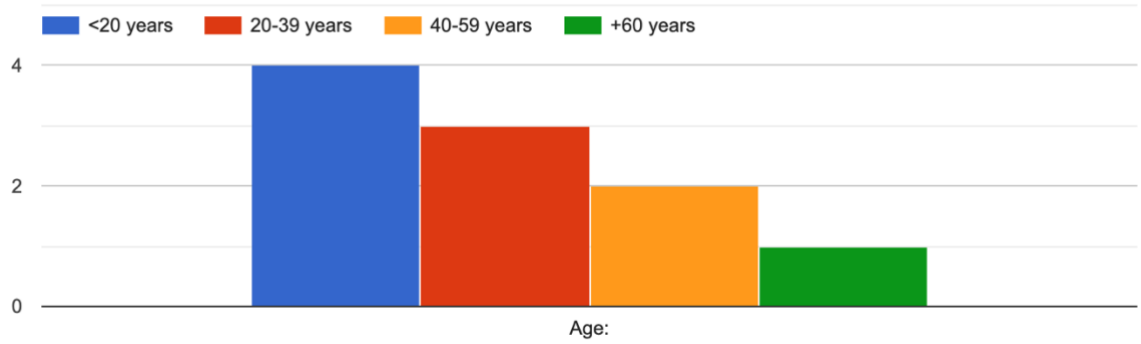

Figure 13. Age Demographic of Experiment

The 10 identical NFTs made for this experiment were all created on OpenSea, since this is the largest NFT marketplace and therefore best reflects the average NFT purchasing process. Although the NFT was built for the Polygon (MATIC) network, the NFT itself was never minted on chain, and instead still resides on the database of OpenSea, as a so-called *soft mint*. The NFT will only be minted on the Polygon network once a holder wishes to do so and pays the necessary minting fees. For simplicity purposes, to save gas fees for all parties and since in this case security and decentralization can be neglected, the experiment has refrained from hard minting the NFTs on Polygon. The experiment NFT design is shown in Image 5 and can be found on OpenSea under:

https://opensea.io/assets/matic/0x2953399124f0cbb46d2cbacd8a89cf

Image 5. Buy Me Experiment NFT

The experiment was to be conducted by a supervisor. The supervisor was to digitally send the participants an instruction page, which explained the task of the experiment. Once the participant finished reading the instruction page, the participant had the opportunity to ask the supervisor questions regarding the objective of the task. Any questions directly intended to simplify completing the task, were not answered by the supervisor. Once the supervisor felt the participant had fully understood the task objective, the supervisor would start the timer and the participant was allowed to start with the task. The participants were also allowed to ask the supervisor questions during the experiment, yet again related to understanding the objective of the task. Necessary help was provided only in the cases were the supervisor felt the participant was missing the goal of the task. The supervisor would stop the timer once a purchasing bid from the participant was received over OpenSea. The task would also have ended if the experiment time had exceeded one hour.

The instruction page, the participants received, was as follows:

> *Dear Participant,*
>
> *This is a bachelor thesis experiment examining the learning curve of buying an NFT for an industry beginner.*
>
> *You have volunteered to participate in this experiment and have clearly expressed that you have previously never bought, sold or owned an NFT.*
>
> *If the former statement is correct you may proceed with the experiment.*
>
> *The overall task is quite simple: Buy this NFT!*

By clicking on the link above you should be forwarded to the NFT marketplace "OpenSea", and shown the following NFT:

(If this is not the case please report to your experiment supervisor)

The objective of the experiment is to time how long it takes you form receiving this task to successfully making a purchasing offer on this particular NFT.

The timer starts once you have finished reviewing these instruction with your supervisor and he gives you the notice to start. The time is stopped once you have successfully sent off your purchase offer for the NFT.

Although this experiment is timed, the goal is to complete this task correctly. So please don't rush!

In addition, after completing the task you will also be asked few questions by your experiment supervisor regarding your experience.

Completing this task is a unique challenge to all participants due to the wide range of technical know-how at the point of starting this experiment. Even if you have zero knowledge of what an NFT is, don't be discouraged, as the intent of this experiment is to examine the learning process of the average individual on this topic.

<u>Completing this task requires three steps:</u>

1. Create a digital wallet and connect it to OpenSea ("Metamask" recommended)

2. Add funds to that wallet in the form of cryptocurrencies (provided by supervisor)

3. Send the purchasing offer for the experiment NFT

Important:

The crypto funds required for this experiment are provided by your supervisor.

Once you have created your digital wallet you may request those funds by sending your wallet address to your supervisor. If you send an invalid address, your supervisor will repeatedly respond with: ***"Invalid Adress! Please send a valid wallet address"****, until you provide a valid address. If a valid address is provided your supervisor will send you 5 USD. This is also the recommended amount you should bid to purchase the NFT. Any loss or misappropriation of those funds will result in the experiment ending.*

A lot of this might sound very confusing to you, yet the point of this experiment is to examine the difficulty of purchasing an NFT. Therefore, the rest is for you to figure out!

There are no limitations on where or how you acquire the necessary information to complete this task (this excludes asking your supervisor). All types of digital and physical sources are encouraged.

The experiment will be halted if the experiment time exceeds one hour.

If you manage to successfully place the purchasing offer, this offer will be accepted and you may keep the experiment NFT as a small reward for your participation.

You may begin. Good luck!

After the experiment, the participants were given a questionary with questions regarding their:

- demographics
- knowledge on cryptocurrencies, blockchain and NFTs
- sources used during the experiment
- opinion on the user experience of purchasing an NFT
- perspective on the future of NFTs.

The questionnaire is in Appendix 1.

Experiment Results

As Table 1 shows, the median time required to complete the experiment was 37 minutes and 46 seconds, with the fastest time being 22 minutes and 28 seconds and the slowest time being 46 minutes and 25 seconds. The maximum experiment time of one hour was also never exceeded.

