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Usability Analysis of Non Fungible Token (NFT) Marketplaces

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Usability Analysis of Non Fungible Token (NFT) Marketplaces



A Thesis submitted to the Department of Computer Science and Engineering, Shahjalal University of Science and Technology, in partial fulfillment of the requirements for the degree of Bachelor of Science in Computer Science and Engineering.

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Abstract

The digital art and collectibles industries are currently being revolutionized by a phenomenon known as non-fungible tokens, or NFTs. Digital artists are experiencing a sea change in their life as a direct result of significant sales to a new audience interested in cryptocurrency. Even famous people are getting in on the action because they see it as a fresh method to communicate with the general public. NFTs have a wide variety of applications, and digital art is just one of them. It is possible to use them to signify ownership of any unique object by acting as a deed for an item, whether that thing exists in the physical or digital world. NFTs, which are powered by smart contracts on the Ethereum blockchain, are providing content creators with more power than they have ever had before. Since that NFTs are the original source of the fundamental idea of digital ownership, our goal is to identify the various obstacles that could prevent their widespread adoption. We want to conduct a semi-structured interview with users and non-users of NFT marketplaces because this type of interview assists in the extraction of important information for a variety of instances. We explore the prevalent barriers that are preventing people who are interested in the cryptocurrency sector from engaging in NFT trades. This investigation is carried out through the use of a semi-structured interview. In addition, a cognitive walkthrough is carried out in order to evaluate the practicability of the marketplace from the point of view of a user. The findings of the interview as well as the cognitive walkthrough were examined in order to determine areas of widespread discomfort and possible areas of development. On the basis of these conclusions, an optimal design for an NFT marketplace is proposed here. As a result of incorporating user-centered design concepts into the suggested design and addressing the pain areas that were identified, the end result is a user experience that is both more fun and more efficient. In addition to this, we provide an evaluation framework for several NFT marketplaces, which illustrates the distinctions between the features provided by each of these marketplaces. According to our findings, the entire technology

that supports NFTs must be modified before it can be used by more people. We provide a summary of our findings from a variety of perspectives, including those in which obstacles do exist but potential modifications are offered for the purpose of enhancing and expanding the promotion of NFTs. This study makes a contribution to our understanding of the user experience in NFT marketplaces and provides recommendations for making marketplaces more user-friendly and efficient.

Keywords: Non Fungible Tokens, Crypto, Ownership, Smart Contracts, Ethereum, Blockchain, Usability, Semi-structured interviews, Cognitive Walkthrough.

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Chapter 1

Introduction

Blockchain was first introduced by Satoshi Nakamoto in 2008 [1], as a distributed ledger for transferring bitcoin, the first application of blockchain technology. Nakamoto conceptualized the first blockchain from where this technology found numerous ways to evolve during these years. It has the potential to be used in many more sectors other than transferring bitcoin. Blockchain has emerged as a secure technology in banking and finance, business, government and many other sectors.

Backed by blockchain technology, digital ownership is a new concept which gave birth to a new application of this technology, named Non Fungible Token (NFT). It creates a unique connection between owners and their digital artworks. Since the concept is still new to the world, people are not so willing to invest in digital assets yet. Although one cannot ignore the advantages of digital ownership, the concept needs to be simplified. The key benefit of NFTs is the ability to prove ownership. NFTs have been drawing attention recently among artists and creators. They bear the potential to fabricate a major change in ownership of assets from physical to digital.

Kevin McCoy and Anil Dash are credited with developing the very first non-fungible token, called as “Quantum”, in May of 2014 [2]. Three months after the first introduction of the Ethereum blockchain, the first non-fungible token (NFT) project, Etheria [3], was officially introduced and exhibited during DEVCON 1, Ethereum’s inaugural developer conference, which took place in London in October 2015. The popularity of the 2017 cryptocurrency-themed online game CryptoKitties [4], which generated revenue through the sale of non-fungible tokens (NFTs) representing marketable cats, drew widespread attention to NFTs. The value of the NFT market tripled to \$250

million in 2020 as a result of the strong expansion that the business witnessed in 2020. More than US\$200 million was spent on non-fungible tokens (NFTs) in the first three months of the year 2021 [5].

NFTs are a game-changer for the digital economy. As we spend more and more of our lives online, the way it permits digital ownership has the potential to generate enormous value. Most NFTs are part of Ethereum blockchain, cryptocurrency and blockchain technology being the key facilitator. The main driver factor that has led NFTs to the major breakthrough is artists and creators trying to secure their creations and prevent forgery. Despite NFTs offer unique identity and digital ownership, the ownership rights can be modified. The true owner can transfer the rights by selling his artwork and the buyer can gain access to a digital asset with unique ownership features.

1.1 Problem Statement

Trading of NFTs is not as straightforward as our traditional trading. It follows a series of steps to transact NFTs. NFTs are not as much embraced even among admirers of artworks. One major drawback of NFTs is the lack of knowledge about it. Different NFT marketplaces have different restrictions and guidelines. Even with offering unique features, NFTs are still not widely accepted. Therefore, investigation is required to pinpoint the issues preventing NFTs from being widely used. Managing the intricate transaction procedure in the NFT marketplaces is a major downside of NFT. Wallets have been designed by developers specifically for these transactions. However, linking the wallet to complete a transaction on these markets can frequently be complicated for users. The user interfaces of these markets can be difficult to understand. The marketplaces must be as user-friendly as possible to be widely adopted. Therefore, utilizing various usability evaluation techniques, we seek to examine and comprehend the usability concerns involving some well-known NFT marketplaces.

1.2 Research Objectives

Finding and analyzing usability problems with various well-known Non-Fungible Tokens (NFT) marketplaces is our main goal. Therefore, the main research objectives are:

- To evaluate the selected NFT marketplaces, we aim to build a comparison framework between

these marketplaces.

- To understand the usability concerns of these markets with users and non-users, we intend to conduct a **semi-structured interview**.
- To evaluate and compare the difficulty of frequent activities in the chosen marketplaces, we intend to undertake the **cognitive walkthrough**.
- To create a proper guideline for the NFT marketplaces so that the usability issues get removed and more users get attracted.

1.3 Thesis Contribution

The main contribution of this thesis is to present a evaluation framework and conduct a usability analysis of the NFT marketplace using the semi-structured interview,cognitive walkthrough method and to present an ideal NFT marketplace design that addresses the identified usability issues. Therefore the main thesis contributions are:

- Through a systematic review of literature and an empirical study, this research evaluates the usability of the existing NFT marketplace platforms, identifies the challenges faced by users, and presents design recommendations to overcome these challenges.
- The findings of this thesis contribute to the existing body of research by highlighting the importance of usability in the development of NFT marketplaces. By identifying the key usability issues in the existing NFT marketplace platforms, this research provides insights for platform designers and developers to improve the usability of their products.
- The presentation of an ideal NFT marketplace design based on the identified usability issues provides a practical guidline for designing NFT marketplaces that are user-friendly and easy to navigate.
- The usability analysis conducted in this thesis can inform future research and policy development in the field of NFT marketplaces, and provide valuable insights for researchers and practitioners working to improve the usability of NFT marketplaces.

Overall, this thesis contributes to the ongoing discourse on the usability of NFT marketplaces and provides a comprehensive framework for understanding the key usability challenges in NFT marketplaces. The research findings have the potential to inform future design and development efforts in the field of NFT marketplaces, and provide valuable insights for improving the usability of these platforms.

1.4 Thesis Structure

The rest of the thesis is structured as follows. Chapter 2 describes the background of the study. Chapter 3 discusses the related works with our study so far. Chapter 4 presents an evaluation framework for NFT marketplaces. Chapter 5 summarizes the semi-structured interview procedure with non users of NFTs and analyzes the findings from the interview. The semi-structured interview process with users of NFTs is summarized in Chapter 6 along with an analysis of the results. Chapter 7 presents a cognitive walkthrough procedure with first time users of Opensea and discusses the results based on task completion. Chapter 8 sums up the results from the interviews and cognitive walkthroughs and provides a suggested design for an ideal NFT marketplace. Chapter 9 concludes our study.

Chapter 2

Background

This chapter presents the background knowledge required for understanding NFTs. As NFTs are based on blockchain technology, an elaborate description of blockchain has been introduced along with cryptocurrencies and crypto wallets. NFTs and their difference with cryptocurrencies have been presented as well. Various aspects of usability testing have been provided.

2.1 Blockchain

In a business network, the adoption of a technology known as blockchain, which is a distributed and immutable ledger, may make the process of documenting transactions and keeping track of assets simpler. Blockchain is a distributed and immutable ledger. An asset could be something tangible (like a house or a car), or it might be something intangible (like money or land) (intellectual property, patents, copyrights, branding). On a blockchain network, virtually anything of value may be recorded and sold, significantly lowering the associated risks and costs for all parties involved [6].

A blockchain is a distributed ledger that may be used to store data in a way that makes it extremely difficult, if not impossible, for the system to be corrupted, hacked or exploited in any other way. A blockchain is a sort of distributed ledger that replicates and disseminates transactional data throughout the network of computers that are engaged in the process.

The Blockchain technology is a framework for keeping public transactional records (sometimes referred to as “blocks”) across numerous databases in a network that is connected by peer-to-peer

nodes. Blockchains are sometimes referred to as “blocks”. The term “digital ledger” is commonly used to refer to this kind of storage. Every transaction in this ledger is authorized by the digital signature [7] of the owner, which authenticates the transaction and safeguards it from tampering. Hence, the information the digital ledger contains is highly secure.

2.1.1 Types of Blockchain

There are four different types of blockchains [8]. Figure 2.1 shows the different types of blockchain:

1. **Private Blockchain:** A single entity exercises control over the operations of a private blockchain network. It determines who is permitted to take part in the network and who is not. When it is necessary, the authority has the ability to override, alter or remove any records that are needed to be stored on the blockchain. Private blockchains are useful tools for the efficient operation of privately held companies and organizations. Businesses have the ability to determine network characteristics, access and authorization options and other critical aspects of blockchain security through the use of private blockchains.
2. **Public Blockchain:** Public blockchains contributed to the proliferation of Distributed Ledger Technology (DLT) by facilitating the creation of cryptocurrencies such as Bitcoin and others. The elimination of some issues and challenges, such as centralization and security vulnerabilities is another benefit that comes from the use of public blockchains. Data that is stored via DLT is not centralized in any one location; rather, it is dispersed among a network of peers. Proof of Stake, also known as PoS, and Proof of Work, often known as PoW, are two types of consensus algorithms that are frequently used to validate the correctness of information.
3. **Hybrid Blockchain:** Private blockchains that limit access to just those users who have been pre-approved are known as hybrid blockchains. These blockchains are also frequently referred to as permissioned blockchain networks. Blockchains like this are routinely developed by companies in an effort to obtain the advantages offered by both of the aforementioned systems. They offer a more structured approach to choosing who may participate in the network and in what transactions, which is an advantage.

4. **Consortium Blockchains:** Consortium blockchains, which are very similar to permissioned blockchains, have both private and public sections. However, unlike permissioned blockchains, various organizations will be responsible for maintaining separate sections of a single consortium blockchain network. Once they are up and running, these sorts of blockchains can give an even higher level of safety, despite the fact that they can be more complex to set up initially. In addition, consortium blockchains are the most effective way to collaborate with several enterprises.

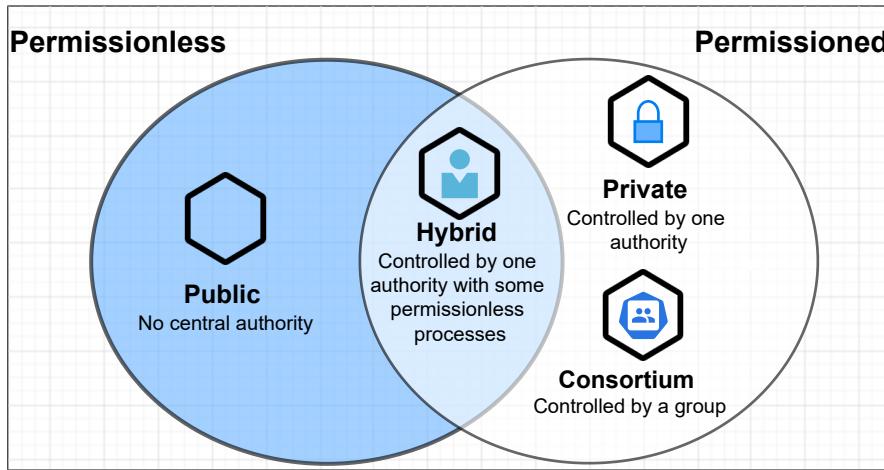


Figure 2.1: Types of blockchain networks

2.1.2 Components of Blockchain

Blockchain consists of three important components: blocks, nodes and miners [9].

1. Blocks:

A block's body is made up of transaction records. One of the blockchain's top concerns is secure record storage. A block nevertheless requires a few other components in order to operate in a blockchain.

The fact that cryptocurrencies mainly rely on encryption is how they got their name. The hash function is the cryptographic technique employed in the case of blocks. A hashing algorithm produces a string of symbols known as a hash. Bitcoin utilizes the SHA-256 [10]

algorithm, but not all cryptocurrencies do. This algorithm creates a unique string of symbols from all the information in a block to be used as the block's ID.

The hash of the block (the block header) is formed from six elements:

- (a) The number of the block's most recent version
- (b) The hash of the block that came before it in the chain.
- (c) A code that is created from the data of the transaction.
- (d) A timestamp indicating the moment the block was initially produced.
- (e) The difficulty goal serves to regulate the level of challenge presented by mining.
- (f) The nonce is the name given to a string of characters that are chosen at random.

Mining cryptocurrencies is done with the intention of discovering the nonce. The miner who finds the nonce that fulfills the current difficulty requirement first will be credited with adding the block to the chain and permanently recording it in the transaction history. Figure 2.2 depicts the structure of a block.

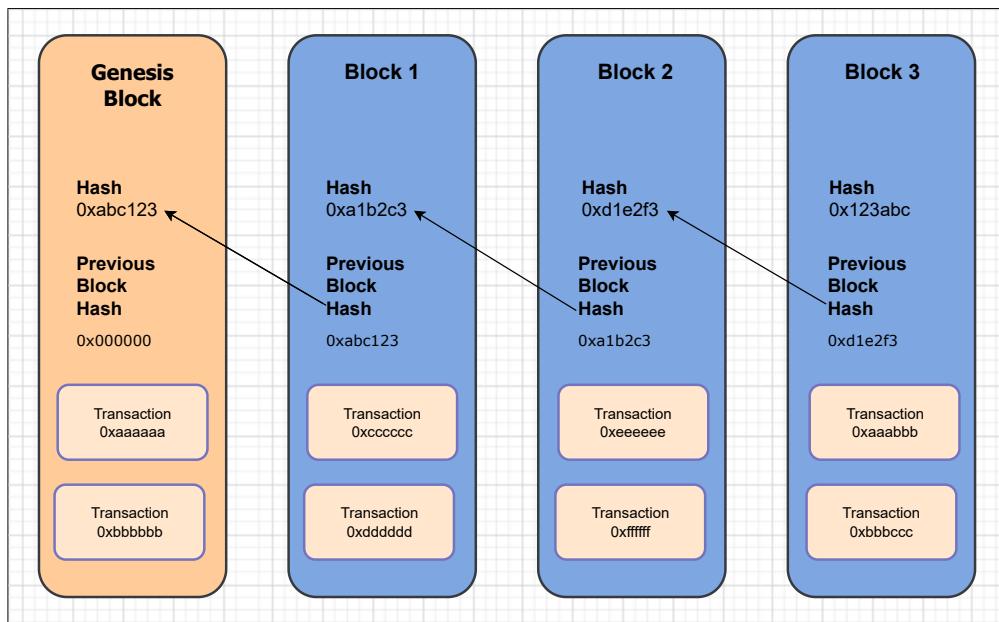


Figure 2.2: Structure of a block

2. Miners:

The process of mining cryptocurrencies is very comparable to the mining of minerals. The vast majority of prominent cryptocurrencies are limited in the amount of coins that can be created. Bitcoin miners use possible solutions to the algorithm in order to increase their chances of successfully mining a new block. To put it another way, bitcoin miners are responsible for extracting new units of cryptocurrency from the system. In common usage, the word "miner" can apply to both the individual who operates the mining equipment as well as the equipment itself. Miners are looking for a certain number known as a nonce. When combined with the data from the block and run through the hashing algorithm, this nonce, along with the block data, will produce the desired result specified by the code governing the blockchain. It is tough to find the nonce, and the only way to do so is to speculate about what it might be. The number of possible nonces is so high that miners are required to try billions upon billions of different combinations before they are successful. In spite of the fact that it is frequently referred regarded as a puzzle, its resolution is actually more dependent on computer processing power, time and luck.

It is a competition to get the mine. In order to locate the nonce, each miner makes a guess, which they then compare with those of their fellow miners. Only the first miner to find any given nonce is eligible to get a mining reward, also known as a block reward, for their contribution to the mining of a new block. This incentive in the Bitcoin protocol, which is currently 6.25 BTC, will be cut in half every 210,000 blocks that are mined, which is roughly equivalent to once every four years. There are varying levels of block rewards available for various cryptocurrencies. The price that users are prepared to charge is directly proportional to how quickly miners select transactions and include them in their blocks. As soon as a solution to the most recent block is found, the winner of the mining competition broadcasts the newly mined block to the rest of the network. After that, the mining industry as a whole moves on to extracting the block that comes after that one. In addition to receiving payment, miners are rewarded with a mining fee whenever they add new transactions to a blockchain. Those users whose transactions are included in a newly generated block are the ones who are accountable for paying this cost. It is a form of compensation for the work that the miners put in. Mining blocks, which involves the resolution of difficult cryptographic riddles, has

as its primary goal not only the addition of new information to the blockchain but also the strengthening of its security. Figure 2.3 illustrates the process of mining a block.

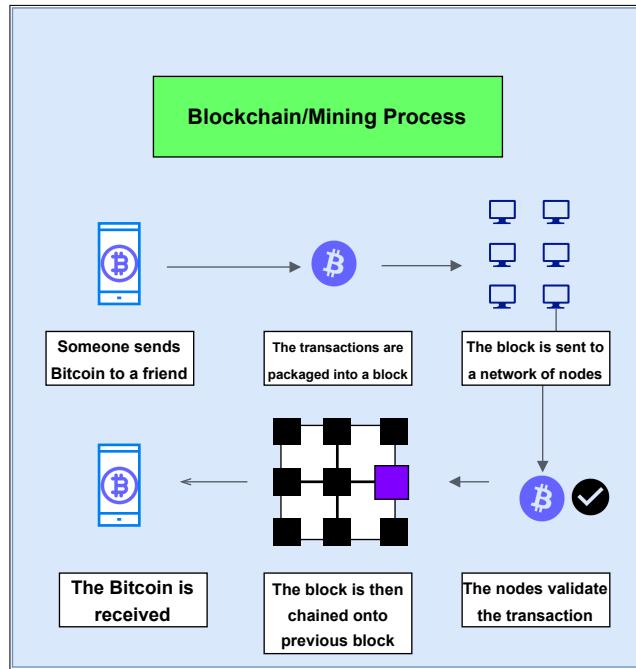


Figure 2.3: Mining of a block

3. Nodes:

One of the many devices that run the blockchain protocol software and typically maintain the transaction history is referred to as a “blockchain node.” A decentralized peer-to-peer network has nodes that link to one another. All blocks and transactions must abide by the protocol regulations, which are ensured by full nodes. They regularly check to make sure that everyone on the network abides by the same regulations. This guarantees the integrity of the network and the reliability of the database.

There are three types of nodes that perform different functions:

Full nodes keep the entire blockchain on hand. In full nodes, every block, from the very first to the most current, is kept. A large amount of hard-disk space is needed to store the complete blockchain. Bitcoin nodes can be trimmed to reduce the size of the disk space.

A node can conserve disk space by being pruned, which involves deleting unnecessary data about fully spent transactions.

Although they serve as wallets, **lightweight nodes** do not store the whole blockchain. To broadcast their transactions to the network, they must establish connections with complete nodes. Lightweight nodes are seen by many users as a straightforward way to send and receive bitcoin.

By incorporating transactions in blocks, **mining nodes** validate transactions. Every blockchain miner ran a mining node in the beginning. Today, mining pools are places where many miners collaborate. These pools capitalize on collaboration by combining the efforts of multiple miners into a single mining node. This increases their likelihood of receiving the mining prize. Figure 2.4 shows the transaction process in blockchain.

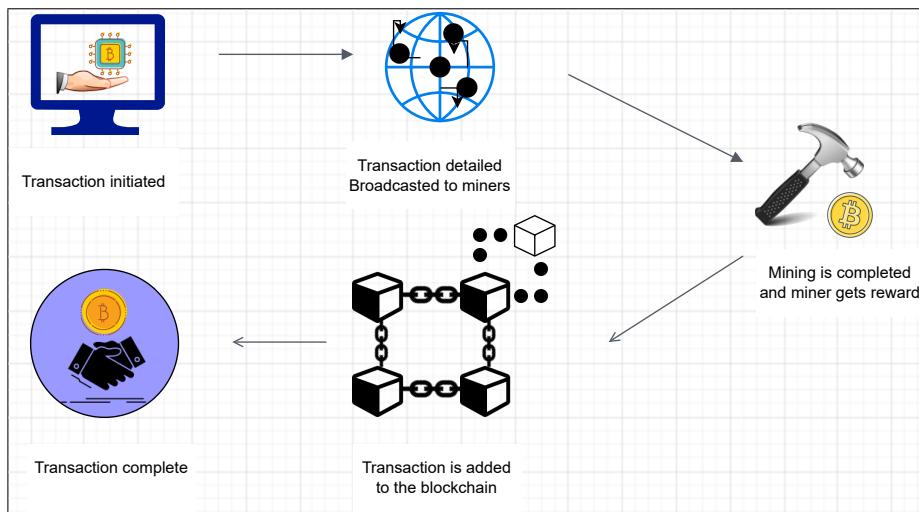


Figure 2.4: Transaction validation through mining nodes

2.2 Non-Fungible Token (NFT)

Tokens that cannot be exchanged for other currencies have emerged from the once-simple concept of bitcoin. Real estate, lending agreements, and works of art are just some of the asset types that may take use of the sophisticated lending and trading platforms made available by today's modern financial systems. Because they make it possible for digital representations of

tangible assets, Non-Fungible Tokens (NFTs) are an important step toward the reinvention of this infrastructure. The idea of creating digital representations of physical objects and the practice of assigning each individual an identifier are not novel concepts. However, when combined with the benefits of a blockchain that cannot be altered and contains smart contracts, these concepts create a tremendous force for change that cannot be stopped. NFTs are a type of cryptographic asset that is held on a blockchain and comes equipped with unique identification codes as well as metadata that allows it to be distinguished from other similar assets. It is not possible to trade or swap them for equivalent value, in contrast to cryptocurrencies, which can be done easily. In contrast to this, fungible tokens, such as cryptocurrencies, cannot be differentiated from one another and, as a result, have the potential to function as a medium for monetary exchanges in the market. Despite the fact that it has been transferred to the buyer of an NFT, the content is nevertheless shared widely on the internet. When the item is sold, the platform retains a very little fraction of the revenues, the current owner receives the remaining proceeds and the original creator is given a sum of money. As a consequence of this, popular digital assets have the potential to produce recurrent revenue due to the fact that they are always being purchased and sold.

