Understanding User Perspectives on Non-Fungible Tokens: Toward an Ideal NFT Marketplace Design

Sohaiya Islam[a,1], Shahriar Ibne Saifullah[a], Farida Chowdhury[c] and Md Sadek Ferdous[c,d,*]

[a]*Shahjalal University of Science and Technology, University Ave, 3114, Sylhet, Bangladesh*
[c]*BRAC University, Kha 224 Pragati Sarani, Merul Badda, 1212, Dhaka, Bangladesh*
[d]*Imperial College London, Exhibition Rd, South Kensington, SW7 2AZ, London, United Kingdom*

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ABSTRACT

The digital art and collectibles sectors are rapidly being transformed by a phenomena known as Non-fungible Tokens (NFTs). NFTs offer a wide range of applications, including digital art. They can be used to indicate the ownership of any unique object by serving as a deed for that item, whether it exists in the physical or digital world. NFTs, which are enabled by smart contracts on a smart contract supported blockchain, thus providing content creators greater control than ever before. The purpose of this research is to highlight the many barriers to the broad use of NFTs. A semi-structured interview with NFT marketplace customers has been carried out since this style of interview helps to extract significant information in a range of situations. The interview technique has been used to monitor and analyze the opinions of people who had participated in marketplace transactions. In addition, a cognitive walkthrough is performed to assess the feasibility of a marketplace from the perspective of a novice user. The interview results and the cognitive tour have been able to identify areas of widespread distress and potential development opportunities. According to the findings, the entire technology supporting NFTs needs to be updated before it can be adopted for widespread adoption by more individuals. A review of our findings from many perspectives is provided, including those in which setbacks exist; however, prospective changes are proposed to improve and increase the marketing of NFTs. Finally, based on these findings, we propose an ideal design for an NFT marketplace.

1. Introduction

Blockchain technology has led to a new era of digital ownership, represented by Non-Fungible Tokens (NFTs), which establish a unique bond between owners and their digital assets. Kevin McCoy and Anil Dash pioneered this concept with the creation of the first NFT, named "Quantum," in May 2014 [76]. Just three months after the inception of the Ethereum blockchain, the groundbreaking NFT project Etheria [28] was unveiled during DEVCON 1 in London, October 2015. The explosive popularity of CryptoKitties [20], a cryptocurrency-themed online game in 2017, further boosted NFTs into the spotlight, showcasing their potential for revenue generation through the sale of tokenized assets.

However, despite their unique attributes, NFT trading is far from straightforward, requiring a complex series of steps to complete transactions. Despite their appeal, NFTs have yet to gain widespread acceptance, prompting the need to investigate the barriers that hinder their adoption. One significant challenge lies in the intricate transaction procedures within NFT marketplaces, requiring the development of specialized wallets for managing these transactions. Nevertheless, integrating these wallets seamlessly into marketplace transactions remains a challenge, often presenting a usability obstacle for users. Our goal in this paper is to examine usability issues related to NFT marketplaces. We conduct interviews with people who have used cryptocurrencies and NFTs in the past to achieve this. Next, we assess a chosen marketplace using a skilled usability evaluation method called a cognitive walkthrough. Our objective is to pinpoint general usability problems along with the benefits of particular ideas so that we may make design suggestions for the advancement of NFT marketplaces in the future.

The main contributions of this article are as follows:

- We present different aspects of our semi-structured interviews with NFT marketplace users and experts on NFTs and cryptocurrencies. This covers a wide range of topics such as their thoughts on these markets, concerns about security, and what restrictions apply while using cryptocurrencies.

- We investigate the usability issues with Opensea, the most popular NFT Marketplace. This explores the design of the user interface as well as any difficulties users may encounter when transacting, linking a cryptocurrency wallet of their choice, creating an account, and retrieving it.

- We recommend a number of suggestions to designing an ideal NFT marketplace. The recommendations are based on the initial experiences with Opensea and by taking into account the most important suggestions for enhancements offered by the participants in the cognitive walkthrough.