Participant #	Gender	Age:	Time:
1	Female	53	00:43:49
2	Male	62	00:25:12
3	Female	56	00:31:16
4	Female	18	00:46:25
5	Male	11	00:22:28
6	Female	11	00:45:37
7	Male	22	00:42:54
8	Male	18	00:37:58
9	Female	31	00:39:59
10	Male	30	00:42:04
	Average:	**31,2**	**00:37:46**

Table 1. NFT Purchasing Experiment Time Results

Table 2 highlights that of the 10 participants, the males were on average 3 minutes and 39 seconds faster in completing the task than the female participants, with the two fastest times being by male participants and the three slowest from female participants. Table 2 also highlights that the average male participant is more than five years younger than the average female participant.

Row Labels	Average of Age:	Average of Time:
Female	**33,8**	**00:41:25**
1	53	00:43:49
3	56	00:31:16
4	18	00:46:25
6	11	00:45:37
9	31	00:39:59
Male	**28,6**	**00:34:07**
2	62	00:25:12
5	11	00:22:28
7	22	00:42:54
8	18	00:37:58
10	30	00:42:04
Grand Total	**31,2**	**00:37:46**

Table 2. NFT Purchasing Experiment Results by Gender

The orange graph in Figure 14 depicts the timed results in order of the age of the participants. The orange Time graph highlights that the fastest participant was also the youngest (one of the two 11-year-olds) and the second fastest time delivered was by the oldest participant (62 years old). Figure 14 also shoes that the second slowest time was also from one of the two youngest participants (the second 11-year-old). The rest of the participants, whose ages are more in the middle of the spectrum, times where all relatively similar.

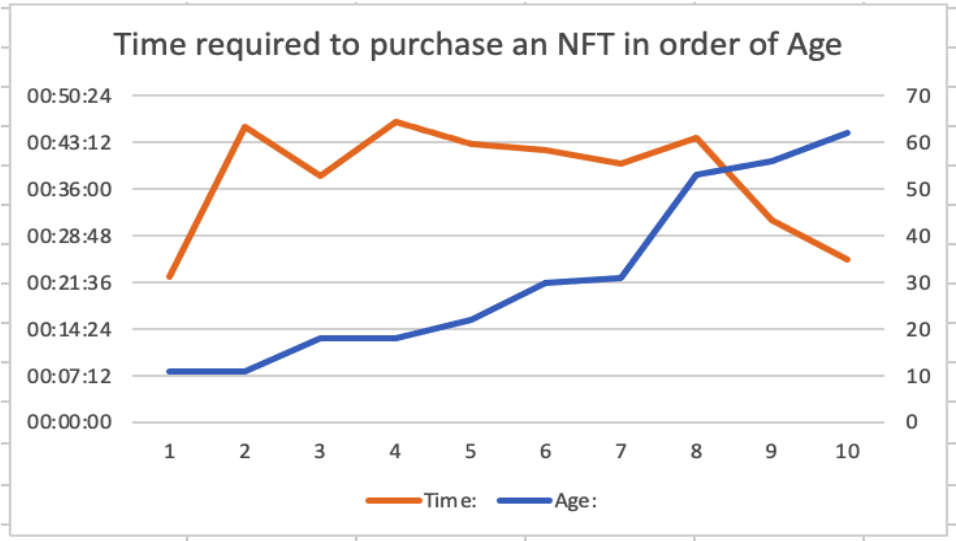

Figure 14. NFT Purchasing Experiment Time Results in order of Age

The questionnaire showed that half of the participants previously owned other cryptocurrencies, yet when it came to NFTs most of the participants stated they had a below average understanding of the technology (Figure 15). This was confirmed, since only one participant could correctly define what an NFTs is, when asked which of the following definitions is most accurate (Appendix 2):

1. *An NFT is similar to Bitcoin, as it represents a digital currency that can be used as a medium of exchange.*

This is wrong, because an NFT is not like Bitcoin or other crypto coins, but instead a digital token representing the certification of ownership.

2. *An NFT is a way of storing digital art on a digital wallet.*

This is wrong, because first, NFTs do not actually store art or other metadata, but are only the certificate proving ownership, and second, only ownership keys are actually stored on digital wallets.

3. *An NFT is a non-interchangeable unit of data stored on a blockchain.*

This, although simple, is the most correct definition of an NFT. Only one out of 10 managed answer this correctly.

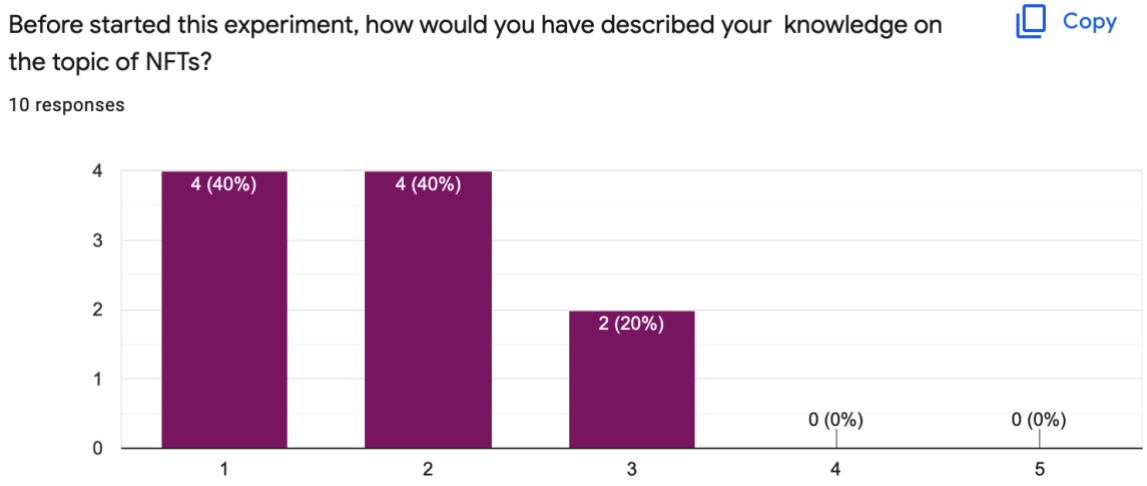

Figure 15. Previous Knowledge of NFTs: 1 = Very Bad / 5 = Very Good (Appendix 2)

As seen in Figure 16, the most common sources the participants used to complete the experiment, were video tutorials, followed by asking a friend. Not a one participant claims to have used books or magazines to acquire the knowledge required to complete this task.