2.2.1 Features of NFTs

Non-fungible assets are valued differently based on their unique attributes and scarcity [11]. NFTs are designed to be:

- **Unique:** Every NFT has its own distinctive quality, which is typically mentioned in the token's accompanying information. NFTs are all unique individuals who exhibit a variety of distinguishing qualities.
- **Digitally rare resource:** NFTs are kept in digital form on distributed ledger networks. As a consequence of this, the certificate of ownership is available across several networks, which makes it possible to determine who the legitimate owner of a digital asset is.
- **Indivisible:** NFTs cannot be acquired or transferred in parts, nor can they be broken up into smaller amounts or divided into smaller amounts.
- **Ownership:** These tokens ensure that the correct person is credited with ownership of the asset that was supplied.

NFTs are capable of representing practically any asset, regardless of whether it is digital, physical, or metaphysical in nature. On the other hand, the most typical forms of non-fungible token assets include works of digital art, digital collectibles, individual pieces of content like as audio or video recordings, and event tickets [12].

2.2.2 Minting of NFTs

There can be only one owner of an NFT at any given moment. The ownership is handled by the one-of-a-kind ID as well as the information, neither of which can be replicated by any other token. The creation of NFTs takes place through the use of smart contracts, which also serve to assign ownership and control the transferability of the NFTs. The transformation of digital data into cryptographic holdings or other digital assets that may be maintained on a blockchain is required for the minting of a new kind of asset. The digital items or files will be stored in a decentralized database or distributed ledger, and once there, they will be inaccessible for modification, deletion or other changes. When someone creates or mints an NFT, they execute code stored in smart contracts that conform to different standards, such as ERC-721 [13]. This information is added to the blockchain where the NFT is being managed. The minting process, from a high level, has the following steps that it goes through [14]:

- Creating a new block.
- Validating information.
- Recording information into the blockchain.

The NFT ensures that the piece of artwork may be bought or sold on the market without any difficulty. It provides a degree of flexibility for future selling or collection, in addition to monitoring ownership. In conclusion, but certainly not least, having a fundamental knowledge of NFTs can provide a trustworthy concept of how to approach the process of their formation and depiction.

2.2.3 Properties of NFTs

NFTs have some special properties:

1. Each newly created token is assigned a one-of-a-kind identification that is inextricably bound to a specific Ethereum address.

2. They cannot be used in place of other tokens on a one-to-one basis directly. For instance, 1 ETH and another ETH are equivalent to one another in every way. When it comes to NFTs, this is not the case.
3. Each token has a corresponding owner, and it is simple to confirm this information.
4. They are stored on Ethereum and can be purchased and traded on any blockchain that is based on Ethereum [15].

When certain varieties of NFTs are marketed, royalties will be automatically dispersed to the individuals who were responsible for their creation. However, despite the fact that it is one of the most potent ideas, it is still in the process of being developed. When an individual's copy of their work is purchased by another person, the producers of the work need do nothing more than sit back and collect royalties because this process is totally automated. The calculation of royalties now requires a significant amount of manual labor and is not known to be very accurate. There is a considerable lack of representation of creators who are given the appropriate amount of payment for their work. If the NFT is constructed in such a way that it will routinely pay a royalty, then there is no chance that it will ever go without payment.

The ERC-721 standard was the foundation to NFTs. The ERC-721 smart contract standard, created by some of the same individuals who created the ERC-20 smart contract [16], outlines the minimal interface ownership information, security, and metadata needed for the trading and distribution of gaming tokens. The ERC-1155 standard [17] expands on the idea by batching many non-fungible token types into a single contract and lowering the transaction and storage costs necessary for NFTs.

By “minting”, which is the process of creating a representation of a file on a blockchain network, content producers can create NFTs. These decentralized networks can maintain unchangeable records that trace each asset’s purchase and sale as well as the owner at any given time. While Solana and Cardano are also frequently utilized, Ethereum is the most popular network for NFTs.

After it has been created, an NFT is a commodity that may be bought, sold or traded. Even if a copy of the original file is made, the record of ownership cannot be changed without the permission of the person who owned the file when the copy was made. The technology is sophisticated, but the records are normally safeguarded by the same method that gives cryptocurrencies their worth.

This process prevents a single token from being cloned and used in several transactions at the same time, which gives cryptocurrencies their value.

Creating an ownership record on a blockchain network is all that is required to make an NFT, which makes it a very simple process. Even while having some level of technical expertise is necessary for the minting process, there are a variety of software tools available that can perform the more fundamental duties. The process of transforming digital data into crypto collections or digital assets that are then stored on a blockchain is referred to as minting an NFT. The digital items or files will be kept in a decentralized database or distributed ledger and once there, they will be inaccessible for editing, modification or deletion. Minting refers to the act of uploading a specific item to the blockchain. This procedure is analogous to the process of minting a physical currency. There are many other uses that may be found for NFTs. For example, they are the ideal method for virtually portraying real-world objects, such as real estate or artwork. Blockchain technology, on which NFTs are built, may also be used for identity management or to eliminate the need for middlemen and establish direct connections between artists and their fans. NFTs have the potential to do away with the need for intermediaries, which would result in streamlined transactions and the creation of new markets. The demand for non-fungible tokens (NFTs) is now being fueled in significant part by collectibles like as digital art, sports cards, and rare items.

Even though NFTs have been around since 2015, their popularity has just lately been on the rise for a variety of different reasons. The first and perhaps most noticeable change is the widespread interest in and acceptance of cryptocurrencies and the blockchain technologies that underpin them. The point at which fanaticism, the economics of royalties and the laws of scarcity collide extends beyond the technology itself. Every customer has the desire to make the most of the opportunity to possess unique digital material and even keep it as a form of investment in their portfolios.

2.3 Cryptocurrencies

Any digital or virtual currency that employs cryptography to secure transactions is known as cryptocurrency, often known as crypto-currency or crypto. Rather of being issued or regulated by a central authority, cryptocurrencies employ a decentralized system to track transactions and produce new units. A digital currency, sometimes known as a cryptocurrency, is an alternative

payment system created using encryption techniques. Cryptocurrencies may function as both a means of commerce and a virtual accounting system due to the use of encryption technology. Use of cryptocurrencies requires a cryptocurrency wallet. A digital asset known as a cryptocurrency (or “crypto”) can be traded without the aid of a central monetary institution like a bank or government. Cryptographic methods are used to create cryptocurrencies instead, allowing users to buy, sell and trade them securely [18].

A cryptocurrency is a kind of currency that is digital, decentralized, and encrypted all at the same time. It is not possible for a single organization or person to control and oversee a cryptocurrency’s value. On the other hand, these tasks are extensively distributed among users of a cryptocurrency and carried out over the internet. Because there is no central bank or other entity that controls how cryptocurrencies are used, the introduction of more units is contingent on the fulfillment of specific conditions. For example, with Bitcoin, new bitcoins can only be produced when a block is uploaded to the blockchain. At this time, the miner is rewarded with bitcoins for their work. After the production of the 21 millionth bitcoin, no further bitcoins will ever be generated again. Although the vast majority of people invest in cryptocurrencies in the same manner that they would invest in other assets such as equities or precious metals, bitcoin may be used to acquire products and services that are more traditionally available. Despite the fact that bitcoin is a novel and interesting asset class, investing in it can be dangerous due to the fact that one needs to do some research in order to understand how each system works effectively. The first cryptocurrency was bitcoin [19]. Depending on how they are utilized, individual cryptocurrency units may be referred to as coins or tokens. Some can be used to participate in certain software programs like games and financial products, while others can be used as storage of value or as units of exchange for goods and services.

Mining is the process that commonly generates new cryptocurrencies. In order to verify that network transactions are legitimate, hard puzzles are solved by computers during the lengthy and energy-intensive mining process. As a kind of remuneration, the owners of those machines are eligible to receive freshly created bitcoin. Other cryptocurrencies manufacture and distribute tokens in different ways and many of them have a noticeably smaller environmental impact [20]. The majority of people will find that acquiring bitcoin through an exchange or directly from another user is the most straightforward method available. The core of a simple transaction is the passing

of a coin from one person to the next. The exchange of cryptocurrency takes place between two different “wallets”, or digital storage locations, where the digital money is kept. Each wallet has both a public and private key associated with it. A recipient address is generated with the use of the public key in order to make it possible for the wallet’s receiver to receive bitcoin. When a private key and wallet are used in conjunction with one another, they form a cryptographic signature. This signature may then be used to help verify bitcoin transactions.

When compared to, for example, the cost of moving money from a digital wallet to a bank account, the transaction cost associated with cryptocurrencies is extremely low or perhaps nonexistent. When it comes to users’ ability to perform transactions, there are no time or day limitations, and there are no limits placed on either purchases or withdrawals. In addition, anybody may use cryptocurrencies, in contrast to opening a bank account, which requires the presentation of many forms of proof and paperwork.

2.4 Difference between Cryptocurrencies and NFTs

Cryptocurrencies and NFTs have several key similarities and some key distinctions. The biggest one is that cryptocurrencies are fungible by definition. NFTs, as their name implies, are non fungible. Depending on their perceived value and demand, each NFT is distinct, special, and valued differently.

Blockchain transactions are used to verify the ownership of both cryptocurrencies and NFTs, which are typically purchased with cryptocurrencies. The most important difference is that the value of cryptocurrencies is totally based on economic factors, such as the fact that they may be used as a medium of exchange or invested in. On the other hand, non-financial transfers are valued in a variety of ways, both economic and non-economic. Artists can use NFTs to sell, advertise and even autograph their creations, which can then be purchased with cryptocurrencies by an investor or collector. NFTs also allow artists to keep 100% of the profits from their sales.

NFT is exclusive and cannot be exchanged for any other item, unlike cryptocurrencies, which can be traded for one another. For instance, while a digital artwork can only exist as a whole and cannot be divided into smaller parts, Bitcoin can. Each token that is non-fungible serves as an authenticity certificate, demonstrating that the digital asset it is attached to is one of a kind and cannot be traded with another. Because of the cryptographic concepts underlying blockchain

technology, an NFT can never be altered, modified, or stolen.

According to some, NFTs are less volatile than cryptocurrencies. Both artists and traders have been drawn to NFT's imaginative, aesthetic side. On the other side, it can discourage people who find the work of creating NFTs to be overly challenging, difficult or cumbersome. As crypto opponents and authorities have frequently noted in their condemnation of cryptocurrencies, they are thought of as high-risk investments in particular. NFT may be used to many different things, such as digital material, gaming products, investments and collateral, domain names, and many other things. Cryptocurrency is utilized for a variety of purposes, including ethical business operations, asset management, and low-cost money transfers. Figure 2.5 shows prime differences between cryptocurrencies and NFTs.

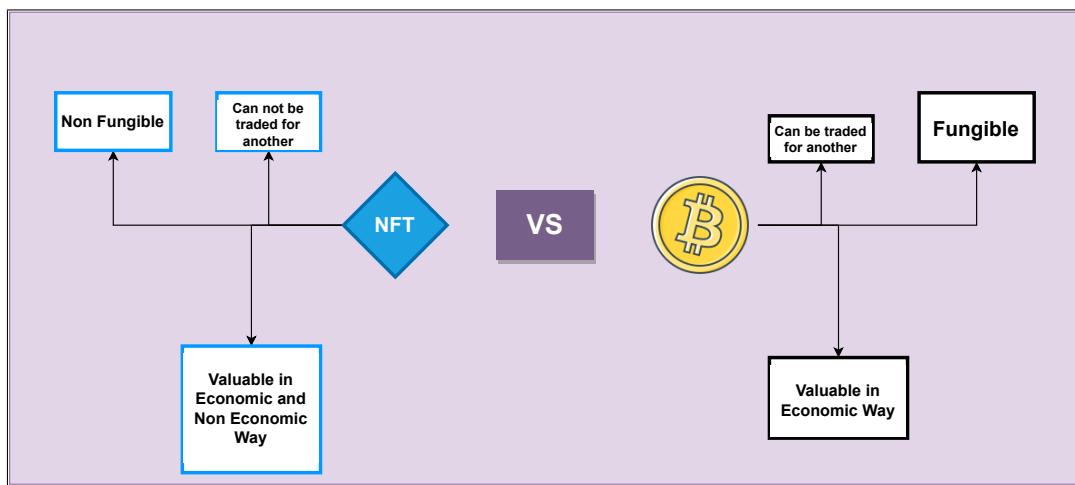


Figure 2.5: Difference between NFT and Cryptocurrency

2.5 Crypto Wallets

The sending and receiving of cryptographic transactions, as well as the storing of cryptocurrencies and the private keys associated with those cryptocurrencies, may be accomplished with the use of a piece of hardware or software known as a cryptocurrency wallet. The construction of a cryptographic wallet requires the use of both public and private key pairs. To create an address that can be used to transmit bitcoin to a wallet, a public key must first be produced from a private

key. This is done so that the public key can then be used to construct the address. When referring to these digital storage devices, the name “wallet” could be a little bit deceptive due to the fact that cryptocurrency wallets do not genuinely store cryptocurrencies in the same manner that traditional wallets do with cash. Rather, traditional wallets retain cash. Instead, they are the owners of the private keys that enable users to carry out transactions and read the public ledger in order to display the balances in their addresses. These private keys allow users to read the ledger in order to display the balances in their addresses. Because of these private keys, users are granted the ability to access the public ledger and view the balances associated with their addresses.

Types of crypto wallets [21]:

- **Mobile wallets:** By scanning a QR code on their cellphones, users may store cryptocurrencies, send and receive transactions, even sweep the private keys of an existing wallet into the app. Mobile wallets include Trust Wallet, Metamask, and Exodus.
- **Desktop wallets:** Wallets that are stored on desktops keep the private keys on the user’s computer. They can disconnect the wallet from the Internet, complete certain transactions without using it, and then reconnect it to the Internet. Desktop wallets, such as Wasabi, Electrum, and Bitcoin Core, are some instances.
- **Web wallets:** Web-based wallets function as browser extensions and have the ability to send transactions, simplifying the user experience when interacting with decentralized applications and other types of softwares. A web wallet is only accessible over the internet. A web browser or an app that is linked to the internet are both required to access it. Either the person who runs the website that houses the online wallet has possession of the coins’ private key, or else it is encrypted and protected by a password. Web wallets include services like as Binance, Trust Wallet and Coinbase, among others.
- **Hardware wallets:** A hardware wallet is a compact, offline storage device for cryptocurrencies. Typically, the hardware wallet is connected to a computer through a USB connection. Hardware wallets include the Ledger Nano S, the Trezor Model One- Crypto Hardware Wallet and the SafePal S1.
- **Paper Wallets:** A paper wallet is a method of offline cryptocurrency storage. This paper

wallet contains the private and public keys of the user, which are accessible through a QR code.

Users receive a private key and a public key linked with their blockchain wallet whenever they create one. Wallets based on blockchain technology use a mechanism involving a public key and a private key. Similar to an email address, a public key may be shared with anybody. When a user generates a wallet, a public key is produced, which may be shared with anyone in order to receive funds. The private key is comparable to a password in that it should not be compromised and the user should never reveal it. This private key is used to spend their funds. If someone gets access to their private key, there is a high possibility that their account is compromised and they might end up losing all the cryptocurrency deposits in their accounts [22].

To send and receive cryptocurrency to and from anywhere in the world, control user's private keys, interact with usernames rather than lengthy, hexadecimal "public key" addresses, and make purchases at merchants that accept cryptocurrency, a cryptocurrency wallet should be able to manage all digital assets in one secure location. [23].

Since bitcoins are very valuable targets for attackers, wallet security is crucial. A few security measures include employing two-factor authentication for exchanges, encrypting the wallet with a secure password and keeping significant amounts on an offline device. Backups, software upgrades and multiple signatures as security measures to protect wallets from malicious assaults may also be considered.

2.6 Usability

The quality of the experience that a user has when dealing with a product or system, such as a website, software, gadget or application, is referred to as the usability of the product or system. Usability refers to the efficacy, efficiency, and overall satisfaction that a product or service provides to its users. Even the cleverest ideas for new products and the most beautiful designs risk being rendered useless if their usefulness is not successfully realized. The term "usability" refers to the ease with which a product may be utilized as well as the speed with which a certain task can be completed employing the product. Usability components are shown in figure 2.6.

Usability is defined by five quality components:

1. **Learnability:** How simple is it for users to carry out fundamental responsibilities the very first time they come into contact with the design?
2. **Efficiency:** How quickly are users able to complete activities when they have become familiar with the design?
3. **Memorability:** How easy is it for users to regain their previous level of skill after a period of time away from the design that they had been using?
4. **Errors:** How many mistakes do users make, how serious are these mistakes and how simple is it for users to get back on track after making mistakes?
5. **Satisfaction:** How easy and enjoyable is it to make use of the design?

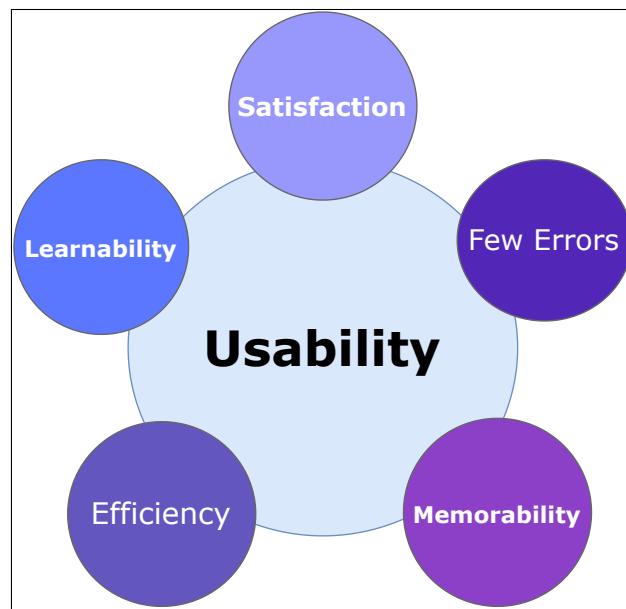


Figure 2.6: Usability Components

2.6.1 Importance of usability testing

Usability testing that is conducted in the appropriate manner, at the right time and with the right group of people may help decrease the likelihood of producing the incorrect product, which

in turn can save time, money, and other valuable resources. When usability testing is performed on a product that has reached its maturity level, it is helpful in understanding the success rate of users and the amount of time it takes for them to accomplish a job.

The purpose of usability testing is to determine how actual users interact with a product and make adjustments depending on the findings. It is essential to ensure that the product is simple to use and that activities can be accomplished without difficulty. The fundamental objective of a usability test is to collect the necessary information to discover usability flaws and enhance the product's design. Tests of usability are often carried out in the earlier phases of the design phase during the development cycle. When done in a timely manner, problem troubleshooting may begin sooner, which eventually results in a reduction in the cost to repair the issues. The longer the development team waits to conduct a usability test, the deeper the issue will get ingrained in the design, making it very challenging to eradicate the issue in the long term. In addition to this, the solutions to the difficulties could end up being fairly pricey.

It is essential to evaluate the user friendliness of a website for a number of different reasons. To get started, it involves the final consumers in the stage of the design process while the product is being created. The applications of the solutions that we are now developing are allowing us to see how successful they are in the real world. Second, those who have a stake in the product may see how it is being used. During the course of the testing, we are able to gain an understanding of both the positive and negative aspects of the program. We acquire insights on how the users operate our application, namely whether or not they operate it in the desired manner. When they use the program, do they find that it gives them a lot of trouble?

Another advantage of usability testing is that it offers the opportunity to improve the effectiveness of the product before it is introduced to the market. The project team is able to generate more innovative ideas for new solutions and enhancements to the existing system by soliciting honest feedback from users and recognizing the difficulties faced by those users [24]. Figure 2.7 reveals the importance of usability testing.

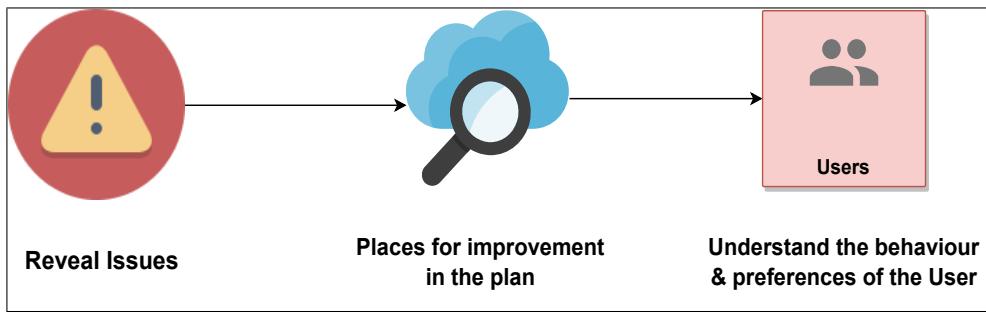


Figure 2.7: Importance of usability

2.6.2 Types of usability testing

There are two different types of usability testing. Usability testing can be either qualitative or quantitative.

Quantitative usability testing: The primary objective of quantitative usability testing is to collect measurements that provide a description of the user experience. A quantitative usability test is a method in which participants carry out critical actions within a system while specified metrics that reflect the user's experience and performance in those tasks are recorded. This data is then analyzed to determine how usable the system is. As a consequence of this, unambiguous measurements are generated, which can then be utilized for reporting on the functioning of the product.

Qualitative usability testing: Testing the qualitative usability of a product or service focuses on gathering insights and results about how people use the product or service in question. When it comes to locating issues with the user experience, qualitative usability testing is the most effective method. Depending on the kind of research being conducted, the minimum number of people that must take part in a qualitative usability test might vary.

In our study, we intend to carry out a **semi-structured interview** [25], which is often qualitative in nature. Semi-structured interviews are a data collection method that relies on asking questions to the participants of the study based on a predetermined framework. However, follow-up questions are also asked based on the responses, which makes semi-structured interviews a mix of structured and unstructured interviews. Interviews that are just semi-structured provide participants the opportunity to explore any pertinent thoughts that may come up over the course of the interview while yet allowing them to maintain their concentration on the topic of interest. Interviews that are

only partially organized are a popular way for collecting new data and analyzing the perspectives of participants on a certain topic.

The way of conducting an interview using a semi-structured format encourages interaction on both sides. Both the interviewer and the candidate have the opportunity to ask questions, which enables a comprehensive conversation on several significant topics to take place. Because the tone of the interview is more conversational, the applicant may feel more at ease talking about techniques and experiences that will highlight the attributes that make them a good match for the position because the tone of the interview is more casual. Even when utilizing a number of different interviewers, they are effective at producing reliable and comparable qualitative data from a wide range of participants. The in-depth nature of the dialogue that takes place during interviews might lead to the development of fresh points of view and insights into the topic at hand.