Structure: The following sections outline the structure of this article. Section 2 presents a brief background on blockchain, non-fungible token (NFT), and Opensea.

*Corresponding author

✉ sohaiyadipra@gmail.com (S. Islam); shahriar31028@gmail.com (S.I. Saifullah); farida.chowdhury@bracu.ac.bd (F. Chowdhury); sadek.ferdous@bracu.ac.bd (M.S. Ferdous)

ORCID(s):

Section 3 provides an overview of the relevant previous research divided into three main parts: NFT marketplace and ecosystem, cognitive walkthrough, and semi-structured interview. In Section 4, we present different aspects of the semi-structured interview, including the interview procedure, coding process, questionnaire design, and the findings. Section 5 presents the cognitive walkthrough evaluation of the chosen marketplace. Section 6 highlights a number of recommendations for an ideal design solution for the selected marketplace, accompanied by potential suggestions for improvements based on user experiences. Finally, we conclude in Section 7.

2. Background

In this section, we present a brief background on blockchain (Section 2.1), Non-fungible Tokens (Section 2.2) and Opensea (Section 2.3).

2.1. Blockchain

A blockchain is a distributed ledger that can 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 [15]. The distributed ledger that replicates and disseminates transactional data throughout the network of computers that are involved in the process.

Blockchain technology is a framework for keeping public transactional records combined in a data structure called *block* across numerous databases in a network connected by peer-to-peer nodes. The sequences of blocks are then chained together following some cryptographic rules, thus creating the notion of Blockchain. Every transaction in this ledger is authorized by the digital signature of the owner, which authenticates the transaction. Hence, the information the digital ledger contains is highly secure. There are four different types of blockchain [36].

- **Public blockchains** contributed to the proliferation of Distributed Ledger Technology (DLT) by facilitating the creation of cryptocurrencies such as Bitcoin and others. 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 (PoS) and Proof of Work (PoW) are two types of consensus algorithms that are frequently used to validate the correctness of information. Bitcoin [8], Ethereum [27], Solana [65] and Cardano [10] are a few instances of public blockchain systems.

- **Private blockchain** is a single entity that 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. Some examples of private blockchains are Hyperledger Fabric [31], Corda [18], and Ripple [59].

- 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. They offer a more structured approach to choosing who may participate in the network and in what transactions, which is an advantage. XinFin [77], Dragonchain [22], Kadena [39] are instances of hybrid blockchain system.

- **Consortium blockchains**, which are very similar to permissioned blockchains, have both private and public sections. 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.

2.2. Ethereum & Non-Fungible Token (NFT)

Ethereum is an open-source, decentralized blockchain technology that is well-known for supporting smart contracts [27]. Ethereum functions as a blockchain that can be programmed, enabling programmers to create and implement decentralized applications. The development of the ERC-20 [24] and ERC-721 [25] token standards , which permit the creation and administration of tokens on the Ethereum network, is one of Ethereum's major innovations. The creation of non-fungible tokens (nfts) - unique digital assets that signify ownership of particular objects, such as artwork, collectibles, or virtual goods - particularly depends on the ERC-721 standard. The NFT market has been propelled by these tokens, which enable developers, artists, and producers to mint, trade, and auction NFTs in a safe and transparent manner on the blockchain, with all transactions being documented on Ethereum's public ledger.

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 assets 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.

Features of NFTs:

- **Unique:** Every NFT has its own distinctive quality, which is typically mentioned in the token's accompanying information.

- **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 divided into smaller quantities, broken up into smaller amounts or acquired or transferred in segments.

- **Ownership:** These tokens ensure that the correct person is credited with ownership of the asset that was supplied.

There can be only one owner of an NFT at any given moment. 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. The minting process, from a high level, has the following steps that it goes through:

- Creating a new block.

- Validating information.

- Recording information into the blockchain.