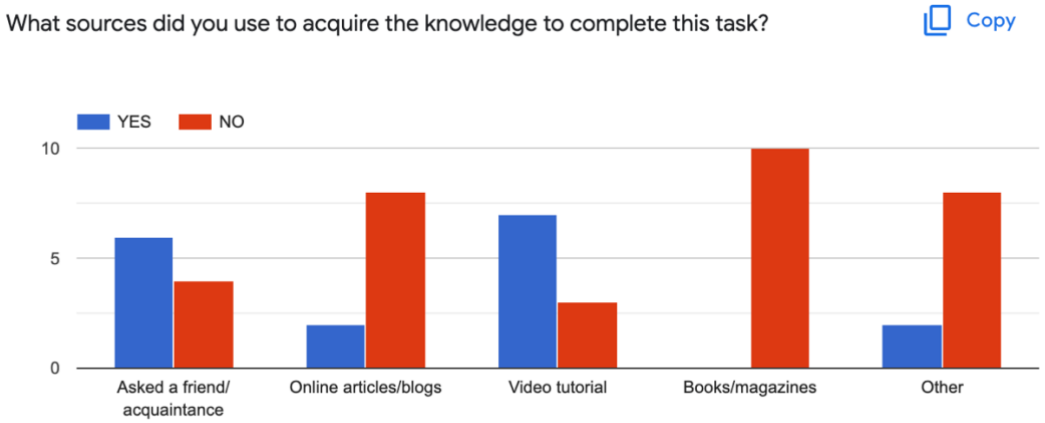

Figure 16. Sources Used During the Experiment (Appendix 2)

The majority of participant felt the experience of buying an NFT was moderately challenging to challenging (Figure 17).

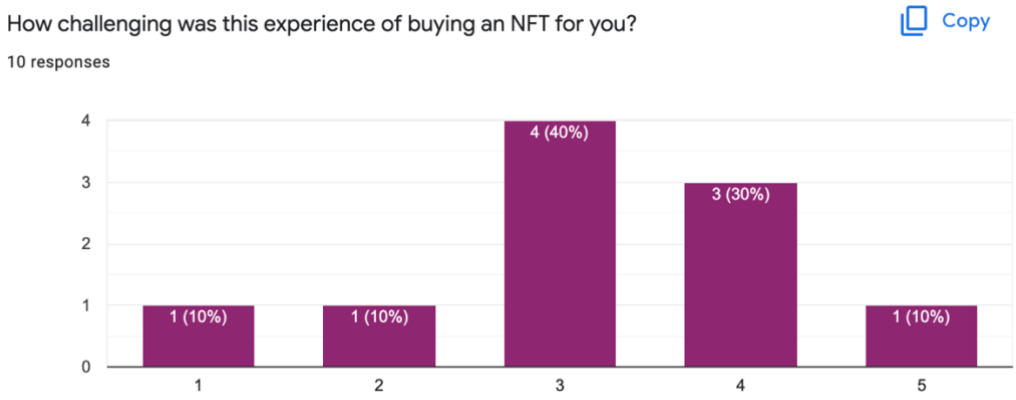

Figure 17. Difficulty of Buying an NFT: 1 = Very Easy / 5 = Very Difficult (Appendix 2)

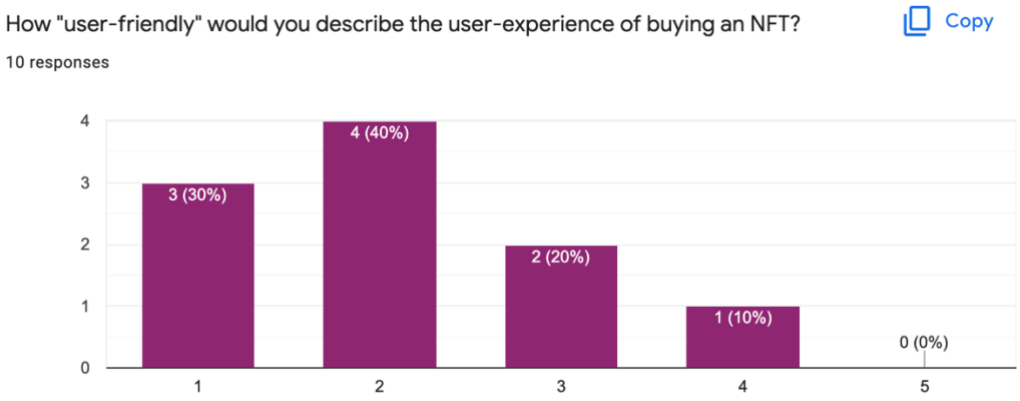

Figure 18. Previous Knowledge of NFTs: 1 = Very Poor / 5 = Very Good (Appendix 2)

As shown in Figure 18, most of the participants stated, that they thought the user-friendliness and overall user-experience of buying an NFT was quite poor. This was often confirmed in the last question of the survey, where the participants were to briefly describe their key take away, from the experiment. As seen in their replies, the most repeated comment was related to how confusing the process was. Here are the answers of each participant in order of when they were recorded (Appendix 2):

1. *Technology has no limit and you never know, what new developments the future holds. Stay open minded.*
2. *UX still too convoluted...*
3. *NFT is the future but need to become more user friendly.*
4. *The realisation of how powerful and impact able this form of currency and art is going to be in the future*
5. *its was very fun*
6. *I think my key experience was a bit confusing buy was also exciting for beating my sister.*
7. *I think it's still quite complicated for the normal person. But I could definitely get into it by building a collection of NFT's and once I get used to the process.A new world 'digital NFT bookshelf!"*
8. *Very confusing!*
9. *Surprised it is so popular when it is so confusing*
10. *Confusing and struggle to see the point ???.*

Although, many answers where related to the poor user experience of the process, many others were also quite optimistic about the future of NFTs. This was also supported by the positive results received on the question, if the participants could imagine themselves buying more NFTs in the future. Five answered with YES, five with MAYBE and not a single participant answered with NO.

The results of the questionnaire can be found in Appendix 2.