We also target to perform **cognitive walkthorugh** [26] which is a technique used to evaluate the learnability of a system from the perspective of a new user. The objective of a cognitive walkthrough, a task-based usability inspection technique, is to identify those elements of the interface that might be difficult for new users by having a cross-functional team of reviewers go through each step of a task flow and respond to a set of predetermined questions. To quickly and accurately determine why a design solution is or is not simple to learn for a new or infrequent user. Any level of the design process can benefit from using this technique to identify significant difficulties. When assignments are assigned to participants who are not already familiar with the interface, cognitive walkthroughs perform best. Someone who has a rough idea of how the application works are aware of what they are doing and how to prevent problems, often subconsciously. People who have a general understanding of how something works frequently miss problems.

The next chapter presents the research works so far related to our study. We have observed and summarized the studies regarding NFTs, it's ecosystem, marketplace volumes and some significant project outlines.

Chapter 3

Related Work

In this chapter, we discuss the research that have been conducted up to this point that are related to ours. These research are separated into three distinct categories by us: NFT marketplace and ecosystem, cognitive walkthroughs and semi-structured interviews.

3.1 NFT Related Work

A few existing research study the security issues of NFTs alongside with analyzing the barriers of them. For example, Sylve Chevet analyzed the whole creation process of “Rare Pepes” [27], one of the first crypto assets to gain significant attention. In his study, he gave a brief overview about “CryptoKitties”, a blockchain game on Ethereum that allows players to purchase, collect, breed and sell virtual cats. The author also explored some other NFT projects and described their usage in real-world applications. Some key points as barriers of NFTs from being widely adopted were summerized.

Dipanjan Das et al. presented the first systematic study of the NFT ecosystem on eight top NFT marketplaces [28]. They provided an overview of the economy that has developed around NFTs. They identified the actors and components in the ecosystem and illustrated them briefly. The authors also studied the scams, malpractices and fraudulent user behaviours.

Joshua A.T Fairfield studied about the legal issues of NFTs. The author provided a taxonomy of NFTs and their attributes that can serve as a guide on ownership restrictions. In author’s study, he found that the legal literature on NFTs is still in very early stages [29]. The author proposed a

stable legal framework for trading of NFTs.

Lennart Ante et al. investigated the relationship between sales of NFTs and prices of cryptocurrencies like Bitcoin and Ether. The authors examined a dataset of 1231 daily observations in NFT sales from January 2018 to April 2021 [30]. Their observation concluded that cryptocurrency markets affect the growth and development of NFT markets. The authors showed that NFT sales are increased with rising prices of bitcoin but rising prices of ether reduces the number of active NFT wallets.

In another study, the author observed the interactions and causal relationships between fourteen NFT projects. The author's analyses relied on a dataset of Ethereum based NFT markets between June 2017 and May 2021. The author focused on the number of NFT sales, the dollar volume of the sales and the number of unique blockchain wallets that traded NFTs. The author clearly illustrated the development of NFT markets on the Ethereum blockchain and suggested that still being at infancy, this market is growing rapidly.

Usman W. Chohan drew attention to the value and scarcity of digital assets with respect to blockchain technology. The author observed different NFT projects and prices and analyzed their value along with the uniqueness of people to pay for them [31].

Qin Wang et al. explored the NFT ecosystems from several aspects. The authors gave a brief explanation about the ecosystem of NFTs, their protocols, standards and properties. They also illustrated the workflow of NFT systems. They presented the “STRIDE” threat model for NFTs and proposed possible solutions for them [32]. But this model was based on the whole NFT ecosystem and not based on particular NFT marketplaces. The opportunities and challenges of NFTs were also examined.

Ferdinand Regner et al. demonstrated the usefulness of NFTs to tokenize digital goods. The authors implemented a blockchain based event ticketing system [33], Ethereum blockchain and NFTs being the core components of the prototype. They attempted to address the questions if NFTs can be used in real world applications and if they can improve existing systems.

Matthieu Nadini et al. analyzed data concerning 6.1 million trades of 4.7 million NFTs between June 23, 2017 and April 27, 2021 [34]. Data were gathered primarily from Ethereum and WAX blockchains. They presented the first overview of some key aspects of NFTs based on six NFT categories.

Daniel Weber discussed about specific characteristics, use cases and associated problems with NFTs. The author's study provided a base for potentials of NFTs and their problems. Although the author's study illustrated NFT sales in US from 2020-2022 [35], it did not analyze data from particular marketplaces. The sales statistics was presented as a whole.

3.2 Cognitive Walkthrough Related Work

Kamil Biernacki et al. focused on a comparative analysis of bitcoin portfolio management solutions. The goal of the study was to determine which tool offers users the best current solution [36]. They carried out a survey and a cognitive walkthrough approach with cryptocurrency users. Shayan Eskandari et al. undertook a thorough usability assessment of six representative Bitcoin clients and proposed an evaluation methodology for evaluating Bitcoin key management strategies [37]. Six Bitcoin clients were each subjected to a series of cognitive walkthroughs in order to assess their usability.

Md Moniruzzaman et al. aimed to identify the potential barriers and usability difficulties of five cryptocurrency management applications [38]. They looked into typical usability problems with desktop and mobile-based wallets using the analytical cognitive walkthrough usability inspection method.

Simin Ghesmati et al. provided a thorough usability analysis of Joinmarket, Wasabi, and Samourai, three popular Bitcoin wallets that incorporate the CoinJoin mechanism. In order to assess the usability and essential design principles of these wallets, a cognitive walkthrough was performed in their study [39].

Bagus Anugrah Ramadhan et al. attempted to assess how well users interact with the three websites where cryptocurrency is most commonly accessed from Indonesia. The study was done to determine the elements that affect user trust in an interface's design and can be used to new designs [40]. Based on user experience, the research's conclusion, suggestions and website design all stated that cryptocurrencies are reliable.

3.3 Semi structured interview Related Work

Tanusree Sharma et al. carried out an exploratory qualitative study that included a code review task and a semi-structured interview [41]. Their results demonstrated a wide range of security procedures and attitudes for smart contracts, as well as the varied tools and resources they employed.

Xianyi Gao et al. reported the findings from an interview study with users and non-users regarding how people evaluate Bitcoin, the most well-known digital currency. Their findings showed that non users believe they cannot use Bitcoin, that users are unaware of how the protocol works, that users have misconceptions about the anonymity of transactions and that participants believe Bitcoin fits the criteria for perfect payment systems [42]. Their findings highlighted the benefits, limitations and entry obstacles of bitcoin.

As we can see, the majority of studies calculate the statistical values of NFT sales over a period of time by combining the data from several different marketplaces. By utilizing a qualitative approach to usability testing, a semi-structured interview, our overarching goal is to gain a better understanding of the challenges associated with NFTs as well as their economic value. We have carried out a **semi-structured interview** with the people who do not use the NFT marketplaces and with those who are users of NFT marketplaces. During this interview, we hope to gain a better understanding of the usability concerns that are associated with NFT marketplaces. We also plan to conduct a **cognitive walkthrough** with first time users of a specific NFT market in order to discover the challenges that users encounter while using these marketplaces for the first time.

The next chapter provides an evaluation framework built upon five selected marketplaces. A comparative discussion between these five marketplaces has been formulated. Short descriptions of ten selected marketplaces have been presented as well alongside with explaining some basic features of NFT marketplaces.

Chapter 4

Evaluation of NFT Marketplaces

A digital marketplace for purchasing and selling NFTs is known as an NFT marketplace. An NFT marketplace is a virtual marketplace for buying and selling NFTs. Through the use of decentralized NFT markets, NFTs may be purchased, sold, or exchanged with other NFTs. The NFT marketplace offers a wide range of features and kinds, which sets it apart from e-commerce platforms. The ability to store, exchange and display NFTs or digital assets to a large audience is part of a distinctive business model that is emerging. Users may store, display, and sell their NFTs to other users on these sites in return for cryptocurrencies or cash. Users can mint their NFTs directly on various NFT marketplace websites.

Using the Ethereum blockchain as a public ledger, NFTs enable the assignment or claim of ownership of any specific piece of trackable digital data. An NFT is formed from digital objects as a representation of digital or non-digital assets. However, ERC-721, which serves as the issuing standard for NFT, is a token standard for Ethereum called ERC (Ethereum Request for Comments). One blockchain that can produce NFTs is Ethereum. The blockchain stores data like as the token ID, holder address, and token URI (Uniform Resource Identifier).

4.1 Working Procedure of NFT Marketplaces

NFT marketplaces serve as a place where people can mint, commerce, buy and demonstrate their resources. They act as a connection between those who create materials and those who purchase it. They are constructed on blockchains, like Solana and Ethereum, among others. The

websites OpenSea, Nifty Gateway, SuperRare, and Snowcrash are all examples of online markets. Ethereum is the backbone of the first three systems, while Snowcrash is supported by Solana. An NFT marketplace functions in a manner somewhat similar to that of a stock market, in which shares may be bought and sold. Because they are not fungible like digital currencies, non-fungible tokens (NFTs) cannot be traded on exchanges way digital currencies can.

A marketplace does not just involve trading and the creation of NFTs. The practice of purchasing and selling digital collectibles was the primary focus of the first online markets. The passage of time has resulted in the emergence of new marketplaces that come equipped with supplementary functions like the fractionalization of assets, tokenization and automated trading. A cryptocurrency wallet, cryptocurrencies themselves as a form of transaction and an account are the three elements that are required to enter a marketplace and make transactions using cryptocurrencies. Digital currencies are kept in cold storage within crypto wallets such as Trust wallet, Sollet, and MetaMask. It is necessary to choose a wallet that is both blockchain-compatible and supportive of the marketplace. The next step is to fill one's digital wallet with the native cryptocurrency of the chain that underpins the market place. When using OpenSea, which is powered by Ethereum, ether must be put to the wallet in an amount that is proportional to the item that is going to be purchased. For use in marketplaces like as Snowcrash, SOL tokens must be deposited into the user's wallet. SOL is the native cryptocurrency of Solana blockchain platform [43].

Following this step, an individual's user profile must be established within the marketplace. Even though the first part of the procedure is the same, different websites could demand different kinds of information from users. To make use of the market, it is important to provide all of the required information. With a funded wallet and a completed user account, collectibles can be purchased conveniently by placing bids [44].

4.2 The Features of NFT Marketplaces

An NFT marketplace is a blockchain based digital marketplace to buy and sell NFTs. An NFT marketplace should have different features so that users can enjoy their visits in the marketplace. These features include :

- An attractive and intuitive storefront for NFT Marketplaces. Storefront will contain information as previews, price history, bids and owner's information etc.

- Separate seller and buyer accounts inside.
- Users can create and sell collectibles.
- NFT Marketplace platforms give the opportunity to bid on listed NFTs.
- NFT marketplace platforms will provide the opportunities to search items or tokens.
- Ratings will help beginners to understand the real worth of collections.

Figure 4.1 shows these features. NFTs need a place to be bought and sold, just like any other commodity. The front-end environment for presenting the files should be user-friendly in NFT marketplaces. Additionally, they need a solid back-end that supports the underlying blockchain technology. There are a lot of excellent NFT platforms to pick from and they all have slightly different features and pricing structures.



Figure 4.1: NFT Marketplace Features

4.3 NFT Marketplaces

There are several NFT marketplaces, each of which operates on its own unique blockchain. These online marketplaces bring in a daily revenue of one million dollars. People go to these marketplaces on a daily basis in order to purchase, sell, and trade NFT. Some of these marketplaces stand out from the rest due to their greater popularity. These are the locations that see the most foot traffic compared to the others. The following is a condensed explanation of several alternative trading system marketplaces:

4.3.1 OpenSea

When it comes to NFT sales, OpenSea [45] is in a league all its own. OpenSea is a digital asset exchange where users can register for free and then search through a wide variety of digital assets. It's user-friendly and helpful for creators, so anyone can make their own NFTs, and it encourages the creative community (known as "minting"). With over 150 distinct tokens accepted for purchases, the site lives up to its name. OpenSea serves as an excellent stepping stone into the NFT ecosystem. Figure 4.2 shows the user interface of OpenSea.

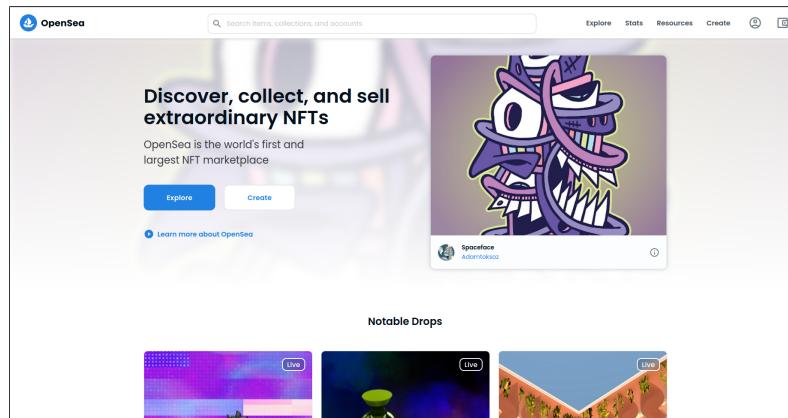


Figure 4.2: User Interface of OpenSea

4.3.2 Axie Marketplace

Axie Marketplace [46] is the online store for the video game Axie Infinity. Axies are mythical animals that can be purchased, trained, and competed against by other Axies for prizes. On the Axie Marketplace, players can purchase brand-new Axies, full lands, and other non-game-related items for use within the game. Axie Infinity coins, also known as Axie Shards, are supported on the Ethereum network. Consequently, they are available for buy and sell on various NFT markets and a few cryptocurrency exchanges, such as Coinbase Global (NASDAQ:COIN). Figure 7.1 shows the user interface of Axie Infinity.

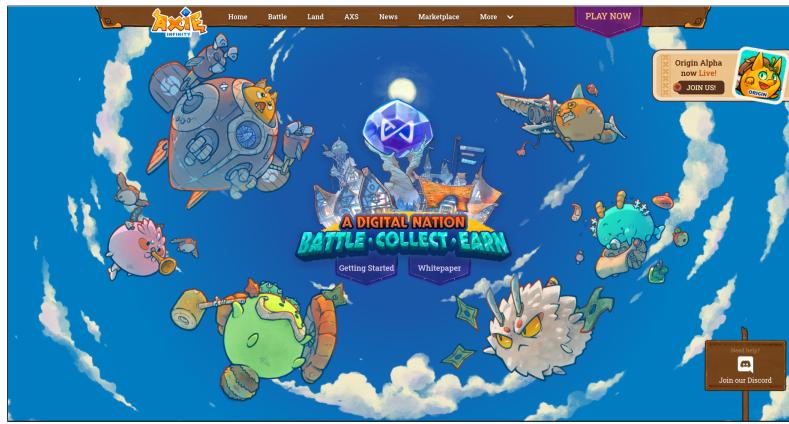


Figure 4.3: User Interface of Axie Infinity

4.3.3 Cryptopunks Larva Labs

Larva Labs [47] rose to prominence thanks to the popular CryptoPunks NFT project. Even though they were initially distributed for free in 2017, some CryptoPunks have now sold for millions of dollars. Larva Labs' other digital art endeavors include Autoglyphs and Meebits. Although Larva Labs' CryptoPunks NFTs are sold out, they can still be bid on and acquired through a number of external marketplaces. However, Larva Labs' several initiatives are worth following, including the Meebits, which may be directly bid on via the firm's integrated marketplace. Figure 4.4 shows the user interface of CryptoPunks - Larva Labs.

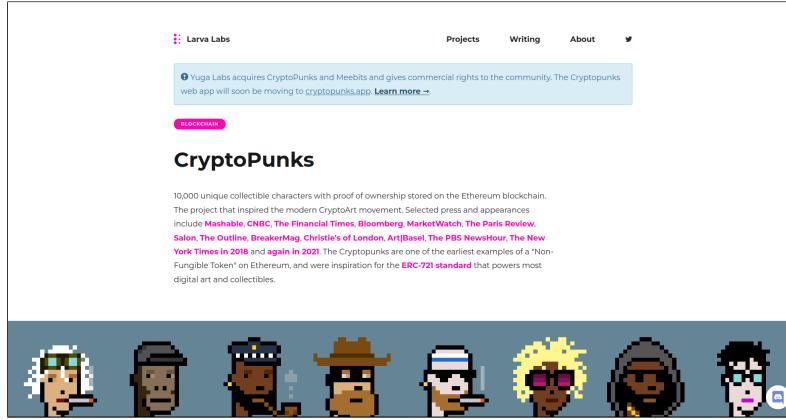


Figure 4.4: User Interface of CryptoPunks - Larva Labs

4.3.4 NBA Top Shot

NBA Top Shot [48] is the National Basketball Association's (NBA) and Women's National Basketball Association's (WNBA) excursion into the world of non-contact basketball (NFT). Collectible moments (video clips and play highlights) and artwork from the greatest basketball leagues in the globe can be purchased. On the Top Shot marketplace website, it is straightforward to register and make purchases. Figure 4.5 shows the user interface of NBA Top Shot.

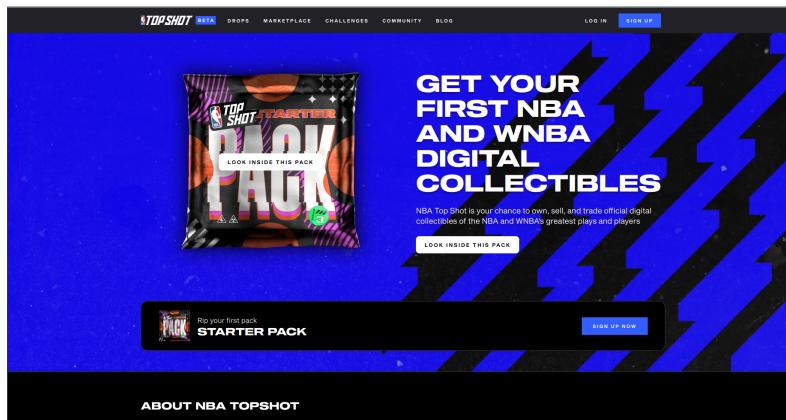


Figure 4.5: User Interface of NBA Top Shot

4.3.5 Rarible

Rarible [49], like OpenSea, is a big marketplace for all types of NFTs. On the site, you can buy, sell, or create many types of art, movies, collectibles, and music. However, unlike OpenSea, it will require its own token Rarible (CRYPTO:RARI) to purchase and sell on the marketplace. The Ethereum blockchain serves as the foundation for Rarible (although artwork can be managed on OpenSea as well using Rarible tokens). The company has formed alliances with a number of well-known corporations. YuM! Brands' (NYSE:YUM) Taco Bell has listed art on Rarible, and Adobe (NASDAQ:ADBE) has just joined with Rarible to help secure the work of NFT artists and producers. Figure 4.6 shows the user interface of Rarible.

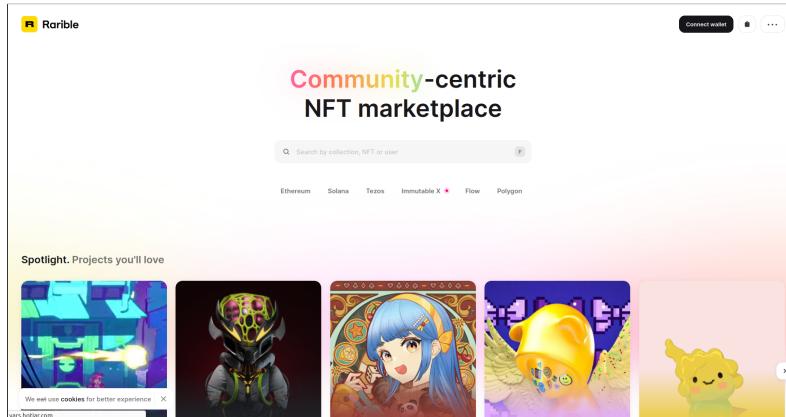


Figure 4.6: User Interface of Rarible

4.3.6 SuperRare

In a manner analogous to that of Rarible, SuperRare [50] is establishing itself as a marketplace for digital producers. The website not only offers artwork, movies, and 3D graphics for sale, but also accepts Ethereum as a payment option, which is convenient for art collectors. Recently, the cryptocurrency platform SuperRare, which is built on Ethereum, announced the launch of its own coin with the same name. Tokens will be utilized in the search for and selection of newly emerging talent for the market. On OpenSea, SuperRare NFTs behave exactly the same as Rarible NFTs in that they can be bought and sold. Figure 4.7 shows the user interface of SuperRare.

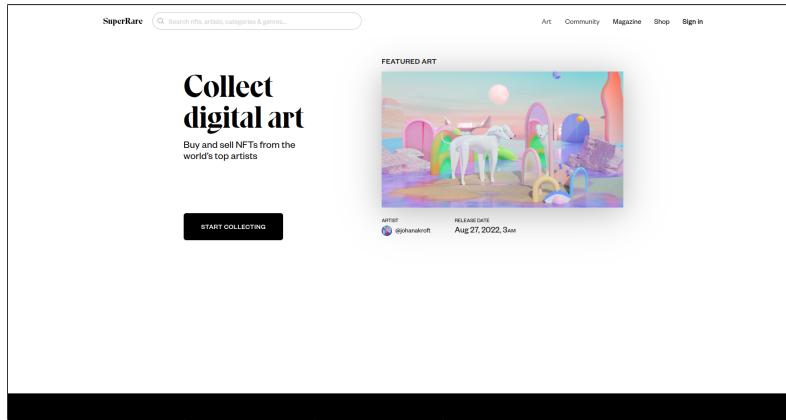


Figure 4.7: User Interface of SuperRare

4.3.7 Foundation

Foundation.app [51] was designed to be an easy-to-use and uncomplicated platform for placing bids on digital artwork. Transactions are conducted using Ethereum. Since the marketplace's launch at the beginning of 2021, it has generated more than \$100 million in revenue from the sale of NFTs. Customers can begin making purchases with nothing more than an Ethereum-funded cryptocurrency wallet if they are invited to join the platform by the Foundation community, which issues invites to artists interested in participating. Although Foundation is not the best place to begin when searching for a quick and easy approach to begin generating one's own NFTs, the market does provide a large number of artworks that can be viewed in an uncomplicated manner and offers a lot of options to choose from. Figure 4.8 shows the user interface of Foundation.

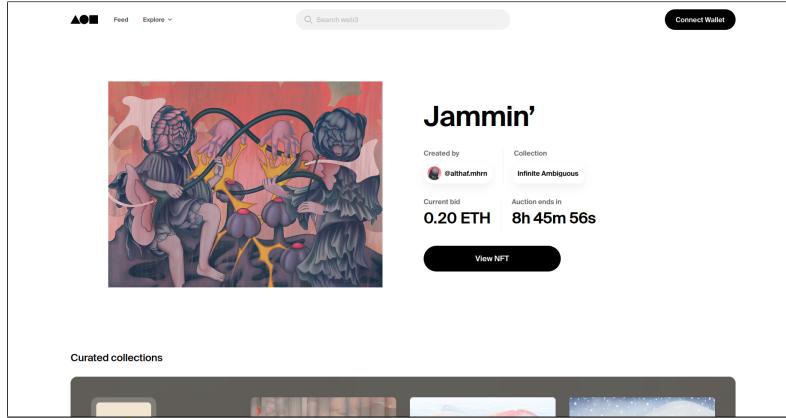


Figure 4.8: User Interface of Foundation

4.3.8 Nifty Gateway

Because of Nifty Gateway [52], some of the most well-known digital artists are now up for sale, like Beeple and Grimes, who is both a singer and songwriter. It is an online gallery that is curated by art and is managed by the Gemini cryptocurrency exchange (controlled by the Winklevoss twins). NFTs, which are also known as Nifties, are digital assets that are founded on Ethereum. Figure 4.9 shows the user interface of Nifty Gateway.