Creating NFTs involves several key steps that leverage blockchain technology to mint unique digital assets. First, the creator chooses a blockchain platform that supports NFTs, with Ethereum being the most popular due to its ERC-721 token standard [25]. Next, the creator needs a digital wallet compatible with the chosen blockchain to manage their assets and pay for transaction fees, commonly known as "gas fees" on Ethereum. After setting up the wallet, the creator selects a marketplace (like OpenSea [52], Rarible [57], or Mintable [48] where they can mint their NFT. The minting process typically begins by uploading the digital file (e.g., artwork, music, video) that will be tokenized. The creator then adds metadata, including the name, description, and attributes of the NFT, and sets any desired royalties, which allow the creator to earn a percentage of future sales. Once all the details are finalized, the creator initiates the minting process by paying the necessary fees, which results in the NFT being recorded on the blockchain as a unique token, verifiably owned by the creator. This NFT can then be sold, traded, or transferred on the marketplace, with all transactions transparently tracked on the blockchain.

NFT standards are crucial in defining how non-fungible tokens function across different blockchain networks. The most widely adopted standard is Ethereum's ERC-721 [25], which introduced the concept of unique, indivisible tokens, making it ideal for digital art, collectibles, and other one-of-a-kind items. Building on this, ERC-1155 [23] emerged as a more versatile standard, allowing the creation of both fungible and non-fungible tokens within the same contract. In addition to the widely known ERC-721 [25] and ERC-1155 [23] standards on Ethereum, several other NFT standards have been developed across different blockchain platforms. For instance, on the Binance Smart Chain (BSC)

[12], the BEP-721 [5] and BEP-1155 [4] standards function similarly to Ethereum's ERC-721 and ERC-1155, enabling the creation of unique and multi-token assets on BSC. Of the three main token standards used by Tezos [70], only the FA2 [30], often referred to as the TZIP-12 [71], is non-fungible. Non-Ethereum standards are being developed by blockchains like Cosmos [19], NEAR [51], and Ceramic Network [11], among others. Another example is Solana's Metaplex standard [47], which is tailored for the high-speed, low-cost Solana blockchain, making it a popular choice for large-scale NFT projects [38].

2.3. Opensea

The OpenSea trading platform provides an online marketplace for NFT inventors, sellers and buyers [52]. OpenSea is a cross-blockchain platform, which means it supports multiple blockchains, including Ethererum [27], Polygon [55], Solana [65] and Klatyn [42]. NFTs can be browsed by categories, such as art, collectibles, music, photography, virtual worlds and gaming. OpenSea's user-friendly platform and instructive content may be useful for newcomers interested in purchasing, trading and minting NFTs. It also features relatively modest costs and a large assortment of NFTs. Furthermore, the OpenSea mobile app is accessible for both iOS and Android smartphones.

3. Related Work

In this section, we present the research studies related to this research. The presented studies are organized into three categories that include the NFT marketplace and ecosystem (Section 3.1), cognitive walkthrough (Section 3.2) and semi-structured interview (Section 3.3).

3.1. NFT marketplace and ecosystem

Several existing studies have explored the security issues of NFTs and investigate the challenges they faced. For example, Chevet et al. analyzed the whole creation process of "Rare Pepes" [13], one of the first crypto assets to gain significant attention. In the study, a brief overview about "CryptoKitties" [20], an Ethereum-based blockchain game, was discussed along with describing the usage of some various other NFT projects.

Das et al. presented the first systematic study of the NFT ecosystem in eight top NFT marketplaces [21]. They identified the actors and components in the ecosystem and studied the scams, malpractices and fraudulent user behaviors.

Shilina et al. explored various NFT-related subjects in their study published in [64]. Their research encompassed an examination of the NFT ecosystem, its use cases, and market, as well as a discussion of its key features and standards. Additionally, the study delved into the challenges and security concerns associated with NFTs.

The views on NFT marketplaces from NFT creators were studied by Sharma et al. [62]. They discussed the motivations behind creating NFTs, engagements with NFT communities and the difficulties they faced with NFTs. In

addition, they offered design recommendations for NFTs to overcome the current obstacles in the ecosystem.