Experiment Discussion

Due to the small sample size of the experiment, none of the data collected in this experiment is statistically significant and should therefore be considered accordingly. Nevertheless, the experiment does give some inclination to several approximate conclusions, which clearly seem to lie in favor of proving the experiment hypothesis. This would be the conclusion, that the process of purchasing an NFT for the first time, is quite the lengthy, technically challenging activity, which according to most participants lacks in user-friendliness. This conclusion would hold significantly more merit than some of the other possible experiment conclusions, since all the data in the experiment unanimously points in favor of that statement.

Other conclusions one could derive from the data, would most likely be more easily disputed and controversial. For example, the results of the experiment would argue, that on average men are more skilled at purchasing NFTs, than females. The experiment data would also argue, that in the range of 11 to 62 years, age does not seem to play a deciding factor in the learning curve of purchasing an NFT. The previous two conclusions can obviously not yet be deemed as proven true, yet when compared to some of the empirical data collected of the participants, can still be quite useful.

This empirical data was generally collected by the experiment supervisors, during their conversations with the participants, and holds real practical insight and puts the results of the experiment into perspective. For example, the fastest experiment participant, the 11-year-old boy, also had some of the poorest knowledge of NFTs and blockchain technology, yet because he was the most experienced gamer of the test group, he managed to leverage those skills to his advantage. In contrast the second fastest participant, the 62-year-old man, although never having purchased an NFT and being the oldest participant, was the most blockchain knowledgeable participant of the group, and therefore also did not struggle during the experiment. The slowest time on the other hand, was an 18-year-old girl, who generally considered herself to be quite tech savvy, had issues, because she decided to do the experiment on her tablet device, instead of on a laptop or desktop. She struggled, since she battled to find adequate sources to help her purchase an NFT on a tablet. These last three examples paint a much clearer picture of what the real challenges are for an increased NFT adoption. This holds especially true when compared to the dryer, quantitative data examples of the previous paragraph, which generally lead to totally different assumptions.

Even though this experiment was technically challenging for many of the participants, the process of purchasing an NFT was severely simplified for the necessary parameters required in an experiment. The participants were, for example, not required to actually buy

cryptocurrencies themselves, but received them from their supervisor. This would have been another hurdle the participants would have needed to overcome. The largest challenge in this experiment was creating a digital wallet, yet even here the survey proves, that most participants did not actually acquire significant additional knowledge on the functioning and utility of blockchain technology or non-fungible-tokens. This can largely be attributed to the fact, that most participants just blindly followed the instructions of video tutorials, friends and blogs, rather than trying to understand what is happening behind the scenes.

One could argue, the user understanding of NFTs is not that important. For example, many people that know how to open a bank account, do not have any understanding of accounting, finances, or banking. Many people can also use search engines, such as Google, yet have near zero knowledge of coding or its underlying algorithm. The NFT space is also slowly arriving to a similar future. Even during the process of conducting the experiment, OpenSea incorporated Apple Pay, as an extended payment method for their platform, making the purchasing of NFTs significantly easier and more accessible than before (Chipolina 2022).

The real issue this experiment managed to highlight, is that having a technical understanding of blockchain or NFTs is not necessarily the leading challenge in the way of bringing NFTs into the *Laggards* phase of its technology adoption lifecycle (Rogers 1962). Instead, factors such as, user experience, utility, a clear regulatory and legal framework, and cybersecurity are possibly some of the biggest challenges for the future of NFTs. Companies currently wishing to capitalize on NFTs, be it for a membership club or in any other way, will have to navigate these challenges and often be pioneers of in the space.

5 Summary

The research goal of this thesis was to understand how blockchain technology, and specifically NFTs, will revolutionize the future of business, as well as to develop a basic implementation strategy for companies wanting to capitalize on this. Specifically, the thesis intended to define a rough execution guide for membership based, NFT strategies. This required an extensive theoretical framework, starting by explaining the technology, presenting its use-cases, analyzing successful case studies, and debating the risks and challenges connected to NFTs. In addition, the study conducted an experiment to collect empirical data, and finally combined everything to define a universal NFT implementation process. Although companies wishing to incorporate NFT based business models, will be required to understand the technology extensively, the thesis has discovered that their consumers most probably will not have to.

As mentioned in the introduction of this thesis, the emergence of the internet is still the most accurate comparison to the current state of blockchain technology. While the Internet focuses on information exchange, blockchain focuses on value exchange. The adoption pattern, the impact on business procedures and the fast paste development of both technologies are thus far remarkably similar. Even though most people have very little knowledge about how the internet works, using web-based applications has become second nature to most humans and consumes a large part of their lives. This was not always the case. In the early days of the pre-Web Internet, users where required to be a lot more clued up on the underlying technology. Roughly only a decade ago, simple tasks such as searching for a website or setting up an email address, were exponentially more challenging. The thesis experiment leads to the conclusion, that the current state of blockchain and NFTs is in a similar position to where the internet was back then. The Technology Adoption Lifecyle of Roger (1962) and fast-paced development seen in crypto, would argue that blockchain technology is seeing an even faster adoption than the Internet.

The NFT adoption is happening so fast, that during the writing process of this study, numerous sections had to be updated due to the constant developments seen in the technology. Even a few days before the publishing of this thesis (9 May 2022), Instagram announced that they have started testing NFTs on their platform for selected creators in the United States. Originally Instagram is only providing support for NFTs on the Ethereum and Polygon chains, but support for Flow and Solana are planned to follow soon (Mosseri 2022).

Developments like these will jumpstart the full adoption of NFTs in society and like with the World Wide Web and social media, almost every consumer-based business, will soon be required to incorporate NFTs into their business somehow. Companies that are actively

investing in the research and development of NFT business strategies early, will most likely, reap significant rewards in the future.

List of references

Aderemi, D. 2021. NFTs for crowdfunding and 4 other creative use cases. Retrieved on 28 April 2022. Available at https://defitimes.io/news/nfts-for-crowdfunding-and-4-other-creative-use-cases/

Antonopoulos, A. 2015. Mastering Bitcoin. Sebastopol, CA: O'Reilly Media.