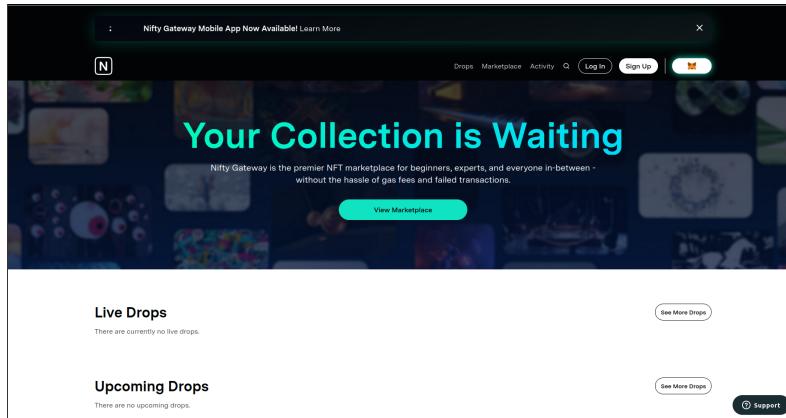


Figure 4.9: User Interface of Nifty Gateway

4.3.9 Mintable

An open marketplace that aspires to be like OpenSea and is backed by the billionaire Mark Cuban is going by the name Mintable [53]. Ethereum will be required in order for users to purchase and trade non-fungible tokens (NFTs) on Mintable. Minting of NFTs is also supported on the platform for creators of all stripes (from photographers to musicians) who wish to monetize their work by selling it as a digital asset. An ambitious NFT collector or creator must first buy Ethereum from a cryptocurrency exchange. Next, they must link their wallet to Mintable in order to make bidding and buying possible on the marketplace. Figure 4.10 shows the user interface of Mintable.

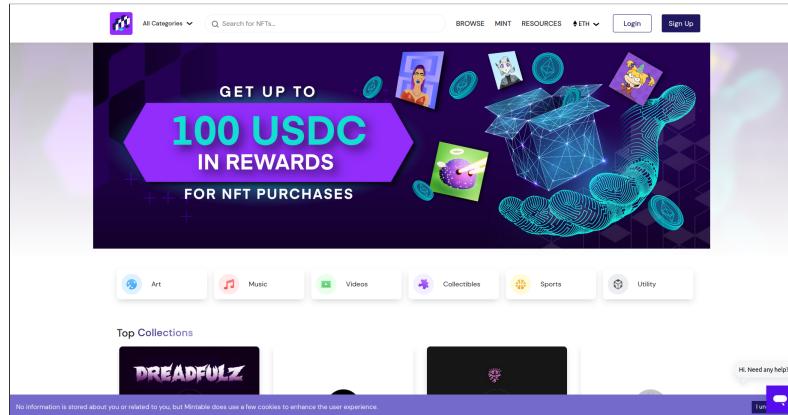


Figure 4.10: User Interface of Mintable

4.3.10 Theta Drop

Theta [54] is a blockchain-based platform that was developed with the goal of decentralizing the online video and television distribution industry. In 2021, the NFT marketplace known as Theta Drop made its debut with support for the digital collectibles associated with the World Poker Tour. The World Poker Tour was one of the first companies to utilize ThetaTV and currently streams material using the service. Theta has developed its own blockchain technology and utilizes it. The purchase of Theta Tokens (CRYPTO:THETA) is obligatory for anyone who wishes to take part in the Theta Drop NFT marketplace. Figure 4.11 shows the user interface of Theta Drop.

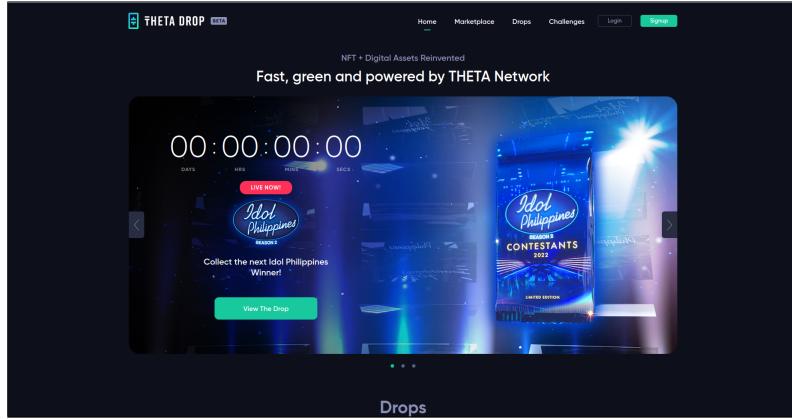


Figure 4.11: User Interface of ThetaDrop

4.4 Marketplace Selection

We selected the marketplaces focusing on the primary category of supporting different blockchains and discovered their features. Two separate markets shared the same blockchain network. They were chosen despite this, however, due to the fact that the differences between these two markets were readily apparent. The selected marketplaces are:

1. Opensea
2. NBA Topshot
3. Rarible
4. Mintable
5. ThetaDrop

4.5 Evaluation Framework

In this section, we compare our selected five marketplaces based on some common features offered by them. We have developed an evaluation framework based on eight criteria and discussed

Blockchain	Example	Wallets >= 5	Credit card	Fee >= 5%	Royalties >= 5%	Mobile app	Documentation	Live Online
Ethereum	Opensea	•	•	○	•	•	•	○
Polygon	Rarible	•	•	•	•	○	•	•
Ethereum	Mintable	○	•	•	○	○	•	○
Theta	Theta Drop	•	•	•	N/A	○	•	○
Flow	NBA TopShot	○	•	•	•	○	•	•

• means yes , ○ means no in the table.

Table 4.1: A comparison between selected five marketplaces

each of them in the following subsections. This framework summarizes our selected marketplaces through eight different characteristics they offer to their users. Table 4.1 shows a comparison between selected five marketplaces with respect to different features.

Supported Blockchains: Many of these marketplaces were designed to support multiple blockchains so as to offer their users more flexibility while trading or minting NFTs. But some of these exist to support a single blockchain. Opensea, which can be considered as a pioneer in NFT marketplaces, supports multiple blockchains, the supported blockchains being Ethereum, Polygon, Klatyn and Solana. After Opensea, there comes Rarible offering to support multiple blockchains, which include Ethereum, Polygon, Flow and Tezos. The remaining three from our selection support a single blockchain. Mintable supports only Ethereum, ThetaDrop supports its own blockchain Theta and NBA Topshot supports only a blockchain named Flow.

Supported Wallets: A significant difference can be observed in the number of supported wallets by these marketplaces. While Opensea supports 16 wallets, Mintable supports only 3. Rainbow, Trust and Metamask are the wallets that Minatable supports. Considering this feature, Rarible and ThetaDrop comes in between where the number of supported wallets by Rarible is 7 and this number is 5 for ThetaDrop. It has also been observed that a marketplace is supporting only one wallet which is the case for NBA Topshot. NBA Topshot supports only one wallet named

Dapper while debit cards can also be used here.

Supported Cryptocurrencies: Thousands of cryptocurrencies now being available, each of our five marketplaces support multiple currencies. ETH is supported by three of them. Opensea supports SOL, USDC and DAI, Mintable supports credit card, Rarible supports visa card, all these alongside with ETH. ThetaDrop keeps up with both visa card and credit card along with their own currency named ThetaFuel. Although NBA Topshot currently holds up only with credit card, available resources say that they will implement Flow Token in later times. Table 4.2 shows a comparison between these marketplaces for their supported cryptocurrencies.

Marketplace	ETH	SOL	DAI	USDC	ThetaFuel
Opensea	•	•	•	•	○
Polygon	•	•	○	•	○
Mintable	•	•	○	•	○
Theta Drop	○	○	○	○	•
NBA TopShot	•	○	•	•	○

• means yes , ○ means no in the table.

Table 4.2: A comparison of supported cryptocurrencies between selected five marketplaces

Transaction Fee: Transaction fee is a major concern in NFT marketplaces. Due to the complexity of the transaction and increased network traffic, NFT transaction fees are typically expensive. Transaction fees do not have any fixed value. They may fluctuate with different marketplaces. From our selection, Mintable and ThetaDrop applies the highest of fees. Mintable applies 10% transaction fee on printable NFTs and a 2.5% for traditional NFTs. This amount for ThetaDrop is also 10%. OpenSea puts in lesser fees which is 2.5%. Rarible divides their 5% into half, 2.5% on the buyer side and 2.5% on the seller side. NBA Topshot presses 5% fee for any transaction taking place.

NFT Categories: NFTs can be of different types. Some can be named as generative art, photography NFTs, sports card, collectibles, PFP, Domain, Gamified NFTs. Different collection of nfts are available in different marketplaces. As we can see that, different types of NFTs like Art, Collectibles, Domain names, Music, Photography, Sports, Trading cards, Utility, Virtual worlds can be found in Opensea. In Rarible, NFTs like PFP, Art, Metaverse, Domains, Photography, Music, Games, Sports, NSFW, Earning are available. Art, Music, Videos, Collectibles, Sports, Utility NFTs can be found in Mintable. Only sports related NFTs can be found in NBA TopShot marketplace. NFTs like Gaming assets, Art, Collectibles, Sports can be found in ThetaDrop.

Royalties: Royalties from NFTs give the original owner a percentage of the sale price each time the NFT creation is sold on a marketplace. The average NFT royalty typically ranges from 5-10%. Royalties take the form of agreements or licenses that lay out the terms by which a third party can use assets that belong to someone else. Intellectual property comes in the form of copyrights, patents or trademarks. Royalties can be earned on books, music, minerals, franchises, and many other assets. In Opensea and Mintable, the royalties are 0-10% and 2.5% respectively. In Rarible, the royalty can go up to 50%.

Mobile Application: Mobile application is the easiest way to keep track of NFT collection and discover new assets from the world's digital marketplace for crypto collectibles and non-fungible tokens (NFTs). Mobile application is used to keep track of NFTs from phone. From our selected marketplaces, only Opensea has a mobile application and no other marketplaces have implemented mobile application yet.

Training Support: All the marketplaces like Opensea, Rarible, Mintable, NBA TopShot marketplace use documentation as training support. Only Rarible and NBA TopShot use online live as training support.

4.6 Discussion

The purpose of this investigation is to evaluate and contrast five distinct NFT marketplaces with respect to a variety of parameters. As we can see, several NFT markets provide a variety of different advantages to entice people to sign up for their services. The ability to handle several blockchains is a feature that can only be found in Rarible. These marketplaces support different wallets. 16 wallets are supported by Opensea. Additionally, Rarible and Theta Drop keeps up with five wallets. However, Mintable and NBA TopShot only holds up to a maximum of five wallets. So Opensea is actually most user-friendly as this accepts most wallets. So, users with different wallets can access the marketplace and buy nfts without any additional hazards.

All the selected marketplaces accept credit card. So people can buy and sell NFTs easily. Transaction fees also differ in these marketplaces. Transaction computation uses energy, much like all computing systems. Transaction fees are assessed each time a transaction is requested in order to enable miners be paid for the labor they are performing. This holds true for straightforward cryptocurrency transactions that carry out smart contracts, as well as for creating or selling NFTs. In Opensea, the transaction fee is 2.5 percent. All other chosen marketplaces have higher prices than Opensea. In Rarible, 2.5% goes to the buyer and 2.5% goes to the seller. The fee in Mintable is 2.5% for conventional NFTs and 10% for printable NFTs. For Theta Drop and NBA TopShot, the costs are 10% and 5%, respectively. Different marketplaces also support different cryptocurrency. Opensea supports the most cryptocurrency. Rarible, Mintable, NBA TopShot support 3 cryptocurrency according to our comparison table. Theta Drop only support theta fuel. There is support for a single blockchain across OpenSea, Mintable, ThetaDrop, and NBA TopShot. Only cryptocurrencies are supported for use in the OpenSea payment system. Each of these companies, Rarible, Mintable, ThetaDrop, and NBA TopShot, maintains a relationship with either a credit card or a visa card. The transaction cost charged by Mintable and ThetaDrop is the highest, while OpenSea's is the lowest. Up to fifty percent of potential royalties can be monetized using Rare's platform. There was absolutely no information that could be located on the royalties in ThetaDrop. Royalty fees can be as high as ten percent on OpenSea, whereas they are only two and a half percent on Mintable and five percent on NBA TopShot. Although mobile applications make it incredibly simple to communicate and interact with any application, OpenSea is the only company that has really created its own mobile application. Other than these five carefully chosen markets,

none of the others have yet created their mobile applications. NFTs have not yet arrived at a point where they have gained widespread awareness as of the present day. Because it is still a somewhat complicated technology for consumers, it is essential for these marketplaces to make available helpful information for the convenience of their customer base. The creation of documentation is the most important step to take in order to simplify the usage of these marketplaces. Documentation is offered by all five markets, but in addition to this, Rarible and NBA TopShot both organize live online sessions just for their customers.

The following chapter details a semi-structured interview process with participants who have no experiences of NFT transactions. We consider their perspectives on these markets and their views for not starting trading NFTs. We discuss each participant's responses collectively.

Chapter 5

Semi-structured Interview with Non Users of NFTs

In this chapter, we present our semi-structured interviews with such participants who are not users of NFT marketplaces but familiar with the concept of NFTs and cryptocurrencies. We describe our interview procedure, recruitment process, the demographics of our participants. We observe the acquired responses of the participants and summarize the findings. We also present a discussion of the results with graphical approaches.

5.1 Purpose

The objective of this **Semi-structured Interview** is to understand the perspective of non-users towards NFT marketplaces and cryptocurrencies. So far, we have conducted a semi-structured interview with non users of Non-Fungible Tokens marketplaces. The goal of this interview with non users of NFT marketplaces is to know why they did not buy or sell any NFTs in these marketplaces and what their opinion is towards cryptocurrencies. This includes what they fear about these marketplaces, what the security issues are, what regulations are needed in using cryptocurrencies. So, the purpose of this interview with non users is to know the reasons why they are not interested enough to use cryptocurrencies in the NFT marketplaces.

5.2 Methodology

In this section, we discuss the process that we used to recruit participants and their demographics, as well as our interview process and a summary of the interview questions that we asked.

5.2.1 Participants

We recruited 12 participants aged from 22 to 25 years old, of which everyone was a non user for an NFT marketplace. All participants were undergraduate university students in Bangladesh. The recruitment focused on having knowledge about cryptocurrencies and NFTs but experience of transactions in NFT marketplaces was not expected from any of the 12 users.

We refer our recruited 12 non user participants as NU1 to NU12. Among 12 participants 10 were male and 2 were female. The educational background for each of them are undergraduate students.

5.2.2 Interview Procedure

We conducted semi-structured interviews in person during September 2022. Each interview lasted for 15-25 minutes. The questions for the interview were previously written in a script. We also asked follow-up questions to the participants to clarify their responses. Audio recordings of the participants were taken, later they were converted to text.

We took a pilot study at first during August 2022. One participant was chosen for the pilot study and it took time of about 21 minutes.

5.2.3 Interview Coding

The two writers of this study coded the interviews. We began by constructing labels from interview responses using in-vivo coding [55], and numerous themes emerged based on participants' viewpoints on each issue. We then used axial coding [56] to further categorize the data and uncovered new concepts and themes. To assure the consistency of our outcomes, coding was verified and re-coded several times for distinct themes. We will provide representative quotes from participants as we discuss the themes in the findings section.

5.2.4 Interview Questionnaire

We posed several pre-planned queries to our audience. They were asked some follow-up questions to further explain their viewpoints based on their responses. Following a few important NFT related essential themes, we created the questionnaire. First, we were interested in learning how much familiarity the participants had with the fundamentals of NFTs and cryptocurrencies. They also talked about their NFT transaction experience. We were interested in learning how they felt about NFT marketplaces and the NFT industry as a whole. Their worries about the potential effects on security and privacy were taken into consideration followed up by some miscellaneous questions at hand.

5.3 Findings

Our findings from the semi-structured interviews that we conducted with the 12 people who took part in this study are presented in this section. We questioned our participants about their prior experience with cryptocurrencies and NFTs, as well as their visits to existing NFT marketplaces and transactions involving NFTs. In addition, we inquired as to whether or not they were aware of the safety concerns as well as the legislation that pertain to the NFT marketplaces.

5.3.1 Cryptocurrency Background

We asked all of our participants if they were familiar with the concept of a cryptocurrency and NFT. We asked them about their experience with cryptocurrencies and if anyone has used them, what is the time period of their usage.

Nine non-user participants stated cryptocurrencies as digital currency. Only one of them described in detail of transaction mentioning the concept of private key: “*Only a person with a private key can make a transaction.*” The remaining three participants responded that they know the fundamental concept and that it works on blockchain technology. Two of our twelve participants have experience with cryptocurrencies. NU7 stated that he has experience with crypto investment on CoinMarketCap. NU9 has experience with Bitcoin. He only used it once and the purpose was to purchase an IP address: “*I used bitcoin 2 years ago to purchase an IP address.*”

5.3.2 NFT Background

All twelve of our participants described NFTs in their own words. One of them described NFTs as a digital signature for a particular asset. NU1 stated, “*NFT is a digital signature for that art. As it is public, everyone can see that this art only belongs to me. No one can appeal that the art belongs to him as that art is digitally signed by me.*” Our two participant stated that he knows only the fundamental concepts of NFTs. The response from the remaining nine participants were similar to some degrees. Each of them described NFTs as a unique token or a cryptographic token to ensure digital ownership. For example, NU6 said, “*It is a cryptographic identity code of digital or physical assets using blockchain technology. Using NFTs, we can identify anything uniquely.*” Similarly, NU7 reported, “*NFTs are unique cryptographic tokens that exist on a blockchain and cannot be replicated unlike cryptocurrencies. NFT is a solution of some real life problems like ownership management, asset liquidity.*” NU9 responded, “*It is a unique token on a blockchain network that is associated with a particular asset.*”, correspondingly.

5.3.3 Visits in NFT Marketplaces

We asked our participants if they have ever visited any NFT marketplaces. Eight of them visited the marketplaces out of curiosity. They wanted to explore these places due to the recent hype of NFTs. One participant visited for research purposes. Majority of them visited OpenSea.io, only one of them visited both OpenSea.io and CryptoKitties. Three of them visited being interested after watching a video or reading a news article related to NFT. For example, NU5 said, “*I remember one youtube channel Corridor crew bringing a guest Beeple(a digital artist) and they talked about NFTs and the Beeple talked about his whole collection of NFT selling. That got me interested in NFTs and the NFT marketplaces.*” Similarly, NU7 said, “*I have seen a news article on facebook where a picture of a cat is sold for 1 million dollars. Then I visited this market place and tried to know how it works.*” Likewise, NU8 said “*I have visited NFT websites. I was mainly influenced by reddit posts.*” Three of the twelve participants never visited any of the marketplaces. They stated that they never felt the necessity or curiosity to visit any.

5.3.4 Trading of NFTs

Diverse opinions were formed when we asked our participants about the reasons that are holding them back from trading NFTs. But two key reasons were found during our interview. One being legal issues and fear of losing money being another one. High gas prices were also reported. Three of our participants expressed that they did not start trading NFTs because of high gas prices. We asked one of them if the gas prices were reduced, will he be interested in trading NFTs or not. His answer was in affirmative, revealing that he would be interested if gas prices were reduced. The root reason we found was the legal barriers. Five participants asserted that as NFTs and cryptocurrencies are illegal in their countries, this demotivated them the most. They do not feel secure about trades of NFTs as it is illegal and no smooth exchange system exists. One of them said that he is interested in trading but legal issues are the only reasons that demotivated him: “*In my country NFT trading is illegal so I could not trade NFTs. But I am willing to invest in NFTs. So legality issues are the main barriers in my case which demotivated me.*” Our five participants felt insecure to invest on NFTs, the security issues of NFTs made them unenthusiastic. Only one of the participants did not find NFTs to be worthy of millions. NU1 stated that although him being the owner, anyone can make a copy of his asset and use it in real life. So it does not make sense to him to spend so much on such artworks: “*Any person can make a copy of my asset and use it in their life though it is secure in the digital NFT world and there I am the owner of that asset but for me it does not make any sense. Why should I spend so much for any asset that anyone can use in their real world?*” Another one of our participants said that NFTs were not required for his daily life transactions but if needed he is willing to adapt the technology: “*Because, in general, financial transactions of my daily life do not require it. There is no demotivation. If I needed NFTs for any of my purposes, I would use it. Let us say I am open to using and adapting to NFTs in daily life.*”

5.3.5 NFT as Investment

Only two of our participants do not consider NFTs as an investment. They do not find it reasonable to invest millions of money on something that has no physical existence. NU1 reported: “*No, I do not consider NFT as an investment. Because it is not feasible in real life. I would not spend my money on something which has no physical existence.*” Similarly, NU5 answered: “*No. Main reason for not considering investing in NFT is I think the craze and others things make it*

more overrated thing. And my fear is when the craze is gone the value of NFT will also be gone.” NU11 thinks it would be wise to wait until the marketplaces get stable: “*It could be a good idea to consider NFT as an investment, but I think waiting for the market condition to be stable can be a good idea.*” Others think that NFT is a good investment. Profits can be gained through buying and selling of NFTs. As a follow up question, we asked one of them that if he has any assumption of prices of NFTs going down. In his response, he said that as the technology is quite new and there have been too much hype about it, situation of prices going down will not arrive: “*I do not think that this kind of situation will arrive. Because it is quite new technology and the hype is just rising.*” But one participant thinks that prices may go down any time: “*But if prices go down in future, there clearly remains a risk of losing money.*” To achieve preferable facts, we asked one participant if they should invest in NFTs when they do not have enough knowledge about the whole system. NU9 does not find it mandatory to understand the whole system for just buying or selling NFTs: “*I do not think that for investing in NFTs, the knowledge for the whole system is required. If I just want to buy/sell NFTs, I only need to know the process of exchanging the monetary value. I do not need to know how that NFT has been created or uploaded in the marketplace.*” Only one of our participants, NU8, mentioned minting of NFTs as a good investment as well: “*I also consider investing in NFT mint is also profitable.*”

5.3.6 Security and Privacy

Ten participants expressed their concerns about the security of NFT marketplaces. Two participants mentioned NFT marketplaces as centralized ones and they were fearful that their account might get hacked. NU1 said, there are chances of losing the private key: “*NFT is a centralized marketplace, so there is a chance of hacking the private key from the centralized authority and using our NFT tokens as theirs.*” He also revealed his anxiety about malicious smart contracts being uploaded in the marketplaces: “*NFT is based on blockchain so there is a use of smart contracts. So malicious smart contracts can be installed in the NFT marketplace networks and our token can be exploited.*” In a similar way, NU7 stated: “*Some market places are centralized, so any account can be hacked.*” Almost everybody brought up the point of fake marketplaces and fake uploads. They also mentioned the threats of fraudulent activities. NU8 indicated the technology for minting NFTs as a newer technology and addressed this at an unstable

state: “*The underlying technology for minting NFTs are new, so it is in an unstable state, attacks can be possible there too.*” Alongside with discussing about the security threats, NU3, NU5 and NU6 mentioned the underlying technology for NFTs as a reliable one.