Fairfield et al. explored the legal challenges surrounding NFTs [32]. The research introduced a taxonomy of NFTs and their characteristics which can serve as a reference for ownership restrictions. Furthermore, a robust legal framework for NFT trading was proposed.

Ante et al. explored the connection between NFT sales and the pricing of cryptocurrencies such as Bitcoin and Ether by analyzing a dataset comprising 1231 daily observations on NFT sales from January 2018 to April 2021 [1]. The authors showed that NFT sales increased with the rising prices of Bitcoin; however, the rising prices of Ether reduce the number of active NFT wallets.

In another study, based on a dataset of Ethereum-based NFT markets between June 2017 and May 2021, the author observed the interactions and causal relationships between fourteen NFT projects [2].

Chohan et al. [14] drew attention to the value and scarcity of digital assets with respect to blockchain technology. The author explains the subtle differences between how NFTs should and can function, as well as the potential these non-fungible assets have in the digital realm. It also provides arguments against the conceptual and functional significance of these assets, as well as possible risks.

Wang et al. gave a brief explanation about the ecosystem of NFTs, their protocols, standards and properties [73]. They presented the "STRIDE" threat model for NFTs and proposed possible solutions for them . This model was based on the whole NFT ecosystem and not only on any particular NFT marketplaces.

Regner et al. implemented a blockchain-based event ticketing system [58], with Ethereum and NFTs being the core components of the system. They attempted to address the questions of whether NFTs could be used in real-world applications and if they could improve existing systems.

Roy et al. conducted a longitudinal analysis of several promotion services that promoted unique NFT initiatives in [60]. Their findings revealed that a significant portion of these initiatives were fraudulent, along with the accounts associated with them. Additionally, they identified several flaws in the current anti-scam policies. To address this issue, they developed a machine learning classifier tool based on their methodology to identify fraudulent NFT initiatives.

Nadini et al. analyzed data on 6.1 million trades of 4.7 million NFTs between June 23, 2017 and April 27, 2021 [50]. They presented the first overview of some key aspects of NFTs based on six categories.

Weber et al. provided a basis for potentials of NFTs and their problems [74]. Although the study focused NFT sales in US from 2020-2022, it did not analyze data from any particular marketplace.

3.2. Cognitive walkthrough

Utilizing a survey and a cognitive walkthrough method with cryptocurrency users, Biernacki et al. concentrated on a comparative analysis to assess which tool provides the best current solution for holding cryptocurrencies [6].

Eskandari et al. applied the cognitive walkthrough method to comprehensively assess the usability of six selected Bitcoin clients and suggested an evaluation framework for Bitcoin key management strategies [26].

Moniruzzaman et al. [49] investigated typical usability problems with desktop and mobile wallets using the analytical cognitive walkthrough usability inspection method.

Ramadhan et al. conducted an evaluation on user interactions with the top three websites frequently used to access cryptocurrencies in Indonesia. [56]. Based on the user experience, their conclusion, suggestions and website design all indicated that cryptocurrencies are reliable.

3.3. Semi-structured interview

Sharma et al. conducted an exploratory qualitative study that involved both a code review task and a semi-structured interview [63]. 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 on their evaluations of Bitcoin [34]. The results indicated that non-users feel incapable of using Bitcoin, users lack understanding of the protocol, users have misconceptions regarding transaction anonymity, and participants think Bitcoin meets the standards of an ideal payment system.

In [61], the authors presented a semi-structured interview with non-users of NFT (people who do not use the NFT marketplaces but have knowledge about cryptocurrencies) and evaluated five NFT marketplaces. The study used semi-structured interviews with non-users of NFT marketplaces to gather perspectives on various NFT-related topics, such as backgrounds, attitudes, transactions, marketplaces, ecosystems, and security concerns. The findings revealed that most of the participants had limited understanding of NFTs and avoided participation due to local regulations. Although many viewed NFTs as a good investment despite security doubts, they provided basic recommendations to encourage NFT participation.