Assia, Y. 2012. bitcoin 2.X (aka Colored Bitcoin) – initial specs, Article. Retrieved on 20 April 2022. Available at https://yoniassia.com/coloredbitcoin/

Atlantic Councill. 2022. Central Bank Digital Currency Tracker. Map. Retrieved on 16 April 2022. Available at https://www.atlanticcouncil.org/cbdctracker/

Axie Infinity. 2022. Ronin Ethereum Sidechain. Whitepaper. Retrieved on 27 April 2022. Available at https://whitepaper.axieinfinity.com/technology/ronin-ethereum-sidechain

Binace Academy. 2022. What Are Meme Coins?. Article. Retrieved on 14 April 2022. Available at https://academy.binance.com/en/articles/what-are-meme-coins?utm_campaign=googleadsxacademy&utm_source=googleadwords_int&utm_medium=cpc

Bang, J. 2019. Hard Fork (Blockchain). Image. Investopedia. Retrieved on 12 April 2022. Available at https://www.investopedia.com/terms/h/hard-fork.asp

Barrett, E. 2022. Twitter will help users verify their NFT profile pictures—but only if they subscribe to its premium Blue service. Article. Fortune. Retrieved on 28 April 2022. Available at https://fortune.com/2022/01/21/twitter-blue-nft-profile-pic-hexagon-frame-feature-verification/

Bitcoin.org. 2022. Website description. Retrieved on 27 March 2022. Available at https://bitcoin.org/en/about-us#owntxt4-title

Bitcoin Suisse. 2021. A Look at Crypto Sectors. Retrieved on 17 March 2022. Available at https://www.bitcoinsuisse.com/research/decrypt/a-look-at-crypto-sectors

Bleilevens, D. 2021. The Ultimate NFT Project Launch Guide. Article. Retrieved on 3 May 2022. Available at https://beleevens.medium.com/the-ultimate-nft-project-launch-guide-d40fd53fe97e

Blockchain.com. 2022. Website function. Retrieved on 27 March 2022. Available at https://www.blockchain.com/explorer

Board Ape Yacht Club. 2022. Website. Retrieved on 28 March 2022. Available at https://boredapeyachtclub.com/#/gallery

Carnhan, M. 2022. NFT Adoption And The New Crypto Paradigm. Article. Nasdaq. Retrieved on 26 April 2022. Available at https://www.nasdaq.com/articles/nft-adoption-and-the-new-crypto-paradigm

Caselin, B. 2022. Why Bitcoin Mining Is a Matter of National Security. CoinDesk. Retrieved on 23 March 2022. Available at https://www.coindesk.com/layer2/2022/04/04/why-bitcoin-mining-is-a-matter-of-national-security/?s=03

Chainlink. 2022. Introduction to Chainlink VRF. Whitepaper. Retrieved on 4 May 2022. Available at https://docs.chain.link/docs/chainlink-vrf/

Chipolina, S. 2022. OpenSea Enables NFT Purchases With Credit Cards, Apple Pay. Article. Decrypt. Retrieved on 6 May 2022. Available at https://decrypt.co/96615/users-can-buy-opensea-nft-with-credit-card-apple-pay

Cristie's. 2022. Beeple (b. 1981) EVERYDAYS: THE FIRST 5000 DAYS. Online Auction. Retrieved on 25 April 2022. Available at https://onlineonly.christies.com/s/beeple-first-5000-days/beeple-b-1981-1/112924

CryptoKitties. 2022. CryptoKitties. Application/game. Retrieved on 21 March 2022. Available at https://www.cryptokitties.co/

Cryptopedia Staff. 2022. Layer-1 and Layer-2 Blockchain Scaling Solutions. Cryptopedia. Retrieved on 17 March 2022. Available at https://www.gemini.com/cryptopedia/blockchain-layer-2-network-layer-1-network

CryptoSlam. 2022. NFT Collection Rankings by Sales Volume. Data. Retrieved on 27 April 2022. Available at https://cryptoslam.io/

Coachella. 2022. Coachella Collectibles NFTs. Website/Marketplace. Retrieved on 4 May 2022. Available at https://nft.coachella.com/

Coingecko. 2022. Top Smart Contract Platform Coins by Market Capitalization. Database. Retrieved on 19 April 2022. Available at https://www.coingecko.com/en/categories/smart-contract-platform

Consensys. 2022. What is Ethereum? Article. Retrieved on 17 April 2022. Available at https://consensys.net/knowledge-base/ethereum/

Daniels, C. Where Did NFT's Come From? The History of Non-Fungible Tokens | NFT Origins Explained. Video. YouTube. Retrieved on April 20 2022. Available at https://www.youtube.com/watch?v=uJnzykET3aQ&t=10s

Decentraland. 2022. Market. Market Place. Retrieved on April 27 2022. Available at https://market.decentraland.org/lands

Dwyer, K. 2022. What Are Cryptocurrency Layer 2 Scaling Solutions?. Article. CoinMarketCap. Retrieved on 30 March 2022. Available at https://coinmarketcap.com/alexandria/article/what-are-cryptocurrency-layer-2-scaling-solutions

Elyashiv, T. 2022. Non-Fungible Tokens for the Supply Chain. Article. SPiCE VC. Retrieved on April 28 2022. Available at https://www.sdcexec.com/software-technology/ai-ar/article/21915598/spice-vc-nonfungible-tokens-for-the-supply-chain

Ethereum Foundation. 2022. What is the Ethereum Foundation?. Website descriptions.

Retrieved on April 11 2022. Available at https://ethereum.foundation/about/

Ethereum. 2022. Blockchain Bridges. Article. Retrieved on April 19 2022. Available at https://ethereum.org/en/whitepaper/

Ethereum. 2022. CONSENSUS MECHANISMS. Article. Retrieved on April 11 2022. Available at https://ethereum.org/en/developers/docs/consensus-mechanisms/

Ethereum. 2022. Ethereum Whitepaper. Whitepaper. Retrieved on April 15 2022. Available at https://ethereum.org/en/whitepaper/

Exodus. 2022. Website. Bitcoin.org. Retrieved on 30 March 2022. Available at https://bitcoin.org/en/about-us#owntxt4-title

Financial Times. 2022. How NFTs became a $40bn market in 2021. Article. Retrieved on 24 April 2022. Available at https://www.ft.com/content/e95f5ac2-0476-41f4-abd4-8a99faa7737d

Ferré, I. 2021. Companies with the most bitcoin on their balance sheets. Article. Yahoo Finance. Retrieved on 15 April 2022. Available at https://finance.yahoo.com/news/companies-with-the-most-bitcoin-on-their-balance-sheets-165302396.html?soc_src=social-sh&soc_trk=ma

Flyfish Club. 2022. The World's First NFT Restaurant. Website. Retrieved on 5 May 2022. Available at https://www.flyfishclub.com/

Frankenfield, J. 2021. Shitcoin. Article. Investopedia. Retrieved on 15 April 2022. Available at https://www.investopedia.com/terms/s/shitcoin.asp#:~:text=The%20term%20shitcoin%20refers%20to,developed%20after%20bitcoins%20became%20popular.