To look into more of the plot, we asked all of them if lack of security was the reason for them to not start any trading of NFTs. NU3, NU8, NU9 clearly stated that security issues were not the reason for them for not starting trading of NFTs. Others listed this as one of the many reasons for them.

To get a clear picture of their point of view about securing the marketplaces, we asked everybody what they think of possible security measures that can be taken. NU1 and NU7 denoted that marketplaces should be decentralized. For instance, NU1 said: “*For me, the NFT marketplace has to be decentralized.*” He also stated: “*It has to make sure that any chaincode uploaded in the network is not malicious. All malicious chaincode has to be removed before updating the network.*”

NU6 introduced the idea of cross site forgery attacks: “*I think we have to prevent cross site request forgery attacks to stop faking marketplaces.*” NU9 provided the idea of user authentication and private information: “*Digital assets’ secret pieces of information should be private by all means. Measures to preserve user authenticity and data rights should be implemented.*” NU3 and NU6 anticipated that proper monitoring of these marketplaces might solve the security threats, with NU3 saying: “*But people need to be careful about these fake marketplaces. The authorities should monitor these often.*” and NU6 saying: “*In my opinion, proper monitoring of the marketplace should be done.*” No clear responses were formed from NU11 and NU12 on the security aspect.

5.3.7 Introducing Enthusiasm in NFTs

Diversified opinions were formed when we asked about the required initiatives that can make them interested in trading NFTs. NU1 added: “*To make me feel interested, first of all, the security issues have to be solved. Again all the marketplaces have to be combined. The value of NFT has to be stable because I do not want to lose my money.*” NU2 asserted reduced gas prices and registration fees as an effective measure, saying; “*As for me the marketplace should be a place for anyone to buy or sell their preferred NFTs. For that to do so the gas price as well as the registration fee should be lessened for the mass people.*” NU3 and NU5 responded that more knowledge and available resources about NFTs will draw more of their attention. We then asked NU5 whether the transaction process was complex for him. His answer was in affirmative, acknowledging: “*Yes, the*

transaction process seems to be complex to me. I think I need to learn more about this technology and these marketplaces should provide enough resources for users to clear these confusion." NU3 also added that if NFTs were legal in her country, this would make her feel interested: "*I might be interested in trading in marketplaces in the future once it will be legal and popular in my country.*"

The response from NU9 was similar to NU3 to some degrees. His response was: "*Creation of a secure exchange system for local fiat currency with cryptocurrency like bitcoin, ethereum. This could encourage me.*" From NU4, NU6, NU7, NU10 and NU11, general opinions were developed like proper valuation of items, exciting deals on marketplaces and achieving authenticity. From NU8, it was evident that improvement in the whole system would make him feel interested, stating: "*As NFT and blockchain both are in a premature phase, more market influence is needed. More clear view on the profit system of NFT is also required. Faster transaction and trading is also a requirement.*"

5.3.8 Regulations

We were focused to know the thoughts of our participants whether regulations should be applied in NFTs. Four participants, NU4, NU6, NU9 and NU12 do not think that regulations are required, with NU6 adding: "*No. Because it is a trustable technology which is verified by all peers. Anyone can see his history and verify it.*" In a similar way, NU9 said: "*Apparently, I cannot think of any regulations required if privacy and security concerns are well checked on trading NFTs.*" Although NU4 does not feel the necessity of implementing regulations, he also said: "*Right now I do not think any regulations are needed. But when the platform reaches enough popularity NFT theft should be dealt with extreme care.*" All the remaining participants supported the idea of putting some regulations on NFTs, with NU2 saying: "*Though everything is done in a decentralized matter, there should be regulations as well as an authority who will maintain them for the sake of security reasons.*" NU3 connected absence of regulations with low volume for NFT trades: "*Yes, I think regulations are required. As there is no regulations, people have doubts in their minds about whether to trade in NFTs or not.*" NU8 joined the idea of regulations with prices of NFTs, demonstrating: "*There should be proper regulations of minting nft. Rarity, utility and tangibility should be regulated because these influence the price of NFTs*"

5.4 Discussion

Through our semi-structured interview with NFT non user participants, we were able to grasp various views regarding NFTs. In this chapter, we discuss our major findings. We prepared our set of questions keeping NFT basics, NFT transactions, attitude towards NFT marketplaces and ecosystems, security and privacy in mind. As the answers came in, we figured out:

1. Most of the participants do not hold any extensive knowledge about NFTs. They are only familiar with some common terminologies.
2. Almost everybody felt secure about cryptocurrency and blockchain technology, but particularly NFTs could not succeed in doing so.
3. All ten participants expressed their fear for security and privacy of NFTs. None of them felt completely secure in NFTs.

Out of our twelve non user participants, two of them claimed to know the fundamental concepts of NFTs, not mentioning any terminologies. Two participants shared to have one time experience in cryptocurrency. Our remaining eight participants described NFTs as unique digital assets. Some of them mentioned NFTs unable of being copied.

Despite having heard names of some marketplaces, three participants never visited any. Nine participants visited Opensea, three of them visited because of some promotions on social media, one visited for research purpose and five of them visited out of curiosity due to the recent hypes. Only one among these nine visited Cryptokitties besides OpenSea. Figure 5.1 shows the number of the participants visiting marketplaces.

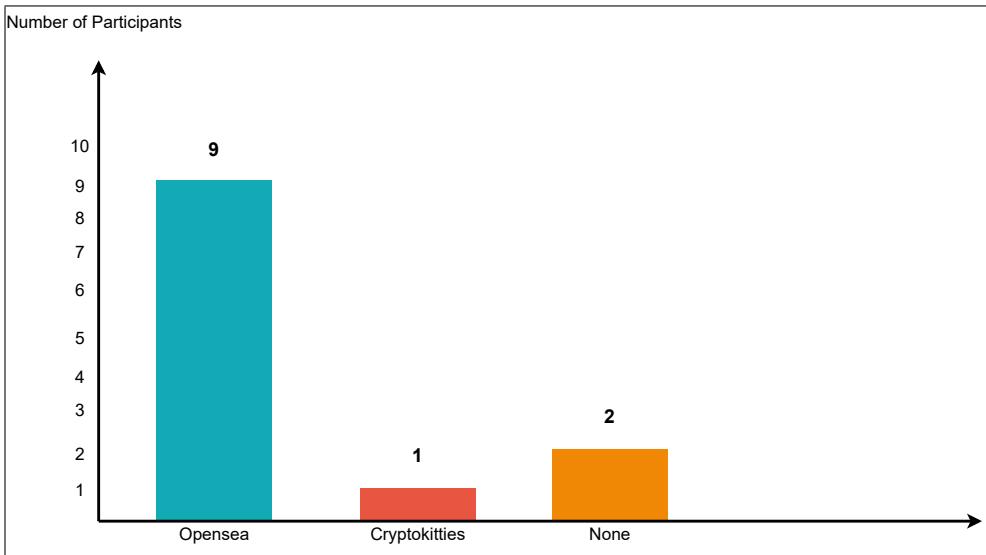


Figure 5.1: Participants visiting NFT marketplaces

None of our participants had any experience of NFT trades. One participant did not find NFTs worthy of recent buzz. He did not feel enthusiastic on something without any physical existence. One participant admitted that he wanted to start trading but high gas price was standing in his way. Six participants were afraid of trading because NFTs are illegal and no straightforward system exists for exchange of fiat money with cryptocurrencies in their region. One participant acknowledged NFTs not required for any kinds of daily financial transactions, although mentioning of not being demotivated. Three of them did not hear too much about NFT trading.

Even though the participants did not have any experience in NFT trading, we asked them if they consider NFTs as investments. Figure 5.2 shows the number of participants who think NFT as investment and who do not. Two of them do not consider NFTs as investments and the reason behind is similar. They think of NFTs as an overestimated technology. On the other hand, nine participants think of NFTs as good investments. As the technology is quite new, they are assured of the prices getting higher and putting money in it might be profitable.

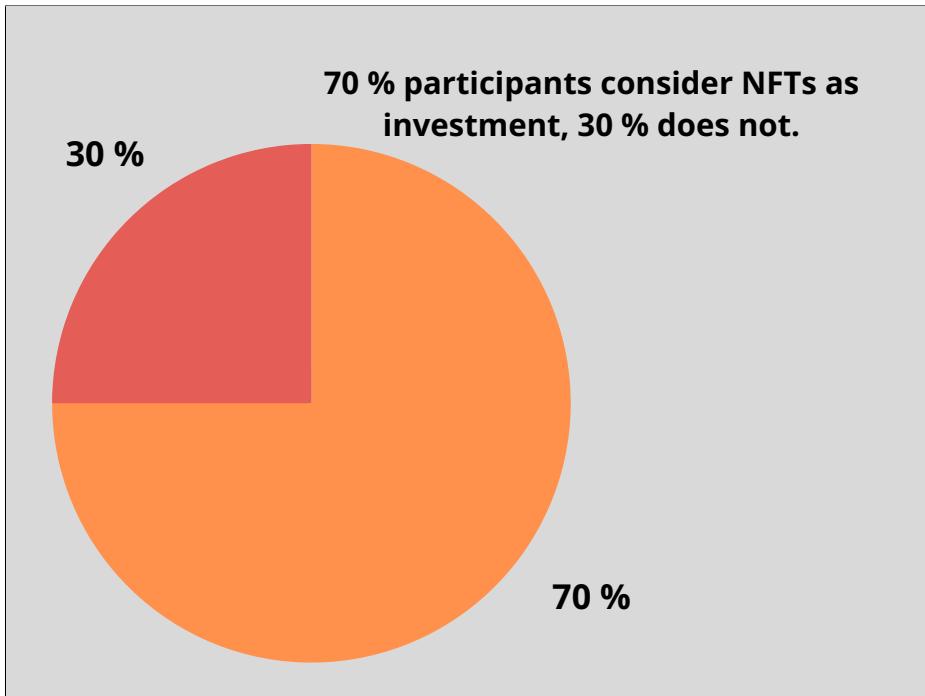


Figure 5.2: Participant views as investment

We inquired about the attendees' worries regarding NFTs' level of security. We also asked them for some recommendations that could help address these concerns. Two of the participants have admitted that the technology that is being used is reliable, nonetheless, they are not completely satisfied with the security measures. Nearly everyone expressed their unease regarding bogus markets and fraudulent uploads. Very few of them brought up the issue that NFTs are still in early phases and in unstable situations, which is something that needs to be emphasized. Two participants agreed on not having much knowledge about the security concerns.

When it came to offering alternative remedies to security problems, the viewpoints that were uncovered were not particularly diverse. Everyone took an important step toward preventing fake markets and fake uploads by taking preventative measures. In addition to this, the authentication of users and the decentralization of marketplaces were both implemented.

We did research to find out different strategies that might be utilized to pique the attention of our participants in the aforementioned marketplaces. There was consensus between two participants about the provision of a more transparent picture and an increased availability of resources. Two others place an emphasis on the elimination of legal obstacles and the construction of a seamless

exchange system between fiat currency and cryptocurrencies. A drop in the cost of gas fees was proposed by one of them. The participants who are still with us believe that if they are assured that they will not lose their money, then they will feel engaged.

There are four participants that do not believe that there is a requirement to impose restrictions on NFT platforms. The eight people who are still participating strongly desire for there to be some rules. In their view, rules are an absolute necessity in order to preserve the markets and find solutions to the existing security problems. Figure 5.3 shows the number of participants who think there should be regulations and who do not.

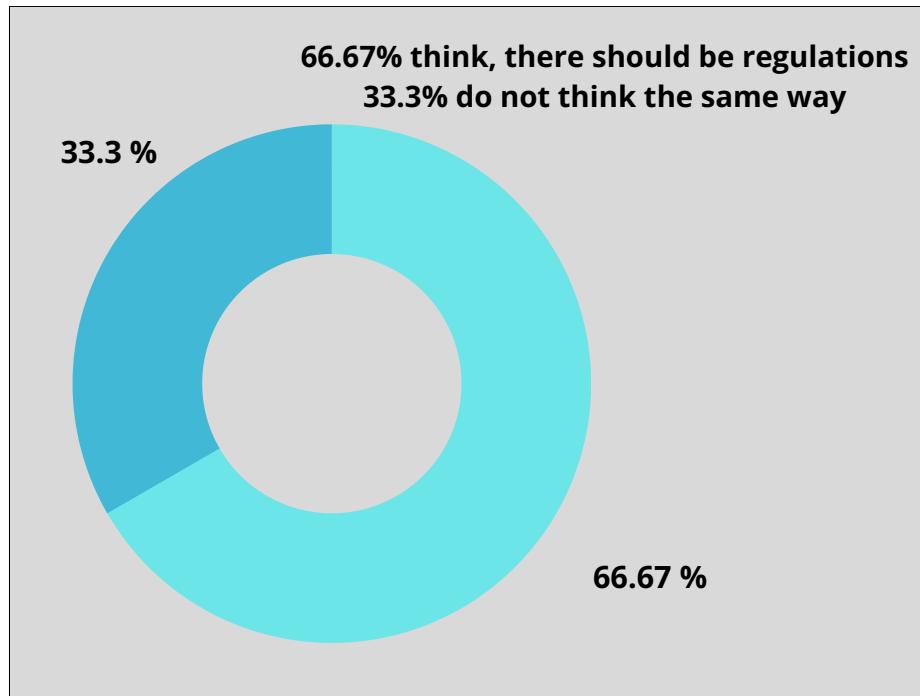


Figure 5.3: Participant beliefs on regulations

The next chapter represents another semi-structured interview procedure with such participants who have experience of NFT transactions. We take into account their viewpoints towards these marketplaces with some possible improvement suggestions. We discuss the answers of all the participants as a whole.

Chapter 6

Semi-structured Interview with NFT Users

In this chapter, we go over the interview process, the participant recruitment process and the participant demographics. The participant's acquired reactions are observed, and the results are summarized. Additionally, we provide a discussion of the findings using graphical methods.

6.1 Purpose

The goal of this **Semi-structured Interview** is to learn about users' attitudes towards NFT marketplaces and cryptocurrencies. In this section, we conducted a semi-structured interview with users of NFT marketplaces. The purpose of this interview with users of NFT marketplaces is to learn why they made NFT transactions in these marketplaces and what their thoughts are on cryptocurrencies. This covers their thoughts on these marketplaces, security concerns, and what restrictions are required when using cryptocurrencies. So, the goal of this interview with users is to learn why they became interested in cryptocurrencies and doing trades on NFT marketplaces.

6.2 Methodology

In this section, we describe our participant recruitment process and their demographics, our interview procedure and an overview of our interview questionnaire.

6.2.1 Participants

We recruited 12 participants aged from 24 to 50 years old, of which everyone was a user for an NFT marketplace. Participants were from different parts of the world with many different professions including software developers, software testers, professors and blockchain developers. The recruitment focused not only on having knowledge about cryptocurrencies and NFTs but also experience of transactions in NFT marketplaces. Table 6.1 shows the demographics of the participants for the semi-structured interview.

Participants	Occupation	Region(continent)
User1	Professor	Europe
User2	Blockchain Developer	Asia
User3	IT specialist	Europe
User4	Computer Engineer	Asia
User5	Lecturer	Asia
User6	Blockchain Developer	Asia
User7	Blockchain Developer	Asia
User8	Software Engineer	Asia
User9	Researcher	Europe
User10	Researcher	Europe
User11	Researcher	Europe
User12	Web3 Developer	Asia

Table 6.1: Participants Demographics

We refer our recruited 12 user participants as U1 to U12. Among 12 participants 10 were male and 2 were female. The educational background for each of them are different and they were recruited based on our acquaintances and from social media like Facebook and Twitter.

6.2.2 Interview Procedure

Our participants were spread across different countries. Therefore, we opted to conduct semi-structured interviews in person, through Google Meet and Zoom during November and December

in 2022. Each interview lasted for 30-60 minutes. The questions for the interview were previously written in a script. We also asked follow-up questions to the participants to clarify their responses. Audio recordings of the participants were taken, later they were converted to text.

6.2.3 Interview Coding

The interview coding was done by the two authors of this study. We began by using in-vivo coding [55] to construct labels from interview replies and multiple themes developed based on participants' perspectives on each topic. Then, for further categorization, we employed axial coding [56] and discovered various concepts and themes. Coding was checked and re-coded numerous times for various themes to ensure the consistency of our results. As we discuss the themes in the findings section, we will offer representative selections of quotes from participants.

6.2.4 Interview Questionnaire

We asked some predefined questions to our participants. Based on their responses, some follow-up questions were asked to clarify their outlook. We prepared the questionnaire following some key points related to NFTs. At first we wanted to know how much knowledge the participants hold about the basics of NFTs and cryptocurrencies. Their experience with NFT transactions were also discussed. We wanted to get a hold of their attitudes towards NFT marketplaces and the whole ecosystem of NFTs. Their concerns with security and privacy implications were considered with possible improvements suggested followed by some miscellaneous questions.

6.3 Findings

In this section, we present our findings from our semi-structured interviews with our 12 participants. Our participants were questioned regarding their prior experience with cryptocurrencies and NFTs, as well as their visits to existing NFT marketplaces and transactions involving NFTs. In addition to this, we queried as to whether or not they were aware of the potential threats to one's privacy posed by the marketplaces. We inquired as to whether or not they consider NFTs to be investments and whether or not they believe the NFT marketplaces require regulations.

6.3.1 NFT Background

We asked each of our twelve participants if they were familiar with cryptocurrencies and NFTs. We wanted to know about their cryptocurrency experiences and type of cryptocurrencies they have interacted with. We also tried to know if they have any idea of the strategy in which NFT operates. Five of them did not mention anything about their experience with cryptocurrencies. Only U5 described the procedure of buying cryptocurrencies in his country. As he said: “*In my country first we have to buy stable coins like USDT or USDC. These transactions are not considered as blockchain transactions. And later we can purchase cryptocurrencies using those stable coins.*” Another five participants clearly stated a point of time which was the starting that they started handling cryptocurrencies. Both U1 and U8 started using cryptocurrencies in 2017, where U1 said: “*I have been using cryptocurrency mostly for 3 reasons: staking, trading and development purposes. I have used Ethereum, Tezos and bitcoin.*” Despite knowing about Bitcoin transactions, U2 has no experience of using it, as he said: “*I have used Ether. I know how bitcoin transactions work but I have not used bitcoin.*” U3 started using Bitcoin in 2019. He is the only one from our twelve participants who invests in cryptocurrencies: “*I used to follow cryptocurrency from around 2016. So now I invest some of my investment into cryptocurrency.*” U4 mentioned about his cryptocurrency background, saying: “*I studied a little about cryptocurrencies during the covid period and I started trading in 2021, May or June, not in a very large volume. My main platform for cryptocurrency is Binance.*”

About NFTs, all of the participants described them as digital assets which cannot be duplicated. Most of them defined NFTs as ownership of unique items. Only U2 and U5 mentioned about the ERC tokens. U2 said: “*NFT is a Non-Fungible token. It has no fungibility. It originated from the ERC-721 token.*”. Simililar response came from U5: “*The most popular non-fungible token standards on the Ethereum network are ERC-721 and ERC-1155. ERC-721 and ERC-1155 is used for transacting multiple tokens in a single transaction.*” U10 did not know about the NFT protocol while U5 and U9 had understanding of the NFT protocol where U5 described the protocol thoroughly but U9 did not say anything in detail. The remaining nine participants did not provide any information regarding the protocol.

6.3.2 Visits in NFT Marketplaces

We wanted to know about the marketplaces they keep an eye on and the frequency of their visits. Other than U8, everybody visited Opensea. Some of them visited other marketplaces as well along with Opensea. U8 did not test out Opensea, we came to know about Reddit's own marketplace only from him, saying: "*I have not tested out Opensea. However I have checked out some Tezos based NFT marketplaces namely Legendao and one marketplace based on secret blockchain. Also I have checked the marketplace owned by Reddit.*" U8 and U5 visited secret network based marketplaces where U8 did not mention the marketplace name but U5 visited secret network based marketplace which is Stashh, "*I have visited Opensea and Stashh. Stashh is based on a secret network.*" U1 visits different marketplaces based on categories, "*I mostly visit four marketplaces. They are Objket, ArtForge for arts. I also visit OneOff for music. I also visit Opensea.*" U2 and U3 visit Binance as well along with Opensea. U2 and U9 also checks on Coinbase. Although U4 has knowledge about Uniswap, he prefers Opensea and Rarible. NiftyGateway, MakersPlace and some other marketplaces are visited by U6, Axie Marketplace, Larva Labs/CryptoPunks, SuperRare etc are visited by U7 and Soonaverse is visited by U11.

U1, U2 and U4 visit the marketplaces to see the prices, newly launched NFTs and to observe the whole marketplace. U1 stated: "*My purpose for visiting these marketplaces is to see how these marketplaces are evolving over the days.*" U1 mentioned about authenticity issue in these marketplaces and we asked him if he thinks authenticity as a problem for these marketplaces. He asserted: "*Yes, authenticity is a big issue in these marketplaces. When someone buys a NFT, he/she does not know if the NFT is authentic or not. If one same NFT gets sold to multiple people, then ownership becomes an issue. Another problem could be that many NFTs can be simply downloaded from pirated sites.*" U4 gave similar response when we asked him about his visits: "*I used to visit to see the prices of NFTs or to see the possibilities of launching a new product.*" Four participants, U2, U5, U7 and U9 visits for research and development purposes. Like U2 said: "*As a blockchain developer, I observe these marketplaces for customer requirements.*" The reason for U5 was his project, "*I did a project on NFT. So as a part of background study I visited various marketplaces.*" and the reason for U7 was developing his own NFT, "*I visited to know the scenario of marketplaces to develop our own NFT.*" Only U11 said that he visits to buy NFTs, "*I have visited to see, save and buy NFT.*" U3 and U6 visits out of curiosity. U3 started his trading out of curiosity. He described

the story of his first trade, “*Initially I started to follow the NFT marketplace out of curiosity. I minted a digital art with Eth and listed it to sell in the marketplace. To my surprise, the art gold sold for 80 dollars.*” U8 and U10 did not provide any objectives for their visits.

None of them visits the marketplaces daily. Some visit occasionally, some visit rarely. U1 stated, “*I do not visit these marketplaces daily but I often visit these marketplaces.*” Likewise U5 said, “*Earlier I visited those sites frequently. But nowadays I am supposed to visit those places occasionally.*” U4 visits weekly, “*Weekly I visited like 4-5 times. Not necessarily every day, maybe 2 times a day to see the transaction volume or any updated news.*” Other participants did not give any clear response about their frequency of visits.