After reviewing the research studies conducted thus far, we can conclude that studies have been conducted to analyze some of the most well-known NFT creations, such as Cryptokitties, Rare Pepes, has been done through studies [13]. Additionally, research has been done on the NFT ecosystem's systemic investigation which also outlines the fraud and swindles that occur within the ecosystem [21]. A study to date has also suggested a danger model for NFTs as well as potential remedies [73]. Research has also been done on how NFTs can be adapted for use in current applications [58]. Numerous cryptocurrency tools have undergone cognitive walkthroughs [26, 49]. Up until now, semi-structured interviews have been used to illustrate smart contract security concerns [63]. In a study, user and non-user perceptions on bitcoin were examined [34]. The non-user viewpoints on NFTs were reported in another study

Authors	NFT Ecosystem	NFT Security Evaluation	Crypto Wallet Evaluation	Crypto User, Non-User Evaluation	NFT Non-User Evaluation	NFT User Evaluation	NFT Marketplace Analysis
Biernacki et al. (2021) [6]	○	○	●	○	○	○	○
Das et al. (2021) [21]	●	●	○	○	○	○	○
Xianyi Gao et al. (2016) [34]	○	○	○	●	○	○	○
Moniruzzaman et al. (2020) [49]	○	○	●	○	○	○	○
Roy et al. (2024) [60]	○	●	○	○	○	○	○
Shilina (2022) [64]	●	●	○	○	○	○	○
Wang et al. (2021) [73]	●	●	○	○	○	○	○
Shahriar et al. (2022) [61]	○	○	○	○	●	○	○
Our contribution	○	○	○	○	○	●	●

Table 1

Comparison of existing work on NFT ecosystem, security, and usability. A filled dot (●) indicates that the study addressed the corresponding category, while a blank dot (○) indicates that it was not covered.

[61]. Numerous studies calculate the statistical values of NFT sales over a period of time by combining the data from several different marketplaces [1, 2, 50]. No study has been done yet to examine the usability problems with any NFT marketplace. Research conducted to date has examined the NFT ecosystem as a whole, but has not taken into account any specific NFT marketplace. As of yet, no design has been put up for the NFT marketplace. There has also been no study to observe NFT users perspectives. A comparable method has not been used to identify usability problems for NFT marketplaces, despite cognitive walkthrough revealing flaws with bitcoin clients' usability.

By utilizing a qualitative approach to usability testing, a semi-structured interview, our overarching goal is to gain a better understanding of the views of users of NFTs as well as their concerns on various aspects of NFTs. We want to identify and assess the usability problems of a certain NFT marketplace through cognitive walkthrough. Drawing from our observations and analysis of the cognitive walkthrough process results, we also suggest an optimal design for NFT marketplaces that could potentially address current usability issues. Table 1 serves as a comparative table that highlights the differences between existing works and our contribution.

4. Semi-structured Interview with NFT Users

In this section, we present a semi-structured interview with users of NFT marketplaces. The objective of this interview is to understand different aspects of users' perspectives on NFT marketplaces and cryptocurrencies, along with their motivations for engaging in various activities involving NFTs within these platforms and their views on cryptocurrencies.

4.1. Methodology

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

Participants: We recruited 12 participants with ages ranging from 24 to 50 years, all of whom had previously used at least one NFT marketplace. The participants were from various regions of the world and had diverse professional backgrounds, such as software developers, software testers, professors, researchers, and blockchain developers. The selection criteria emphasized not only familiarity with cryptocurrencies and NFTs but also with the practical experience of transactions in NFT marketplaces. Table 2 shows the demographics of the participants for the semi-structured interview.

Participant	Occupation	Region
User1	Professor	Europe
User2	Blockchain Developer	Asia
User3	Software Engineer	Europe
User4	Computer Engineer	Asia
User5	Lecturer	Asia
User6	Blockchain Developer	Asia
User7	Blockchain Developer	Asia
User8	Software Tester	Asia
User9	Researcher	Europe
User10	Researcher	Europe
User11	Researcher	Europe
User12	Web3 Developer	Asia

Table 2: Demographics of the participants

These 12 participants are labeled as *U1* through *U12*, with 10 males and 2 females. The participants had diverse educational backgrounds and were recruited through our personal networks and various social media platforms.