Frankenfield, J. 2021. Initial Coin Offering (ICO). Article. Investopedia. Retrieved on 20 April 2022. Available at https://www.investopedia.com/terms/i/initial-coin-offering-ico.asp

Forkdrop.io. 2019. Article. Retrieved on 2 April 2022. Available at https://forkdrop.io/what-is-a-bitcoin-fork

Gatto, J. Parsafar, Y. Khoury, G; Almasi, P. 2022. Tokenization and the Law: Legal Issues with NFTs. Article. The National Law Review. Retrieved on 6 May 2022. Available at https://www.natlawreview.com/article/tokenization-and-law-legal-issues-nfts

Gautam, V. 2022. 10 Big Brands That Have Dipped Their Toes Into The NFT World. Article. Retrieved on 25 April 2022. Available at https://www.indiatimes.com/worth/investment/brands-that-have-entered-nft-world-560907.html

Hayes, A. 2022. Meme Stock. Investopedia. Retrieved on 23 April 2022. Available at https://www.investopedia.com/meme-stock-5206762

Hayward, A. 2021. The Biggest Crypto Story of 2021: NFT Boom. Article. Decrypt. Retrieved on 27 April 2022. Available at https://decrypt.co/88636/biggest-crypto-story-2021-nft-boom

Hoffmann, T. 2022. CRYPTOPIA: Bitcoin, Blockchains and The Future of the Internet. Documentary. Retrieved on 19 March 2022. Available at https://www.youtube.com/watch?v=Y2qe3hFeQ5g&t=719s

IPFS. 2022. IPFS powers the Distributed Web. Website. Retrieved on 2 May 2022. Available at https://ipfs.io/

Jagtiani S. & McDonald M. 2021. ‘Laser Eyes’ El Salvador Leader Makes Bitcoin Legal Tender. Bloomberg. Retrieved on 27 March 2022. Available at https://www.bloomberg.com/news/articles/2021-06-09/el-salvador-president-says-nation-adopts-bitcoin-as-legal-tender

Johnston, M. 2021. Understanding the Downfall of Greece's Economy. Article. Investopedia. Retrieved on 30 March 2022. Available at https://www.investopedia.com/articles/investing/070115/understanding-downfall-greeces-economy.asp

Karayaneva, N. 2021. Real Estate NFTs: How It Began. Article. Forbes. Retrieved on 28 April 2022. Available at https://www.forbes.com/sites/nataliakarayaneva/2021/11/24/real-estate-nfts-how-it-began/?sh=59414a8b3b12

Kharif, O. & Bloomberg. 2022. Bored Ape Yacht Club creators buy up rival token collections to become an even bigger NFT powerhouse. Article. Fortune. Retrieved on 30 March 2022. Available at https://fortune.com/2022/03/11/bored-ape-yacht-club-yuga-labs-buys-cryptopunks-meebits-nft/

Klein, E. 2021. The Way the Senate Melted Down Over Crypto Is Very Revealing. Article. The New York Times. Retrieved on 28 April 2022. Available at https://www.nytimes.com/2021/08/12/opinion/senate-cryptocurrency.html

Langridge, St. 2021. What Is Tokenomics?. Article. CoinMarketCap. Retrieved on 30 March 2022. Available at https://coinmarketcap.com/alexandria/article/what-is-tokenomics

Larva Labs. 2022. CryptoPunks. Website. Larva Labs. etrieved on 20 April 2022. Available at https://www.larvalabs.com/cryptopunks

Ledger. 2022. THE DIFFERENCE BETWEEN COINS AND TOKENS. Article. Retrieved on 18 April 2022. Available at https://www.ledger.com/academy/crypto/what-is-the-difference-between-coins-and-tokens

Litecoin.org. 2022. WHAT IS LITECOIN?. Homepage. Retrieved on 15 April 2022. Available at https://litecoin.org/

Liquid. 2022. List of Celebrities Embracing NFT Marketplace. Blog. Retrieved on 25 April 2022. Available at https://blog.liquid.com/celebrities-in-nfts

MakerDAO. 2020. The Different Types of Cryptocurrency Tokens Explained. Article. Retrieved on 20 April 2022. Available at https://blog.makerdao.com/the-different-types-of-cryptocurrency-tokens-explained/

Mattei, E. S. 2021. The Future of NFTs: How PFP-Based Projects Took Over the Market. Article. ARTnews. Retrieved on 26 April 2022. Available at https://www.artnews.com/art-news/news/pfp-nfts-future-market-1234602384/

Mcnmara, R. 2022. CELEBRITIES THAT OWN BORED APE YACHT CLUB NFTS. Article. Benzinga. Retrieved on 28 April 2022. Available at https://www.benzinga.com/money/celebrities-that-own-bored-ape-yacht-club-nfts/

Messari. 2022. Messari database. Data. Retrieved on 17 April 2022. Available at https://messari.io/

Mosseri, A. 2022. NFTs on Instagram. Twitter Post. Twitter. Retrieved on 9 May 2022. Available at https://twitter.com/mosseri/status/1523655590672695296

Napoletano, E. & B, Curry. 2022. Proof of Stake Explained. Article. Forbs. Retrieved on April 10 2022. Available at https://www.forbes.com/advisor/investing/cryptocurrency/proof-of-stake/#:~:text=With%20proof%20of%20stake%2C%20participants,transactions%20and%20earn%20a%20reward.