6.3.3 Handling of Wallets

It is expected that all twelve of our participants utilize at least one crypto wallet because they all regularly or occasionally use NFT marketplaces. U1 and U3 maintain hardware wallets for transactions alongside with software wallets. Other than U6 and U8, everybody uses the Metamask wallet. U6 uses Phantom wallet which is based on the Solana blockchain. U8 did not name his used wallets, rather he said: “*With Legendao, it is Tezos based NFT marketplace, so you have to use the relevant wallet. The same goes on for the secret network based NFT marketplace.*” U1 also uses a Tezos wallet to get connected with OneOf. Only U5 has interacted with the Keplr wallet, saying: “*I have used Keplr and a self developed wallet as well for my project.*” U2, U10 and U11 uses Phantom wallet side by side with Metamask. Accompanying Metamask, U3, U4 and U12 hold wallets in Binance too. U3 considers Binance as a safe place to store his assets. He said: “*I prefer to keep my assets in Binance rather than in the cold wallet. I do this because to bring my assets from the cold wallet to the binance wallet, it takes a gas fee. That is why I keep my assets in the Binance wallet and I would say it is safe as Binance holds quite a good reputation in the market.*” We have observed that U11 uses the most wallets: “*I use Phantom, Brave, Firefly, Metamask, Coinbase, Bitpanda wallet.*” U7 and U9 only use the Metamask wallet.

6.3.4 NFT Transactions

We were curious to know about the frequency of their NFT transactions. Most of them make transactions rarely or have made it for one or two times. Only U3 is very frequent with his

transactions, as he said: “*I very frequently make transactions. I also visit or scan the marketplaces and follow the Binance marketplace for NFT on a regular basis.*” With this response, we wanted to know if he has ever visited Mintable, Rarible, ThetaDrop or marketplaces like these and he replied in affirmative: “*Yes I have visited these. But I did not make any transactions in these marketplaces.*” U1 does not have many transactions of NFTs but he transacts in Distributed Exchange (DEX). So, we asked him about DEX and he asserted: “*Many tokens are assigned against Ethereum blockchain. For instance, to exchange token Unicorn into token Carv, there should be a DEX.*” U2, U4, U5, U6 and U12 completed a single NFT transaction. Among them, U5 has made his transaction with the Stashh marketplace, saying: “*I uploaded an NFT in Stashh. And that is the only transaction I have ever made in any marketplace.*” U10 and U11 rarely make any transactions where U10 made it only twice buying two NFTs. U7, U8 and U9 committed transactions multiple times. U7 used his created NFTs: “*Several times, I made transactions of our own made NFT.*” U8 only bought NFTs, he never sold one. He described his reason for buying NFTs in Legendao: “*With a Legendao based NFT, your staking rewards will get a multiplier based on the rarity of your NFT. If it is more rare, the more rewards you can get. That was the only reason that I bought those NFTs.*” Although very few of them have numerous NFT transactions, they all stated that they regularly keep track of the prices of NFTs and the ongoing trend of the types of NFTs.

6.3.5 Trading of NFTs

To get a clear idea of why the participants started trading NFTs, we asked them about their motivation behind this and their field of interest in the marketplaces. we have noticed that U3, U4, U5 and U10 started the trading out of curiosity. They were interested in the technology and wanted to know more about it, as U4 said: “*I started trading to get the most basic level of understanding, to have an entry level experience.*” U5 considers it as a way of exhibiting the creative works created by one. So, to come across such creations, he started his trading. U11 did not provide any clear response for this part of our questions. All of the remaining participants got into trading for their research work or development purposes. U1 had a vision of reducing the frauds: “*If I can make an application that will verify the image or video, spreading fake information can be stopped. From this vision, I started to work with NFTs.*” U8 traded to enhance his staking rewards:

“I invested in a secret network and was also participating in staking, getting rewards for a specific NFT. Based on the rarity of my NFT, my staking reward was getting multiplied.” He provided us with the information that his first transaction was in 2021 and then he again made transactions in 2022. Hence, prices of NFTs dropped down dramatically in 2022, we asked him if he felt any fear making these transactions. He replied: *“The value I was getting from that specific NFT was higher than the risk.”* U10 was required to get connected with the NFT community for her research, so she answered: *“There is a club with people buying NFTs. I started trading to get access to the community that is connected to NFTs.”*

6.3.6 Dissatisfaction and Difficulties Encountered

We were focused to know the difficulties faced by them when transacting NFTs. We also queried about their discontent while visiting the marketplaces. U4, U6, U7, U9, U10 and U11 do not dislike anything about the marketplaces. U6 has no specific displeasure, however, he expressed his concern for the environmental aspects of this technology: *“The process of minting and trading NFTs requires a significant amount of energy which has led to criticism that the NFT market is contributing to environmental problems.”* We wanted to know their opinions about the garbage collections exhibited in the marketplaces. Only U6 shared his outlook: *“I have seen many NFTs very similar to each other and not worth the price which also seem to be fake. I think the marketplaces should opt for some strategies that check uploaded are fulfilling some predefined criteria.”* Others did not provide any specific comment to this query. Later we asked these six participants if they had faced any hesitation using the marketplaces where U6 and U10 had difficulties buying cryptocurrencies and U4 had some technical difficulties: *“After buying NFTs, it is not mentioned in the wallets. It needs to be added manually. It was a hassle before but some platforms resolved it recently.”* The remaining ones did not encounter any noteworthy errors. Our remaining six participants discussed in detail about their dissatisfaction and the problems they came across during their first transaction. Despite talking about some problems of the marketplaces previously, U1 added something more here: *“Sometimes there are no labelling which results in confusion for the users. There should be clearly visible labelling for different types of NFTs. There are no proper pricing models in these marketplaces. So it should be monitored.”* He talked about the hash algorithm when talking about the difficulties during his first transaction. He said: *“Users*

need to use a wallet extension for transactions. This is more secure but not straightforward. People use IPFS to store assets that generates a hash. Anyone can access this hash which is public. So according to me, hash can be an option but not the only way to access the stored files.” U2, U3, U8 and U12 stated that they found it challenging to manage an external wallet. U2 expects following some easier process: “*Cryptocurrencies and wallets are needed to buy/sell NFTs in these marketplaces. It can be considered if buying/selling NFTs can be done using dollars or following any other easier process.*” We asked him if he thinks that the whole transaction process may seem hard for a first time visitor or not and he replied positively: “*Yes, it is a bit difficult. Because they need to set up a digital wallet first and then buy some cryptocurrencies. The price fluctuations also need to be considered.*” U3 expressed his concern about wallets getting hacked. He also had comments about the interfaces of the marketplaces, as he said: “*You can buy bitcoins or NFTs from a lot of places but it can be fake. There are a lot of places where they provide a link. People connect these sites with their wallets and the assets get hacked. Also I think as these platforms are very new, UX is backdated which can be improved a lot.*” U12 finds it cumbersome to add the wallet extension to every browser used and then connect it again and again in the same marketplace. Later we asked each of them what difficulties they had faced while making their first transaction. U3 mentioned some noteworthy dilemma that he encountered: “*When I first sold my NFT in a random marketplace, I did not understand the process of getting my money into my account. Without knowing the process of gas fees, I chose a fast transaction paying a higher gas fee.*” U8 reported high traffic in the marketplaces: “*I think there was quite a high traffic those days. I was not able to connect my wallet for several hours. The other one was due to high load, even when my wallet was connected, my transactions were not getting through.*” U5 thinks that the gas fees charged by these marketplaces are high. Other than managing cryptocurrencies, the rest of his experience was smooth. We inquired U2, U3 and U8 about the worthless collections displayed on the marketplaces. U8 stated: “*It could be because no one is stopping you from duplicating the current assets. For example, anyone can download the image of an artwork and re-upload them as their own NFTs. There is no checking yet in this regard.*” U3 discussed about the utilities provided through NFTs: “*Now buying an NFT provides some utilities. You can not just create NFTs and sell them, you have to provide the utilities and all other services also. However, not every NFT needs to provide any utilities. But avoiding this only works on really renowned or famous artists.*”

6.3.7 NFT as Investment

U3, U5, U6 and U11 consider NFTs as investments. U9 thinks it depends on the specific NFT whether it can be considered as NFTs or not. The remaining seven participants do not consider them as NFTs. U3 said: “*Yes it is an investment but it is very risky. Investing in some really good NFT projects can be a good idea in the long run. But I think that one should only spend very little amount of money in this thing rather than risking everything.*” Similarly U6 answered: “*It is important to keep in mind that we need to understand what NFT we are investing in, whether it is worthy or not.*” As NFTs can be sold at higher prices later, we wanted to know the opinion of U1 about this point: “*For me, that is not an option. I do not like to invest money in NFTs. But many people would do that as it is just an investment strategy.*” U2 does not find it worthy of investments as he visions about prices of NFTs fluctuating soon. Manipulation in the marketplaces prohibits U8 from considering NFTs as investments: “*A person can create an NFT and buy that NFT for higher prices multiple times using multiple accounts. So the same user is responsible for manipulating the value of the NFT. It is quite easy to do these at this moment. So I do not consider NFTs as investments personally.*” U12 explained: “*I do not think NFTs are investments. I think it can be more like a fun project and the price hike/drop depends largely on social media hype.*”

6.3.8 Security and Privacy

We queried about whether they feel secure in the marketplaces or are aware of the security concerns and privacy implications followed by getting hold of their opted measures for protecting their NFTs. Other than U2, U7 and U8, all of them feel secure in the marketplaces. U2 expressed his fear: “*Blockchains can be considered as secure. But newer NFT marketplaces require some information of users for authentication. So, I think this is scary.*” U1 feels secure as he uses his hardware wallet for transactions. U12 also joined the security with wallets: “*Since I am using an external wallet which I have control over, I know my wallet credentials are not being recorded by those marketplaces, even though connecting the wallet is inconvenient.*” U1 stated his outlook regarding security threats: “*I heard on the news that Metamask keeps an ID address, this could be a concern. Ownership of content can be an issue in these marketplaces.*” Following his response, we asked him if he can think of any possible way for preventing re-upload of downloaded images as new NFTs and he replied: “*Yes, someone might do that. To prevent this, machine learning*

algorithms need to be implemented to check pixel by pixel for images.” He uses his hardware wallet which he finds safe and does not take any other measures to protect his NFTs. About the privacy implications, he shared: “*If the wallets keep the IP address when using the browser extension, they can easily see how much money I have in the wallet. This is a huge privacy implication in these marketplaces.*” U4 also provided similar response when asked about the garbage collections shown in the marketplaces. U2 expressed: “*Blockchains can be considered as secure. But newer NFT marketplaces require some information of users for authentication. So, I think this is scary.*” He guards his NFTs by keeping his public and private key safe. He connected the security issues with smart contracts: “*The person who deployed the Solidity code of smart contracts for an NFT marketplace, his address remains there, so through ownership transfer, it can be taken. Also, there are fraudulent activities which make automated NFTs from time to time.*” U3 and U6 feel secure in the renowned marketplaces. They do not trust every marketplace. U3 finds Binance very convenient to use: ‘*In Binance, they hold all the cryptocurrencies of a person, if I pay the right amount of dollars for the cryptocurrency, then Binance just transfers the cryptocurrency from the fund and it gets deducted from the other user.*’ About gurading NFTs, he said: “*I actually keep my assets on Binance because I trust this marketplace. And I keep my private key and other password very secret and safe with me.*” He has no extensive knowledge about the privacy implications in the marketplaces. U11 is also ignorant of any potential privacy consequences. U5 believes that using acclaimed wallets like Metamask or Binance keeps his NFTs safe. U6 discussed about forcing regulations on security purposes: “*I think there is a lack of regulation and standardisation in the NFT market. If the government makes a regulation regarding the NFT and their marketplace, the echo system would be more comfortable for users.*” U8 verifies the marketplaces by visiting their various social media accounts like Twitter, Medium, Telegram and so on. Like U1, he also uses a hardware wallet for transactions. Later, we asked him about the management of his hardware wallet: “*In order to access my NFTs or cryptocurrencies, I have to go through this additional layer of security which is my hardware wallet. Once I have bought the NFT, I would disconnect my wallet from the marketplace as it is very easy to reconnect.*” Others provided similar responses like keeping passwords and keys safe to protect their NFTs form any kind of damage.

6.3.9 Introducing Enthusiasm in NFTs

When we questioned them regarding the necessary steps that can increase their interest in trading NFTs, a variety of viewpoints were generated. However, nearly every opinion centered around resolving the security issues and building a proper pricing model. Like U1 said: “*User privacy needs to be improved and NFT labelling is necessary. Authentic content verification needs to be implemented. These marketplaces can come to a consensus about the NFT pricing.*” Apart from mentioning the security concerns, U2 and U3 talked about the interface of the marketplaces. U2 provided some suggestions: “*The user interface could be improved. Making people familiar with NFTs, some advertisements can be displayed, how people can buy and maintain NFTs, accessibility to a large section of people, making things easier.*” In a similar way, U3 thinks that the interface should be more informative. U8 would prefer some strategies to certify the marketplaces and NFTs: “*One of the issues that could be resolved is the authenticity issue. Like how can we prove that this marketplace is the authentic one and how can I be sure that the specific person is selling the authentic NFT? This needs to be certified somehow that this NFT is a certified NFT. I think this could be improved.*” U9, U10 and U12 gave similar responses regarding improving the usability of the marketplaces, where U9 said: “*Less unnecessary projects or collections more verified accounts, transparent UI should be taken into account.*” Only U11 offered no recommendations for any potential upgrades. The response of the remaining participants revolved around the same discussion.

6.3.10 About Regulations

Nine of the participants want regulations imposed on NFTs. One participant does not want any regulations. The remaining two participants do not want any centralized regulations but some automated mechanisms to reduce fraudulent activities. U4 and U8 requires some strategies developed by the marketplaces rather than maintaining any authoritative body. U4 said: “*I would say that the communities who are using these marketplaces should maintain transparency. The developers should implement some security measures to check for fraudulent activities. If we want to put more regulations then we get back to the centralized system from which blockchain was trying to escape.*” While U8 provided his response: “*They need to simplify the user experience for the general public. Of course you need to enforce some regulations to eradicate the ongoing*

scams and those kinds of stuffs," we asked him if this leads back to the centralized system again and he answered: "*I think yes. But there can be multiple layers here. One of the main reasons people interact with cryptocurrencies and NFTs is money. You need to be sure that you are doing it legally.*" U11 does not think they any regulations are necessary for NFTs. U1 and U12 thinks that some regulations should be maintained on the pricing of NFTs. U1 thinks: "*Yes there should be regulations in pricing. But content wise regulations should not be implemented because that could create censorship which will discourage people from freely using these marketplaces.*" Others want regulations enforced to stop the ongoing frauds. U2 thinks about regulations on collecting NFTs: "*I think that regulation of how many NFTs one person can hold needs to be applied.*" Remaining responses were similar to the previous ones like to avoid scams, put a much higher price and ideas like re-upload same NFTs or copied NFTs. They want regulations to stop these activities.

6.4 Discussion

We were able to understand varied perspectives on NFTs through our semi-structured interviews with NFT user participants. We talk about our key discoveries in this chapter. We developed our list of inquiries with an eye on NFT fundamentals, NFT transactions, mindset toward NFT marketplaces and ecosystems, security and privacy. As the responses poured in, we discovered:

1. Most of the participants interacted with NFT marketplaces for development purposes or research purposes. Very few of them started buying or selling NFTs out of curiosity.
2. Majority of the participants rarely make any transactions. A very few of them are frequent with these transactions.
3. All of them take necessary measures to protect their wallets and NFTs. These steps vary from person to person as they are selected based on the options they find suitable for themselves.

All twelve of them were knowledgeable about cryptocurrencies and NFTs. All of them described NFTs in their own terms. Everybody was experienced with NFT transactions. Two participants described NFTs with the concept of ERC tokens. Others gave a general overview of NFTs describing them as digital assets. Only one participant gave a detailed outline of NFT

protocol. Two participants were not knowledgeable about it while others did not provide any response to this point.

Various marketplaces were visited by them. Except for only one participant, everybody visited Opensea. Binance was visited by two of them side by side with Opensea. The same goes for Coinbase as well. Secret network based marketplaces were also noted down as two participants used to visit them. Several other marketplaces were also reported. Figure 6.1 shows marketplaces visited by the participants.

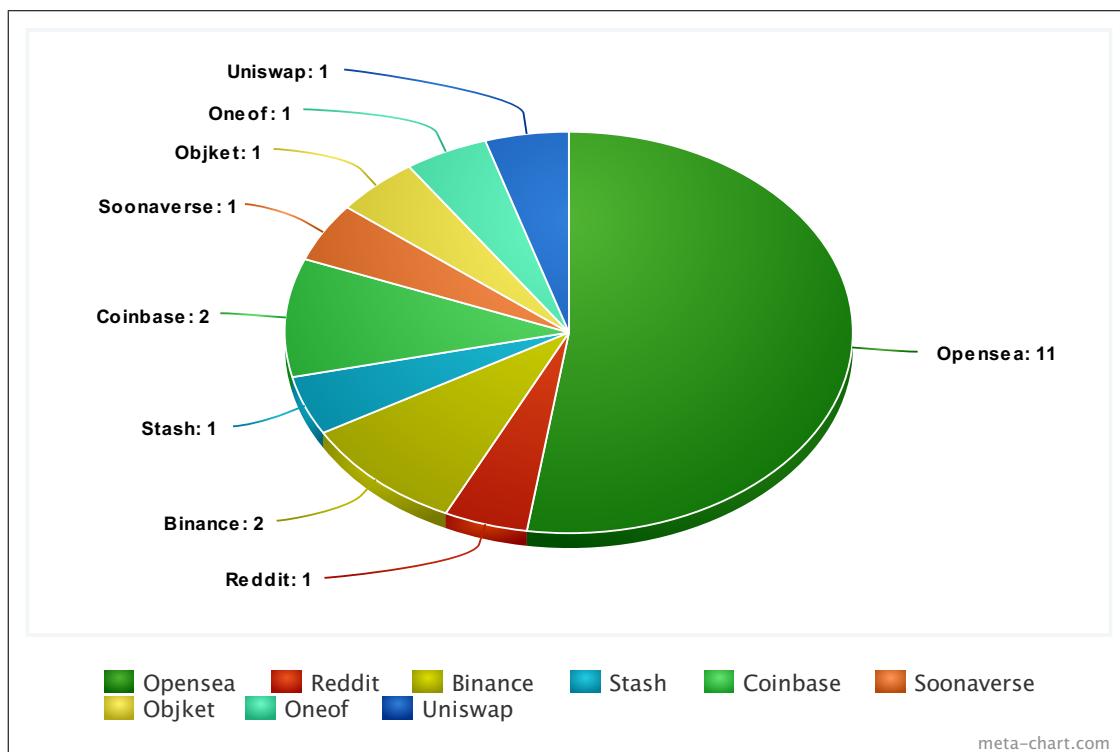


Figure 6.1: Participants' visits in NFT marketplaces

Since all of the participants were users of NFT marketplaces, they maintained at least one crypto wallet. Two participants use hardware wallets which they referred to as cold wallets. Metamask is the most popular wallet among the remaining participants. Only two of the ten remaining participants do not use Metamask. One uses Phantom and the other one uses a wallet for a secret network blockchain. Binance has been used by three of the participants. A few more wallets namely Coinbase, Tezos, Keplr and some other wallets were also noted down from their usage.

Figure 6.2 shows the preferred wallets of the participants to use in the NFT marketplaces to buy or sell NFTs.

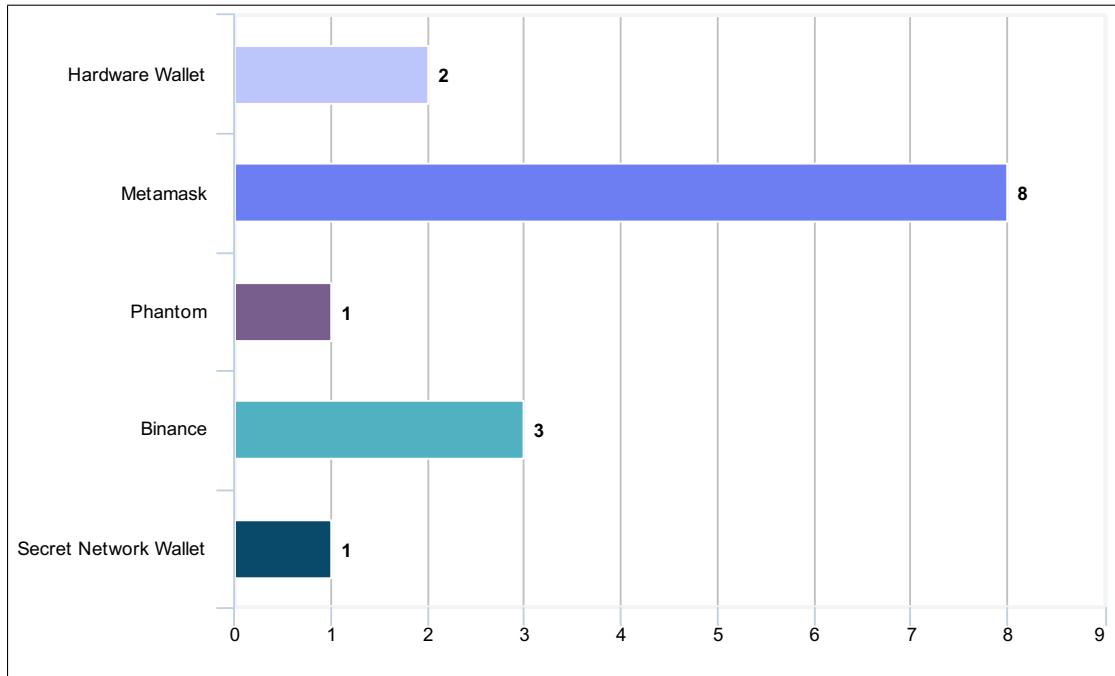


Figure 6.2: Participants' preferred wallet to use in NFT marketplaces

Despite being users of NFT marketplaces, we have got to know about only one participant who is very frequent with his transactions. Most of them rarely make any transactions in the marketplaces. Three of them happened to have multiple transactions. Others bought or sold NFTs for one or two times only. But all of them stated to keep an eye on the marketplaces to observe the prices of NFTs and cryptocurrencies and to be updated with newly launched NFTs.

Two of them think that the user interface of these marketplaces is worth working for. They are not so informative and easy to use for a general person. Other two accepted facing difficulties bringing the bought NFTs to their wallets. One participant expressed his concern about the environmental impact of this technology. One of them suggested to have a proper pricing model. It was also reported that buying NFTs should be an easier process like having an alternative way of managing wallets. Usage of dollars like currency has been suggested by one of them. Other than these, a very common point was established. Almost everybody stated to face difficulties because

of fake NFTs and worthless collections uploaded in the marketplaces.

Four of them do not, for similar reasons, view NFTs as investments. They do not find it worthy to invest in NFTs. As prices get fluctuated very often, they find it risky to spend millions on them. Garbage collections are holding them back from considering it as an investments. Eight participants, on the other hand, believe that NFTs make smart investments. They are confident that prices will rise because the technology is so new and investing in it might be rewarding. Figure 6.3 shows participant views on whether to think of NFTs as investments or not.