Interview Procedure: Given that our participants were located in various countries, we decided to carry out semi-structured interviews online via Google Meet and Zoom during November and December 2022. Each interview had a duration of 30-60 minutes. The interview questions were pre-written in a script. In addition, we posed follow-up questions to participants to better understand their responses. The interviews were recorded and transcribed into text afterward.

Interview Coding: The coding of the interviews was performed by the first two authors of this research. Initially, in-vivo coding [45] was used to generate labels from the interview responses which resulted in several themes, reflecting the viewpoints of the participants on each subject. Subsequently, for further classification, axial coding [75] was applied, which led to the identification of various concepts and themes. The coding was reviewed and re-coded

multiple times across different themes to ensure consistency in our findings. In Section 4.2, we present these themes with representative quotes from different participants.

Interview Questionnaire: We prepared the questionnaire to unravel some key points related to NFTs. At first, we wanted to know how much knowledge the participants have about the basics of NFTs and cryptocurrencies. Their experience with NFT transactions was also discussed. We wanted to understand their attitudes towards NFT marketplaces and the whole ecosystem of NFTs. Their concerns with security and privacy implications were considered with possible improvement suggestions followed by some miscellaneous questions.

4.2. Findings

In this section, we present our findings from the semi-structured interview. The findings are grouped into different categories and are presented in the following.

NFT and cryptocurrency 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 the type of cryptocurrency with which they interacted. We also tried to understand whether they had any idea on how NFTs function. Five of them did not mention anything about their experience with cryptocurrencies. Only U5 described the procedure of buying cryptocurrencies in his country: *"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."* Five other participants explicitly mentioned when they first began dealing with 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."* Although U2 is knowledgeable about Bitcoin transactions, U2 has no practical experience using it. U3 started using Bitcoin in 2019 and is the only participant who invests in cryptocurrencies: *"I used to follow cryptocurrency from around 2016. So now I invest some of my investment into cryptocurrency."* On the other hand, U4 stated:*"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."*

In terms of NFTs, all participants described them as digital assets that cannot be duplicated. Most of them defined NFTs as the ownership of unique items. Only U2 and U5 mentioned ERC tokens. U2 said: *"NFT is a Non-Fungible token. It has no fungibility. It originated from the ERC-721 token."*. A similar 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 are used to transact multiple tokens in a single transaction."* U10 was unaware of the NFT protocol, whereas U5 and U9

were knowledgeable about it; however, U5 provided an in-depth explanation of the protocol, unlike U9 who did not elaborate. The remaining nine participants did not provide any information about their knowledge of how NFT works.

We were curious about which marketplaces they monitor and how often they visit them.

Visits in NFT marketplaces: We wanted to know which NFT marketplaces they monitor and how often they visit them. Other than U8, everybody visited Opensea. Some of them visited other marketplaces as well. We came to know about Reddit's own marketplace only from U8, 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."* U5 visited secret network based marketplace named Stashh [67], *"I have visited Opensea and Stashh. Stashh is based on a secret network."* U1 visited different marketplaces: *"I mostly visit four marketplaces. They are Objket, ArtForge for arts. I also visit OneOf for music. I also visit Opensea."* U2 and U3 visited Binance [7] along with Opensea. U2 and U9 also checked on Coinbase [17]. Although U4 has knowledge about Uniswap [72], U4 prefers Opensea and Rarible. NiftyGateway [35], MakersPlace [44] and some other marketplaces are visited by U6 while Axie Marketplace [37], Larva Labs/CryptoPunks [43], SuperRare etc. are visited by U7 and Soonaverse [66] is visited by U11.