Nakamoto, S. 2008. Bitcoin: A Peer-to-Peer Electronic Cash System. White paper. Retrieved on 4 April 2022. Available at https://bitcoin.org/bitcoin.pdf

NBA Top Shot. 2022. Platform. Retrieved on 25 April 2022. Available at https://nbatopshot.com/

NFT TECH. 2021. A Deep-Dive on NFT Marketplaces. Article. Retrieved on 2 May 2022. Available at https://www.nfttech.com/insights/a-deep-dive-on-nft-marketplaces

NonFungible. 2022. Market Tracker. Data. Retrieved on 24 April 2022. Available at https://nonfungible.com/market-tracker

NonFungible. 2022. 2021 NFT Market Report. Market Report. Retrieved on 23 April 2022. Available at https://nonfungible.com/reports/2021/en/yearly-nft-market-report

Osprey Funds. 2022. Non-Fungible Tokens and the Adoption S-Curve. Article. Retrieved on 26 April 2022. Available at https://ospreyfunds.io/newsletter/non-fungible-tokens-and-the-adoption-s-curve/

Parker, E. 2022. China's digital yuan shows why we still need cryptocurrencies like bitcoin. Article. CNN Business. Retrieved on 21 April 2022. Available at https://edition.cnn.com/2022/02/04/perspectives/china-digital-yuan-cryptocurrency-bitcoin/index.html

Pluck, G. 2014. A Guide to Writing Student Psychology Lab Reports. ResearchGate. Retrieved on 11 April 2022. Available at https://www.researchgate.net/publication/263733635_A_Guide_to_Writing_Student_Psychology_Lab_Reports.

Quiroz-Gutierrez, M. 2022. Bored Ape Yacht Club and its multibillion-dollar ApeCoin, explained: What they are and how investors got rich. Article. Fortune. Retrieved on 28 April 2022. Available at https://fortune.com/2022/03/18/what-is-bored-ape-yacht-club-nft-apecoin-explained/

Redman, J. 2021. 'There's More Work to Do' — 11 Years Ago, Satoshi Nakamoto Sent a Final Message to the Bitcoin Community. Article. Bitcoin.com. Retrieved on 7 April 2022. Available at https://news.bitcoin.com/theres-more-work-to-do-11-years-ago-satoshi-nakamoto-sent-a-final-message-to-the-bitcoin-community/

Rogers, E. M. 1995. Diffusion of Innovation – Fourth Edition. New York, NY: THE FREE PRESS

Rodeck, D & Curry, B. 2022. What Is Bitcoin Cash?. Article. Forbs. Retrieved on 12 April 2022. Available at https://www.forbes.com/advisor/investing/bitcoin-cash/

Saylor, M. 2022. Michel Saylor: Bitcoin, Inflation, and the Future of Money. Lex Friedman Podcast. Interview. Retrieved on 15 April 2022. Available at https://open.spotify.com/episode/4Q5AnqCrbJ3M9Yk4Kh4xjb?si=8c20966df1d64ff4

Scotto, M. 2021. How players make money off NBA Top Shot. Article. Hoops Hype. Retrieved on 25 April 2022 https://hoopshype.com/lists/nba-top-shot-money/

Selkis, R. 2022. Crypto Thesis for 2022. Report. Messari. Retrieved on 24 April 2022. Available at https://messari.io/crypto-theses-for-2022

Sergeenkov, A. 2022. Top Six NFT Marketplaces. Article. CoinMarketCap. Retrieved on 24 April 2022. Available at https://coinmarketcap.com/alexandria/article/top-six-nft-marketplaces

Slance. 2022. What is Web 3.0. Video. YouTube. Retrieved on 21 April 2022. Available at https://www.youtube.com/watch?v=cDmAQm8X5XA

Smorenburg, M. 2021. In Code We Trust: Bitcoin, Blockchain, Cryptocurrencies, Web3.0—A Revolution Governed by Rules, Not by Rulers. House of Qunard.

Statista. 2020. Lifetime spending on in-game purchases in Fortnite according to players in the United States in 2018 and 2020. Data. Retrieved on 27 April 2022. Available at https://www.statista.com/statistics/1239662/fortnite-players-spending-total/#:~:text=According%20to%20a%20February%202020,free%2Dto%2Dplay%20title.

Statista. 2022. Number of smartphone subscriptions worldwide from 2016 to 2027. Data. Retrieved on 26 April 2022. Available at https://www.statista.com/statistics/330695/number-of-smartphone-users-worldwide/

Swan, M. 2015. Blockchain: Blueprint for a New Economy. Sebastopol, CA: O'Reilly Media.

Takyar, A. 2022. ALL ABOUT BLOCKCHAIN SCALABILITY SOLUTIONS. Article. LeewaHertz. Retrieved on 9 April 2022. Available at

https://www.leewayhertz.com/blockchain-scalability-solutions/#:~:text=Sharding%2C%20segregated%20witness%20(SEGWIT),layer%201%20blockchain%20scaling%20options.

The Sandbox. 2022. Map. Market Place. Retrieved on 27 April 2022. Available at https://www.sandbox.game/en/map/

Thomas, L. 2022a. A Guide to NBA Top Shot NFTs: Videos Are the New Trading Card. Article. NFT Now. Retrieved on 25 April 2022. Available at https://nftnow.com/guides/nba-top-shot-guide/

Thomas, L. 2022b. 15 Celebrities Who Are an Active Part of the NFT Community. NFT Now. Retrieved on 24 April 2022. Available at https://nftnow.com/culture/stars-active-in-nft-community/

Thune, K. 2022. What Are NFT Royalties & How Do They Work?. Article. Seeking Alpha. Retrieved on 25 April 2022. Available at https://seekingalpha.com/article/4483346-nft-royalties

Twinfinite. 2021. Most Played Games in 2021, Ranked by Peak Concurrent Players. Article. Retrieved on 27 April 2022. Available at https://twinfinite.net/2021/12/most-played-games-in-2020-ranked-by-peak-concurrent-players/

Vaynerchuk, G. 2021. NFTs For Beginners in 45 minutes. YouTube Interview. Retrieved on 28 April 2022. Available ahttps://www.youtube.com/watch?v=4se4_ZqkcKw&t=252s

Vigna, P. & Casey, M. 2015. Crypto Currency: How Bitcoin and Digital Money are Challenging the Global Economic Order. London: The Bodley Head.