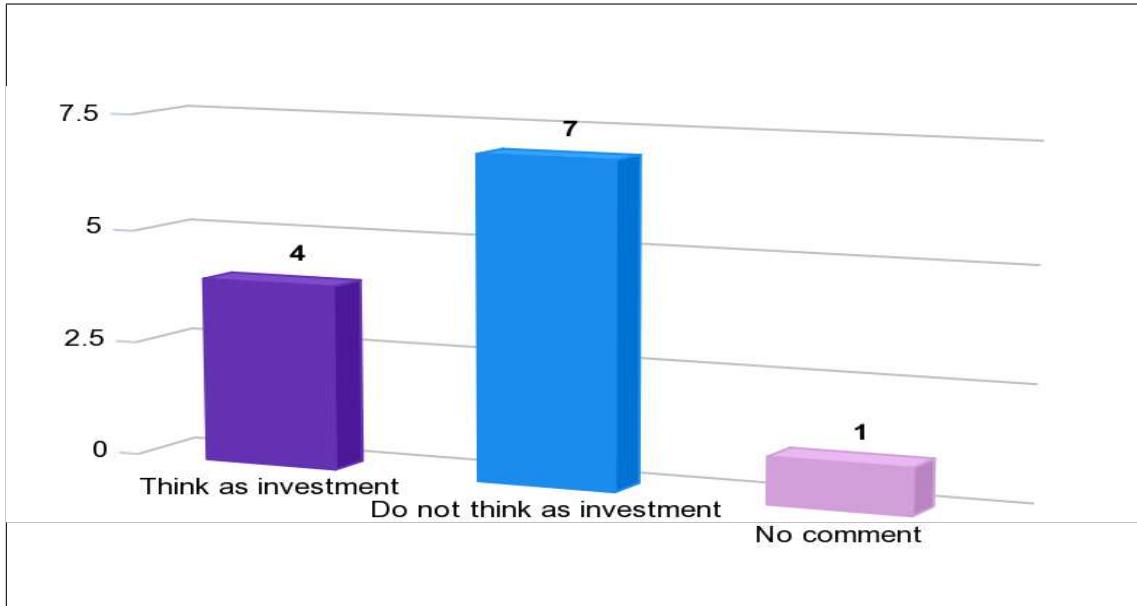


Figure 6.3: Number of participant who think NFT as investment

We found out if the attendees were concerned about the security of NFTs. We also asked them for some suggestions on how to deal with these issues. Three of them did not feel secure in the marketplaces. Their security concerns were centered around the wallet management. Nearly everyone expressed their unease regarding deceptive markets and fraudulent uploads. Some of them feel secure in the renowned marketplaces but not in unpopular marketplaces.

Majority of the participants want a certain degree of regulations imposed on NFTs to eradicate the ongoing scams. Nine of are in support of enforcing regulations where two of them suggested for some kind of automated strategies to reduce fraudulent activities. Only one participant provided negative response about imposing regulations. Figure 6.4 shows the perspectives of the participants

about enforcing regulations on NFTs.

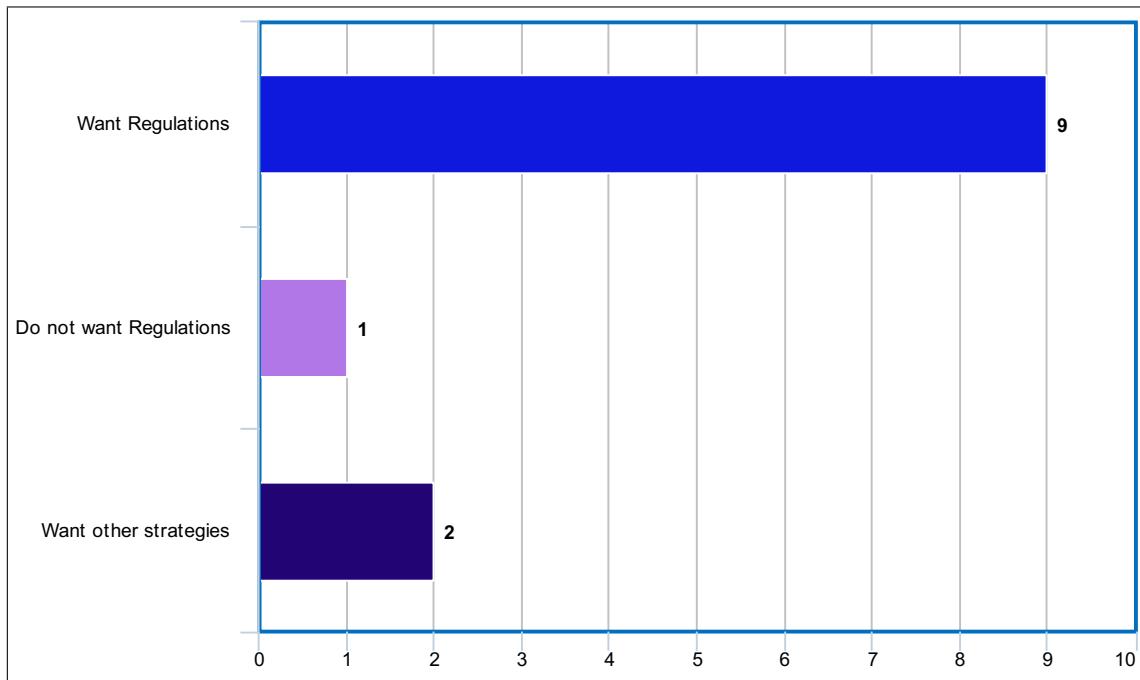


Figure 6.4: Regulations graph

The following chapter introduces a cognitive walkthrough method performed on Opensea. This task based approach has been completed with a set of tasks and a set of prescribed questions. The results have been summarized by analyzing the completion of the given tasks and answers of the questions given by the recruited participants.

Chapter 7

Cognitive Walkthrough With First Time Users of Opensea

In this chapter, we describe our cognitive walkthrough procedure, recruitment process, the demographics of our participants. We observe the usability aspects of the corresponding application and summarize the findings. We also present a discussion of the results with graphical approaches.

7.1 Purpose

Cognitive walkthrough can be used to quickly and accurately identify whether a design solution is simple for a novice or infrequent user to understand, and why it is or is not. This approach can help to identify significant problems at any stage of the design process when we do not have access to actual people, but it is not a replacement for user testing.

The objective of this cognitive walkthrough is to find out the usability issues of Opensea, the most popular NFT marketplace. We have conducted cognitive walkthrough with first time users of Opensea. The goal of this walkthrough is to observe the user experience of Opensea. This includes the difficulties the participants face during performing the tasks along with the design of the interface. The tasks involve creating an account, connecting a preferable crypto wallet, making transactions and recovering the account.

7.2 Participants

We recruited five participants for our cognitive walkthrough evaluation. All of them have experience with usability studies with prior knowledge of blockchain, wallets and NFTs. The age range of the participants is between 24-50 years old belonging to various occupations like undergraduate students, software developers and professors. The participants were recruited based on our acquaintances. None of them had any experience of using Opensea before. Among our five participants, two were female and three were male. We refer our five participants as P1 to P5.

7.3 Evaluated Marketplace

For the purpose of our usability evaluation, we have selected Opensea, the first and largest peer-to-peer marketplace for crypto collectibles, which include gaming items, digital art, and other virtual goods backed by a blockchain [57]. Opensea provides both main network and test network facilities. Opensea main network is used for real transactions with real cryptocurrencies and Opensea test network is used for demo transactions with demo cryptocurrencies. Although many NFTs on OpenSea can be purchased with a credit or debit card, NFT transactions take place using cryptocurrency. In both Opensea main network and Opensea test network, a crypto wallet needs to be set up. For our evaluation, we used Opensea test network for demo transactions with demo cryptocurrencies. As for the wallet, we selected Metamask [58] which is one of the most popular crypto wallets and is based on the Ethereum blockchain [59]. Users can utilize a browser extension or mobile app to access their wallet, which can then be used to connect with decentralized applications. Among many available test networks, our selected Opensea test network is Goerli test network [60].

7.4 Methodology

For our cognitive walkthrough evaluation, we defined a set of tasks. There were six tasks that involved completing basic tasks that users need to perform for any NFT transaction including minting of NFTs and recovery of wallets. Information related to the walkthrough procedure were provided to the participants. There were also a set of questions associated with each task to get hold

of their feedback with suggestions for possible improvements. The walkthrough was conducted during January 2023 and the time taken by each participant was 60 minutes to 90 minutes.

We performed a pilot study with one participant during December 2023. It took time of about 75 minutes.



Figure 7.1: Cognitive Procedure

Each of the following six tasks were performed by all five participants independently to evaluate Opensea.

T1. Installing Metamask and connecting it to Opensea.

This task involves installing Metamask and connecting it to Opensea. Setting up a wallet and connecting it is the primary requirement of the marketplace.

Sub-task 1. Installing Metamask.

The user needs to install Metamask and complete all the steps required to finish the installation process. For the installation, the users should search for available Metamask extension for the particular web browser used. If needed, the users are encouraged to store any necessary information safely that they might think might be required later.

Sub-task 2. Checking balance.

After a successful installation and creation of an account, they should be able to check for a 0.00 balance. To perform further tasks, the users need to switch to a Goerli test network from the Metamask wallet. On the test network, the coordinators will provide the required GEth to perform further tasks. The users should check for the updated balance to confirm that balance has been transferred successfully through the test network.

Sub-task 3. Connecting Metamask to Opensea.

Now, in the Opensea test network, the users need to create an account in Opensea and connect the wallet there. Connecting the wallet automatically creates an account in Opensea, which may be confusing for novice users.

T2. Exploring Opensea about supported NFT categories and finding basic transaction procedures.

This task is about exploring Opensea. Opensea provides various resources for their users. The users should find out under which section they share these resources. They need to take a tour to Opensea to see if they provide enough information to understand the buying process, selling process and bidding process of NFTs. They should find out the minting process as well. Also they need to search for supported categories of NFTs that are displayed on their site. It is up to the users if they want to learn more from these resources.

T3. Minting an NFT.

This task requires minting and listing of an NFT. Convenience for the minting is provided in Opensea. Minting is the process of creating a new NFT.

Sub-task 1. Minting an NFT.

The users should look for a “Create” option in Opensea. They need to upload an image and fulfill the required fields for the creation. There might be some optional input fields which users may skip. After creating an NFT, the users should check for the NFT created in their profile.

Sub-task 2. Listing an NFT.

This task is about listing the created NFT for selling. Listing requires to put a price on the NFT and also the time duration available for the listing. Users may change the default time duration fixed in Opensea.

T4. Performing an NFT transaction.

This task involves buying an NFT listed on the co-ordinators’ profile. This task is about spending some balance from users’ wallet to buy an NFT.

Sub-task 1. Finding out the correct address to transact with.

The co-ordinators provide an address to the users in which an NFT is listed for selling. Every item displayed on the address may not be available for transaction. Some NFTs may already be sold out. The users need to find out the NFTs available for buying.

Sub-task 2. Checking every information before submitting the transaction.

The users need to check every information before the transaction has been submitted. These information include price, transaction address, their balance and so on.

Sub-task 3. Performing the transaction.

After checking all the information required for the transaction, the users can submit the transaction to complete the buying process. They need to look for the NFT added to their profile. They are encouraged to check for the updated balance in their wallet after the transaction.

T5. Login to the account from another device.

In order to complete this activity, the users must restore their wallet on another device and use that wallet to make another transaction from the new device.

Sub-task 1. Restoring the wallet.

The users need to verify if the wallet is installed on the devices used as new ones. Different mobile, computer, browser or any other device different from the previous one can be used as a new device. The users will be in need of installing the wallet if it is not already installed, then make sure they can log in to the wallet on this new device. They are encouraged to check for their balance and other information available on the wallet to confirm the restoration.

Sub-task 2. Connecting the restored wallet to Opensea.

In this step, the users would have to go to the Opensea test network again and connect their restored wallet there. They may be required to switch to Goerli test network from “Settings” one more time. This step follows the same procedure of sub-task 1 from task 1. Checking the information needed to log into the account if the device is changed is the work at hand.

Sub-task 3. Performing a dummy transaction from this new login.

Users have to follow the steps from task 4 to perform one more transaction at the same collection ID. There will be at least one available NFT on the address for the transaction.

T6. Recovering the wallet.

In case any credentials are forgotten, this task entails restoring the wallet. As a lost credential, password has been selected since losing track of the “Secret key” will lead to permanent loss of the wallet.

Sub-task 1. Changing the password

The users may lock their accounts from the Metamask interface and while trying to unlock the account, a “Forgot password?” field will appear. The users are asked to update their password using this field and access their wallet with this updated password.

Sub-task 2. Checking the recovered account or getting a verdict if it is not possible.

This activity is about to check if it is possible to retrieve the wallet by inputting the forgotten password and the secret phase key, or if the loss of information results in the irreversible loss of the wallet and its contents.

Because usability inspection was the primary objective of our study, we used a set of heuristics that had been developed for a usability evaluation [61]. The list of rules that we adhered to is as follows:

G1. Users should be aware of the steps they have to perform to complete a core task.

Throughout the cognitive walkthroughs, it is assumed that each core task can be started by the user because they are knowledgeable enough to do it.

G2. Users should be able to determine how to perform these steps.

It is expected that the user is familiar with the operation of the system. In order for the user to successfully complete the essential steps to complete each core activity, it is crucial that the system model and the user's mental model align.

G3. Users should know when they have successfully completed a core task.

To ensure that users are aware of the task's successful completion, there should be plenty of feedback given to them along the process.

G4. Users should be able to recognize, diagnose, and recover from non-critical errors.

Users will probably make mistakes while carrying out the essential steps, thus it is crucial that they have the ability to fix them. It is important that users receive clear error messages.

G5. Users should not make dangerous errors from which they cannot recover.

It is very likely for novice users that they will not identify the key information stored on the application. It is possible that overlooking these information will lead to permanent damage. Also if any further action is not expected usually from a user, it needs to be clearly notified.

G6. Users should be comfortable with the terminology used in any interface dialogues or documentation.

Since the target users of an application may vary, terminologies used in the interface should be understandable. End users may not be very comfortable with technical terms. If technical terms need to be used, proper clarification should be provided.

G7. Users should be sufficiently comfortable with the interface to continue using it.

It is crucial to be consistent and predictable in the layout because users have grown accustomed to specific interface components behaving in a certain way. Task completion, efficiency and satisfaction will all benefit from doing this.

G8. Users should be aware of the application's status at all times.

It refers to how well users are informed of the system's status. Users can make better judgments when the system consistently keeps them aware of what is happening through suitable feedback delivered in a timely manner.

7.5 Result

In this subsection we try to find out the results of our cognitive walkthrough experiment. The participants were assigned to perform the tasks and the whole experiments were recorded for further analysis. The participants took different times to perform the tasks. All the tasks were divided into subtasks and the times were taken to perform the subtasks. Table 7.1 shows the time taken by the participants to perform the tasks that were divided into sub tasks. By analyzing the results from our walkthrough procedure, we briefly describe our findings below:

Opensea						
Tasks	Sub Tasks	P1	P2	P3	P4	P5
Task 1	Sub Task 1	8.54 min	1.38 min	5.02 min	5.35 min	3.35 min
	Sub Task 2	6.57 min	1.06 min	0.26 min	3.20 min	0.50 min
	Sub Task 3	1.32 min	1.44 min	1.26 min	1.42 min	1.39 min
Task 2	No Sub Task	38.29 min	17.42 min	10.56 min	26.27 min	21.23 min
Task 3	Sub Task 1	5.14 min	2.12 min	2.31 min	8.50 min	2.12 min
	Sub Task 2	1.52 min	1.44 min	1.27 min	0.52 min	1.12 min
Task 4	Sub Task 1	0.33 min	0.22 min	1.40 min	0.47 min	0.51 min
	Sub Task 2	0.31 min	1.20 min	1.05 min	1.10 min	0.44 min
	Sub Task 3	0.24 min	1.09 min	1.48 min	1.24 min	0.37 min
Task 5	Sub Task 1	2.55 min	3.57 min	2.40 min	4.10 min	7.29 min
	Sub Task 2	1.03 min	0.53 min	1.20 min	0.30 min	0.42 min
	Sub Task 3	1.09 min	3.28 min	5.17 min	5.01 min	1.29 min
Task 6	Sub Task 1	2.32 min	4.35 min	1.44 min	3.25 min	1.18 min
	Sub Task 2	0.29 min	0.17 min	0.24 min	0.14 min	0.12 min

Table 7.1: Time taken by the participants while performing the tasks

T1. Installation and Connection: Each of the five participants were able to complete the task. None of them needed any help from the coordinators or to use any external resources to complete sub-task 1 and sub-task 2. P3 and P5 were able to complete sub-task 3 on their own. Other three participants needed help with connecting their wallet to Opensea. P1, P2 and P4 faced difficulties to understand that connecting the wallet is the process of creating an account in Opensea. But with little help from coordinators, they successfully completed the sub-task. P1, P3 and P4 checked every information appeared for the task. P2 and P5 partially checked the information. No external resources were accessed throughout the completion of the whole task. Table 7.1 shows the times that were taken by the participants to perform the task.

Metamask provides step by step instructions for setting up the wallet (achieves G2). It also notifies with a message to not lose the secret key (achieves G3 and G5) and success of the creation of an account. It uses the term “Secret key” which may appear unfamiliar for a novice user (fails

G6). Metamask interface does not show all the available test networks at first (fails G2). Goerli test network gets available after a change in the “Settings” which can be difficult to find for first time users. In Opensea, the wallet icon seems a bit tricky to find (fails G7). Connecting Metamask automatically creates an Opensea account but it is not mentioned explicitly anywhere in the marketplace (fails G1 and G2).

T2. Exploration and Learning: All of them completed the task successfully. None of them needed any help from the coordinators or to use any external resources to find out the resources section. P1 explored the categories like art, collectibles, music, domain names, photography, sports, trading cards, utility, virtual worlds. P2 did not explore all the categories, but a few namely art and collectibles. P3 tried to explore all categories but faced difficulties. He encountered 404 errors for most of the categories. P4 learned about five categories which include art, gaming, photography, membership, pfps. P5 explored the trending and top items in the homepage rather than searching for any particular category. The bidding process was understood by each of them but it seemed difficult to P4 to find where they have described the bidding process. All five participants understood the whole buying, selling and uploading process. No external resources were accessed throughout the completion of the whole task.

There is a “Resources” section quite visible in Opensea (achieves G2). From there, users can go to the “Learn” section to gain necessary information (achieves G6). Users can read about three basic transaction processes which are buying, selling and creating NFTs. Bidding is a fundamental part for buying NFTs but no distinct tutorial is provided for this part (fails G2).

T3. Minting and Listing: The task was successfully completed by each of the five participants. No external resources or help from the coordinators were required by any of them. Each of them created an NFT successfully while only p4 encountered failure in his first try. He completed sub-task 1 with a different asset selected as his NFT. All of them checked their created NFTs in Opensea. P4 needed help from the coordinators to start sub-task 2, however, everybody was successful performing sub-task 2. None of them accessed any external resources during sub-task 2.

Opensea provides a guide for creating and listing NFTs for the users (achieves G1 and G2).

However, users are not alerted when they have successfully created an NFT (fails G3 and G8). No distinct “List” tab is used in Opensea, the process gets started with the “Sell” tab (fails G6).

T4. Performing Transaction: All five participants successfully finished this task. The collection ID was provided to them by the coordinators from where they had to buy one NFT and perform a transaction. By accessing the collection ID, all of them completed sub-task 1 successfully. All of them checked every information before submitting the transaction such as chosen NFT, balance, required cryptocurrency and so on. By checking these information, sub-task 2 was completed. Although P4 faced uncertainty about adding the NFT to his cart, others did not face any difficulty in this step. Everybody committed the transaction, no failure was encountered by any of them. Only P2 did not check the remaining balance in his wallet after the transaction, but others checked it as well. All of them checked the NFTs available as their collected NFTs. No external resources or any help from the coordinators were asked during any of the sub tasks.

Opensea provides guidance for buying NFTs (achieves G1 and G2). Transaction process takes a while to complete, however, neither any message is shown about this ongoing process nor any success message is there to inform the users about the completion of this process (fails G8). Information regarding the buying process is shown in the wallet in detail (acheives G5). The NFT has to be added to cart at first and then it has be bought from there which is considered as redundancy (fails G7). A straightforward “Buy now” option would be more user friendly.

T5. Login from Another Device: Various devices were considered as different ones for fulfilling sub-task 1 of this task. P1 used a different desktop computer, P3 used a different laptop and others changed their web browsers considering them as different devices. All of them installed Metamask for their new devices and connected it to Opensea again, completing sub-task 1 and sub-task 2. Following the same procedure of sub-task 3 from task 4, they were able to perform sub-task 3 as well though the transaction was delayed here also. During any of the sub tasks, no assistance from the coordinators or external resources was requested.

The twelve word secret key is mandatory while trying to log in to the account using a different device. It is required to type the twelve words one by one which is cumbersome for the users (fails G7). A new password has to be entered every time a different device is used, so if the previous

password is lost, it does not lead to any irrecoverable error (achieves G5).

T6. Recovering Account: Each of them locked their Metamask accounts and updated the password by clicking on the “Forgot password?” field. Sub-task 1 also requires the secret key and without providing it to the system, password cannot be updated. All of them updated their passwords and completed sub-task 1. The consistency of the accounts was checked by looking into the wallet balance and sub-task 2 was successfully accomplished by all of them. During any of the sub tasks, no help from outside sources or the coordinators was requested.

In this process also, the twelve word secret key needs to be entered one by one which is difficult for the users (fails G7). If the previous password is forgotten, the account can be easily recovered by updating the password (achieves G4), but no message is shown about the confirmation of the updated password (fails G8).

7.6 Discussion

Six tasks were broken down into smaller tasks in our cognitive walkthrough. Participants performed these tasks in order and answered some questions based on their experiences. After performing each task, they also had the opportunity to provide feedback about improving their experience. Since all of the participants were interacting with Opensea for the first time, they had discrete feedback along with some similar ones. Although the users faced some difficulties understanding certain steps, most of the tasks were performed without any assistance of the coordinators. There were no failures reported in any of the sub tasks, however, the experience of the users as novice ones could be much better.

The installation process of Metamask and the creation of an account is not a complex task. It is pretty straightforward. But the creation of an account to Opensea is a tricky one. Connecting the wallet to Opensea creates an account there, which is not so clear for someone who is using the marketplace for the first time. There could be a prompt which would inform the user about this process. Also, when an unregistered user visits Opensea, no window pops up telling the user to sign up to the marketplace. There could be a pop up window which would advise them to create an account for further usage. Moreover, providing a detailed instruction about using wallets linked with Opensea would help the users a lot. In Opensea, the wallet icon is not so clear to the users.

To make the design more simpler and more user-friendly, a more straightforward icon might be employed. Even though Opensea has resources defining various terminologies associated with NFTs, a more thorough explanation would be more beneficial for those with less experience. They provide separate guides for buying, selling and creating NFTs, but no separate guide for the bidding process is available which is one of the fundamental steps for buying an NFT. The bidding process is described with the buying process, which leads to inconvenience for a user who is trying to learn about it. A separate section describing this would be more convenient. Short videos could be provided for those who find them easier to study from than written documents. Also, two of our participants encountered 404 errors while trying to examine distinct categories which needs to be solved for better user experience.

Since creating NFTs is a primary task of using these marketplaces, a “Create” icon in the homepage would encourage more users to create and upload NFTs. In Opensea, the “Create” tab comes under the profile icon of a user, which can be a bit difficult to find. While creating NFTs, an approximate price suggested by the marketplace would help stabilize the prices of NFTs. Also, they should provide a list of suggested file formats supported by their website so that users do not face frustration while trying to create NFTs with unsupported file formats. When an NFT is created, it needs to be checked out from a user’s profile itself, which may bother the users and they may find this process of confirmation time consuming. An alert message or a pop up window would help the users being sure of their created NFTs. After the creation of an NFT, the owner may list it for selling. A time period that specifies how long the NFT will be available for purchase at that price can be defined during the listing procedure but this step of listing might occur challenging for users with less technical knowledge. A small tooltip would help the users a lot understanding this part. A success message could be shown here as well to confirm the users that NFT has been successfully listed for selling. We asked our participants to buy at least one NFT from a particular collection ID. Since NFTs that have already been sold cannot be purchased, we have observed that NFTs appear in the order of creation rather than the ones that are currently accessible first which created hassle in the users. In our opinion, if newly created NFTs are shown first and sold NFTs are shown later then it would be of use to the users selecting NFTs for buying. In Opensea test network, the bidding option is not available. A user would not be able to grasp the idea from the test network before moving on to the main network with real transactions. One

participant wanted to bid but was not successful. We suggest providing this functionality in the test network will be beneficial for comprehending the concept. While buying an NFT, we have observed that the process takes a while to complete. Also it takes some time to appear the NFT on the buyer's profile while the wallet balance is updated shortly. It created anxiety in three of our participants. It is recommended to show a message about the status of the system. If a transaction is taking long to complete, then an alert message would relieve the users that their money is not lost. The same goes on with the completion of the transaction. A success message would ensure the users about their bought NFTs. We have spotted a redundancy in the buying process. A user needs to add the selected NFT to the cart at first and from the cart, further actions can be taken to complete the purchase. A straight "Buy now" option would help removing this redundancy.

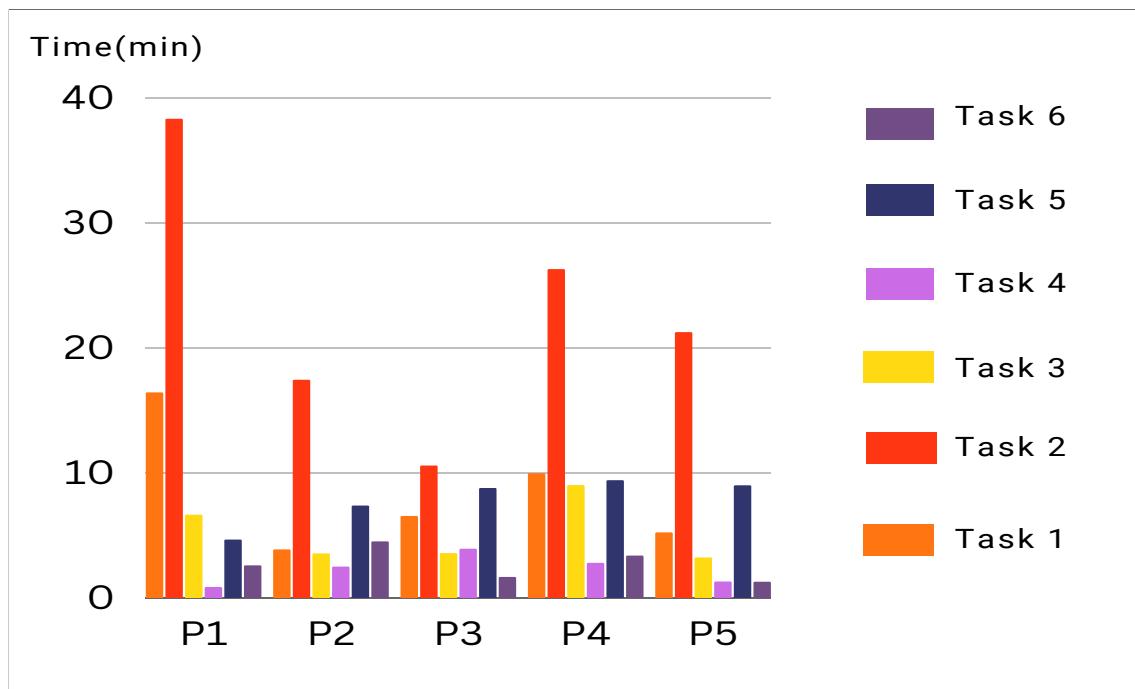


Figure 7.2: Time taken by participants to perform the tasks

Since NFT marketplaces are connected with crypto wallets, we also picked up some tasks regarding wallet management. Mishandling of wallets may lead to permanent damage for a user. We have noticed that if users try to change their previous devices and access their wallets from new devices, then they would have to enter their secret key. Every time the device is changed, a new

password has to be set. There is no shorter way available for doing this. Our participants found it cumbersome to input the twelve word secret key word by word. Moreover, setting new password every time seems unnecessary as more new passwords are hard to remember and difficult to set. If the device is changed and password has been set anew, then all the logins with old password should be logged out for security purposes. But to our surprise, we have noticed that previous logins does not get logged out which may lead to huge security breaches. To attract more users and gain more trust, these issues need to solved very shortly. We have also considered the case of losing track of passwords. If users lock their wallets and forget their passwords, they can log back in by updating the password through the “Forgot password?” option. In this step also, the twelve word secret key is required. We anticipate that copying and pasting the whole secret key at once would be more efficient. However, if the secret key is lost, the user cannot recover the wallet. So an additional layer of security might be considered here.

The Cognitive Walkthrough has some drawbacks despite being extremely adaptable. However, the study’s findings are sufficiently apparent to pinpoint Opensea’s usability problems with basic tasks. The user acceptance and global adoption of NFTs will dramatically increase once these problems are fixed.

The next chapter provides the summary of all the responses from the semi-structured interviews and the cognitive walkthroughs. In this chapter, we analyze the responses and based on that, present an improved design for an NFT marketplace that would attract more people to the world of NFTs, moreover, which would more user-friendly to use.

Chapter 8

Proposed Design from the findings of Cognitive Walkthrough and Semi-Structured Interview

The majority of the Opensea interface was duplicated in the new UI, with some improvements. Several improvements derived from fresh information discovered while conducting the study and participant recommendations. It is assumed that the new prototype has represented a professional and convenient interface design by copying the majority of the interface.

P1 suggested to have a “Create” button in the homepage. She also had difficulties finding out the “NFT 101” section, so suggested to have it on top of the homepage. P3 expected a pop up window as he was visiting for the first time. At first, P5 could not identify the wallet icon. She found the icon a bit tricky to identify. Following these suggestions, the overall layout of Opensea homepage has been duplicated with a simpler wallet icon and a “Create” tab. A pop up window has also been suggested in case of unregistered users. Figure 8.1 shows the suggested homepage for Opensea.

The screenshot shows the OpenSea homepage with the following interface elements:

- Header:** OpenSea logo, search bar, navigation links (Drops, Stats, Resources, Create), user icon, and a shopping cart icon.
- Section Headers:** "Trending" and "Top".
- Table:** A grid showing the top 10 NFT collections based on floor price and volume. The columns include COLLECTION, FLOOR PRICE, VOLUME, COLLECTION, FLOOR PRICE, and VOLUME.

COLLECTION	FLOOR PRICE	VOLUME	COLLECTION	FLOOR PRICE	VOLUME
1 WonderLettersMysteriousClub - GOERLI	< 0.01 ETH	1 ETH	6 V3CoolNft	0.11 ETH	0.97 ETH
2 BoredApeYachtClub - GOERLI - TEST	1.42 ETH	6 ETH	7 RabbitHoleReceipt	-	0.15 ETH
3 Blockies - MGRf3kFBTG	5 ETH	5 ETH	8 test_createOpen	< 0.01 ETH	0.08 ETH
4 HAVAH Friends	0.02 ETH	2 ETH	9 WritableNFT V3	0.05 ETH	0.05 ETH
5 Unidentified contract - gufNqJ902e	1 ETH	1 ETH	10 Padi721	0.20 BNB	0.20 BNB

- Section:** "Trending in Art".
- Call-to-action:** "Get started with NFT 101".

Figure 8.1: Homepage

Figure 8.2 shows the homepage for the users whose wallets have not been connected to the marketplaces yet.

The screenshot shows the OpenSea homepage for unconnected users with the following interface elements:

- Header:** OpenSea logo, search bar, navigation links (Drops, Stats, Resources, Create), user icon, and a shopping cart icon.
- Section Headers:** "Trending" and "Top".
- Table:** A grid showing the top 5 NFT collections. The columns include COLLECTION, FLOOR PRICE, and VOLUME.

COLLECTION	FLOOR PRICE	VOLUME
1 Blockies - MGRf3l	0.30 ETH	
2 BoredApeYachtC	0.15 ETH	
3 HAVAH Friends	0.15 ETH	
4 V3CoolNft	0.12 ETH	
5 Unidentified cont	0.10 ETH	

- Background Message:** "Welcome to OpenSea" and "Don't have your wallet connected? Connect now".
- Section:** "Trending in Art".

Figure 8.2: Pop up window

The entire “Resources” section has remained unchanged with only one added tutorial. The added tutorial is about the bidding process. Since P4 have faced difficulties finding this out, we are suggesting a separate section for it. So when a user visits the NFT 101 section for the first time, the bidding process of the Opensea will be much more easier to understand. Figure 8.3 shows the suggested resources section for OPensea with one added tutorial.

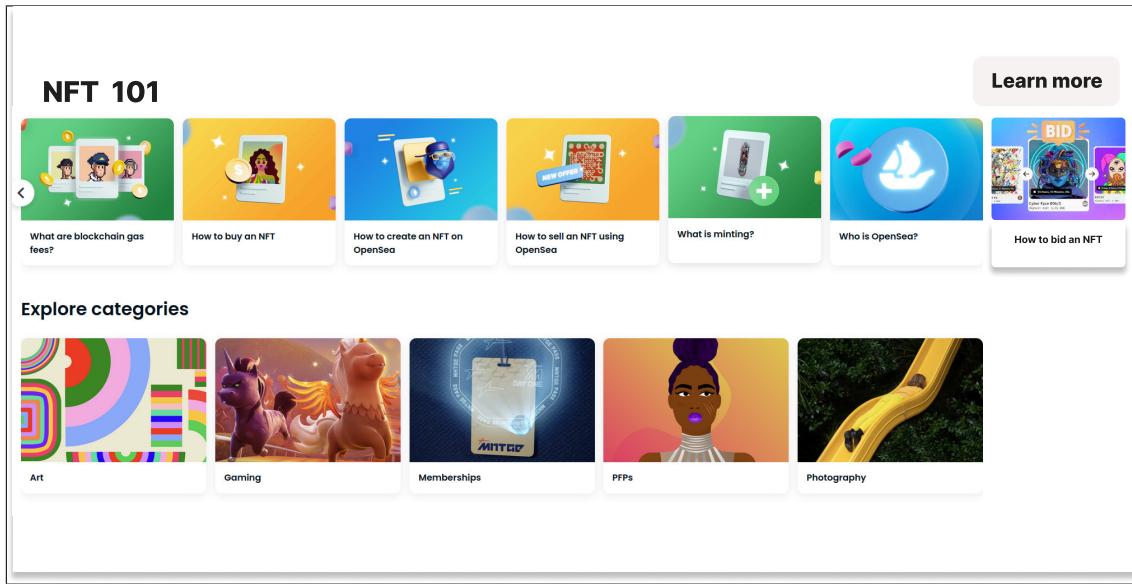


Figure 8.3: Resources page

A “Buy now” option has been added alongside with the “Add to cart” option. P3 and P4 found it redundant to add the items to the cart and then by accessing the cart complete the buying procedure. We have provided a design based on this suggestion where multiple selected items can be added to the cart if needed and from there the buying process can be completed. However, a single selected item can be bought directly from the “Buy now” option. It may or may not be added to the cart based on the preference of the user. The rest of functionalities remain same. Figure 8.4 shows the buying page designed based on the comments of the participants.

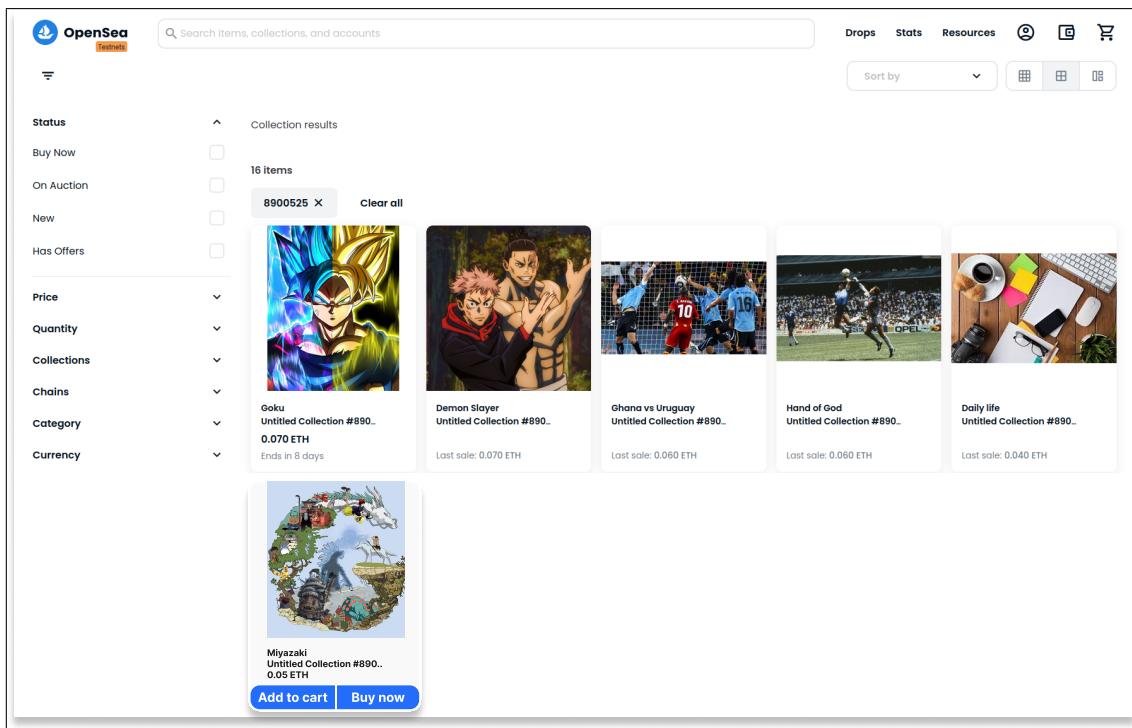


Figure 8.4: Buy now page

Before, when a transaction was made it was not clear that the transaction is still on process but now with a pop up window, it is much more clear to understand that after submitting the transaction, the transaction is still on progress. So a user will not get confused if the transaction has already been done or not. Figure 8.5 presents a pop up window with the status of the buying process.

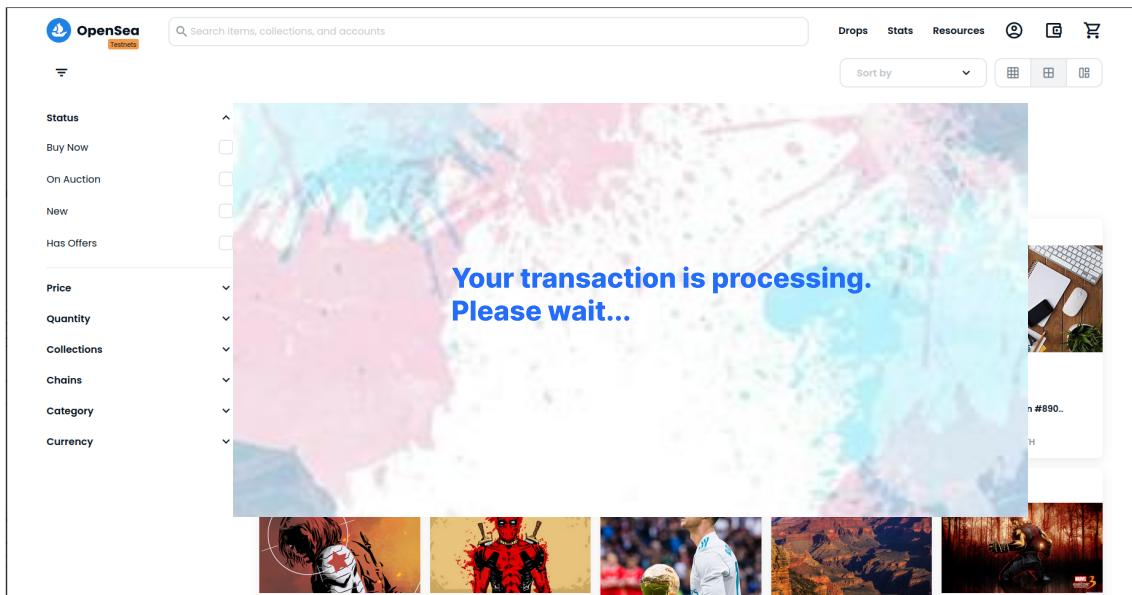


Figure 8.5: Pop up window

P2, P3 and P5 found it cumbersome to input the twelve word secret key one by one. They said it would be convenient for them if the whole secret key could be copied and pasted at once. Only one input box should do the work. Following this suggestion, we are proposing to keep only one input box where the whole secret key can be copied and pasted at once. Figure 8.6 shows the suggested page for recovering accounts with secret keys.

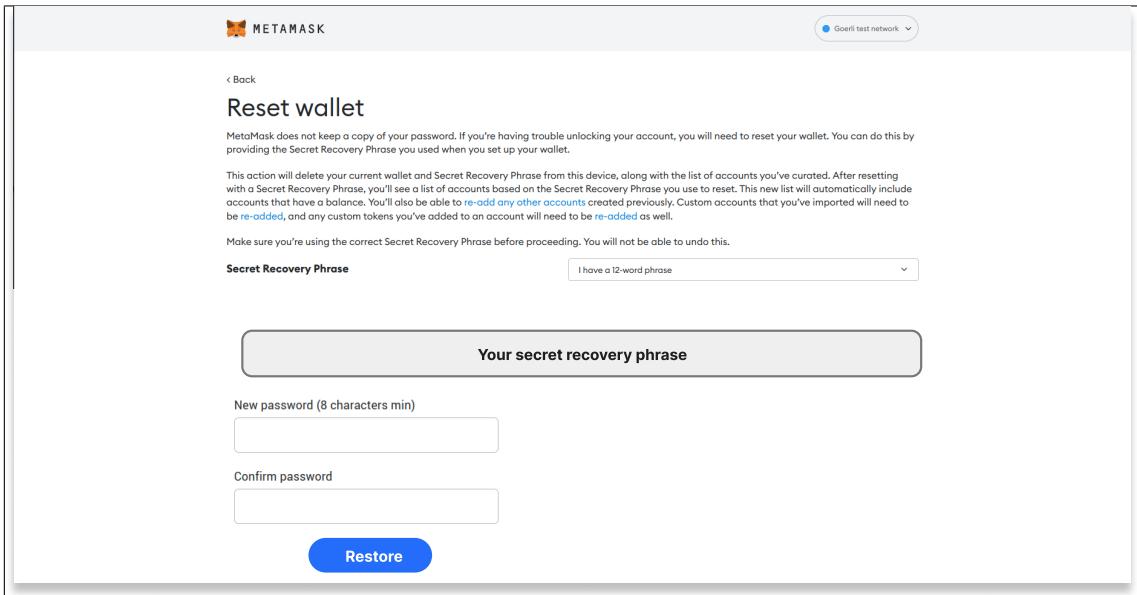


Figure 8.6: Recovery page

P3 found out a massive bug in the Opensea. He found out that after creating a NFT and listing that NFT for selling in his personal account, he can still change the image of the NFT. In his opinion, this should not be possible because if someone creates and lists a NFT and changes the image of the NFT before selling, it violates the rules of authenticity for the NFT.

With the findings of cognitive walkthrough experiment and semi-structured interview, a more suitable and user friendly design has been proposed in this chapter which will make the experience of the users better than before.

Chapter 9

Conclusion

It is not hard to see that non-fiat currencies offer a number of distinguishing ownership features that traditional tangible commodities do not have. It provides opportunities for artists and other creators to exhibit their works, while also providing art enthusiasts with the chance to purchase an original piece of artwork. In a manner analogous to how blockchain technology established a trustworthy network that allowed for the existence of digital money, non-fungible tokens (NFTs) now offer guarantees about the originality, singularity, and ownership of one-of-a-kind assets. NFTs have the potential to alleviate a great deal of suffering; nevertheless, there is a risk that they will also cause a great deal of additional suffering. Since the beginning of the proliferation of NFTs, a variety of concerns have been cited as the primary justifications that detractors of NFTs have brought up. The objective of this study is to investigate the real reasons that are preventing NFTs from getting wider recognition from the points of view of people who are knowledgeable about both cryptocurrencies and NFTs but who have no prior experience working in either of these fields. The participants in this study are people who have never worked in either of these fields before. We made an attempt to cover a wide range of themes, such as safety and privacy concerns, as well as our overall perspective on NFT marketplaces.

We proposed a framework for the evaluation of five different NFT markets. We have compared them with regard to the blockchains that they support, the cryptocurrencies that they support, the transaction fees that they charge, the royalties that they charge, the training support that they offer, the NFT categories that they support, their mobile applications, and the wallets that they support.

It is possible to see, by utilizing the framework, that each of them are distinct from one another in certain respects. Every one of these five marketplaces takes credit cards in order to maintain a connection with the conventional trade system. The most efficient method of communication is through mobile applications; nevertheless, only OpenSea has built their own. Because there has to be a greater availability of resources in order to attract more attention to NFTs, these marketplaces make it easier for users to access the information they seek. The primary strategy utilized by all of them is documentation, with the exception of Rarible and NBA TopShot, who provide their customers live online training sessions.

Throughout the course of this research, we made use of interviews that were only partially organized in an effort to determine the key issues that were presented by NFTs, some of which may still require more exploration. The questionnaire that was used for the interview was split up into five sections, which were as follows: NFT fundamentals, NFT transactions, security and privacy, and attitude toward NFT marketplaces. Because of the way we do research, we have arrived at the conclusion that the whole technology that underpins NFTs need more research and development. It is required to make it feasible for a collection of materials that show more potential to be adopted by a wider number of people. Our study on this subject, in which we would like to investigate challenges that develop during the trading of NFTs in markets, is something that we would like to further in the near future. As a consequence of our study to this point, we have compiled a number of potential answers as well as a list of potential obstacles that might stand in the way of NFTs.

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