VISA. 2022. Visa acceptance for retailers. Website. Retrieved on 12 April 2022. Available at https://usa.visa.com/run-your-business/small-business-tools/retail.html

Welsh, O. 2022. The metaverse, explained. Article. Polygon. Retrieved on 12 April 2022. Available at https://www.polygon.com/22959860/metaverse-explained-video-games

Whiteboard Crypto. 2021. Crypto Coin vs Token (Differences + Examples). Video. Retrieved on 19 April 2022. Available at https://www.youtube.com/watch?v=422HORNUfkU

99Bitcoins. 2018. What is Bitcoin Mining?. YouTube Video. Retrieved on 25 March 2022. Available at https://www.youtube.com/watch?v=BODyqM-V71E

99Bitcoins. 2018. What is Ethereum?. YouTube Video. Retrieved on April 18 2022. Available at https://www.youtube.com/watch?v=BODyqM-V71E

Appendix 1. NFT Purchasing Experiment Questionnaire

NFT Experiment - Questions

Please answer the following questions to complete the experiment.

*Required

1. What gender describes you best? *

Mark only one oval per row.

	Male	Female
Sex:	◯	◯

2. What age group describes you best? *

Mark only one oval per row.

	<20 years	20-39 years	40-59 years	+60 years
Age:	◯	◯	◯	◯

3. Did you own any crypto currencies before you started this experiment? *

Mark only one oval per row.

	YES	NO
Answer:	◯	◯

4. Before started this experiment, how would you have described your knowledge * on the topic of NFTs?

Mark only one oval.

	1	2	3	4	5	
Poor	◯	◯	◯	◯	◯	Excellent

5. How challenging was this experience of buying an NFT for you? *

Mark only one oval.

	1	2	3	4	5	
Not challenging	◯	◯	◯	◯	◯	Very challenging

6. What sources did you use to acquire the knowledge to complete this task? *

Tick all that apply.

	YES	NO
Asked a friend/acquaintance	☐	☐
Online articles/blogs	☐	☐
Video tutorial	☐	☐
Books/magazines	☐	☐
Other	☐	☐

7. How "user-friendly" would you describe the user-experience of buying an NFT? *

Mark only one oval.

	1	2	3	4	5	
Poor	◯	◯	◯	◯	◯	Excellent

8. Which definition best describes the technology of Non-Fungible-Tokens (NFTs)? *

Mark only one oval per row.

	An NFT is a way of storing digital art on a digital wallet.	An NFT is similar to Bitcoin, as it represents a digital currency that can be used as a medium of exchange.	An NFT is a non-interchangeable unit of data stored on a blockchain.
Answer:	◯	◯	◯

9. Can you imagine yourself buying more NFTs in the future? *

Mark only one oval per row.

	YES	MAYBE	NO
Answer:	◯	◯	◯

10. What was your key take away from this experience? *

Appendix 2. NFT Purchasing Experiment Questionnaire - Answers

What gender describes you best? [Sex:]	What age group describes you best? [Age:]	Did you own any crypto currencies before you started this experiment? [Answer:]	Before started this experiment, how would you have described your knowledge on the topic of NFTs?	How challenging was this experience of buying an NFT for you?	What sources did you use to acquire the knowledge to complete this task? [Asked a friend/acquaintance]	What sources did you use to acquire the knowledge to complete this task? [Online articles/blogs]	What sources did you use to acquire the knowledge to complete this task? [Video tutorial]	What sources did you use to acquire the knowledge to complete this task? [Books/magazines]	What sources did you use to acquire the knowledge to complete this task? [Other]	How "user-friendly" would you describe the user-experience of buying an NFT?	Which definition best describes the technology of Non-Fungible-Tokens (NFTs)? [Answer:]	Can you imagine yourself buying more NFTs in the future? [Answer:]	What was your key take away from this experience?
Female	40-59 years	YES	1	3	NO	YES	YES	NO	NO	2	An NFT is similar to Bitcoin, as it represents a digital currency that can be used as a medium of exchange.	MAYBE	Technology has no limit and you never know, what new developments the future holds. Stay open minded.
Male	+60 years	YES	2	3	YES	NO	NO	NO	YES	3	An NFT is a non-interchangeable unit of data stored on a blockchain.	MAYBE	UX still too convoluted...
Female	<20 years	NO	2	3	YES	NO	YES	NO	NO	1	An NFT is similar to Bitcoin, as it represents a digital currency that can be used as a	YES	NFT is the future but need to become more user friendly.

											medium of exchange.		
Male	<20 years	NO	2	2	YES	NO	YES	NO	NO	3	An NFT is similar to Bitcoin, as it represents a digital currency that can be used as a medium of exchange.	YES	The realisation of how powerful and impact able this form of currency and art is going to be in the future
Male	<20 years	NO	3	1	NO	NO	YES	NO	YES	4	An NFT is a way of storing digital art on a digital wallet.	YES	its was very fun
Female	<20 years	NO	1	4	YES	NO	NO	NO	NO	2	An NFT is a way of storing digital art on a digital wallet.	MAYBE	I think my key experience was a bit confusing buy was also exciting for beating my sister.
Female	40-59 years	YES	1	3	YES	NO	NO	NO	NO	2	An NFT is a way of storing digital art on a digital wallet.	YES	I think it's still quite complicated for the normal person. But I could definitely get into it by building a collection of NFT's and once I get used to the process.A

													new world 'digital NFT bookshelf!"
Male	20-39 years	YES	3	4	YES	NO	YES	NO	NO	2	An NFT is a way of storing digital art on a digital wallet.	YES	Very confusing!
Female	20-39 years	NO	1	4	NO	YES	YES	NO	NO	1	An NFT is a way of storing digital art on a digital wallet.	MAYBE	Surprised it is so popular when it is so confusing
Male	20-39 years	YES	2	5	NO	NO	YES	NO	NO	1	An NFT is similar to Bitcoin, as it represents a digital currency that can be used as a medium of exchange.	MAYBE	Confusing and struggle to see the point ???