U1, U2 and U4 generally 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. We asked U1 if the authenticity is a major problem for these marketplaces. U1 asserted: *"Yes, authenticity is a big issue in these marketplaces. When someone buys an 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 a similar response when asked about U4's visit: *"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 visited for research and development purposes. For example, U2 said: *"As a blockchain developer, I observe these marketplaces for customer requirements."* U5 stated: *"I did a project on NFT. So as a part of background study I visited various marketplaces."*. The reason for U7 was developing U7's own NFT: *"I visited to know the scenario of marketplaces to develop our own NFT."* U11 was the only one to visit market places to purchase NFTs: *"I have visited to see, save and buy NFT."* U3 and U6 visited out of curiosity. U3 described the story of U3's 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 the participants go to the marketplaces every day. Some visit from time to time, while others visit infrequently. U1 stated: *"I do not visit these marketplaces daily but I often visit them."* Likewise, U5 said: *"Earlier I visited those sites frequently. But nowadays I am supposed to visit those places occasionally."* U4 wrote: *"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 gave any clear response about their frequency of visits.

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 the Phantom wallet [54] which is based on the Solana blockchain. U8 did not name the used wallets, rather 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 [40], saying: *"I have used Keplr and a self developed wallet as well for my project."* U2, U10 and U11 use the Phantom wallet side by side with Metamask. U3, U4 and U12 hold custodial wallets in Binance along with Metamask. U3 considers Binance as a safe place to store assets as U3 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.

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. Among the participants, U3 is the only one who frequently engages in transactions: *"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 U3 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). Therefore, 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 a 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 buyimg 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.

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 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. 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 U10 answered: *"There is a club with people buying NFTs. I started trading to get access to the community that is connected to NFTs."*

Dissatisfaction and difficulties encountered: Next, we wanted to know the difficulties or dissatisfaction faced by participants while transacting NFTs. U4, U6, U7, U9, U10 and U11 do not dislike anything about the marketplaces. However, a concern was raised by U6 with respect to 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 fraudulent collections exhibited in the marketplaces. Plagiarism is a prevalent fraud in which con artists steal other people's artwork to make counterfeit NFTs that are then put up for auction under the false pretense of being the genuine. Buying these fake NFTs might lead to worthless art because the customers are tricked into thinking they are getting authentic items [60]. Only U6 shared an observation: *"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 difficulties using the marketplaces. It was reported that U6 and U10 had difficulties buying cryptocurrencies. U4 had some technical difficulties and stated: *"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.

The remaining six participants (U1, U2, U3, U5, U8 and U12) discussed in detail their dissatisfaction and the problems they encountered 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."* U1 also talked about the hash algorithm when talking about the difficulties during U1's first transaction: *"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 expected 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 U2 if the whole transaction process may seem hard for a first time visitor or not and U2 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 considered."* U3 expressed one concern about wallets getting hacked and commented on the interfaces of the marketplaces: *"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 to 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: *"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 U5's experience was smooth. We inquired U2, U3 and U8 about the worthless collections displayed on the marketplaces. U8 stated: *"It could 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 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."*

NFT as investment: U3, U5, U6 and U11 consider NFTs as investments. U9 thinks it depends on a specific NFT whether it can be considered as investment or not. The remaining seven participants do not consider them as investments. 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,

U1 stated *"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 believes that investing in NFTs is not worthwhile because U2 anticipates significant price fluctuations in the near future. 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."*

Security and privacy: We inquired whether they feel secure in the marketplaces or are conscious of the security risks and privacy issues, subsequently asking about the measures they have adopted to safeguard their NFTs. Other than U2, U7 and U8, all of them feel secure in the marketplaces. U2 expressed 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 because of using a hardware wallet for transactions. U1 stated the following 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."* Since U1 feels safe while using a hardware wallet, U1 does not take any other measures to protect his NFTs. About any privacy implications, U1

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."*

U12 also uses an external wallet: *"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."* U4 also provided similar response when asked about the garbage collections mechanisms in the marketplaces. U2 guards NFTs by keeping their public and private keys safe and is concerned about 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 guarding NFTs, U3 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."* U3 has no extensive knowledge about the privacy implications in the marketplaces. U11 is also unaware of any potential privacy consequences

U5 believes that using acclaimed wallets such as Metamask or Binance would keep owned NFTs safe. U6 discussed the need to enforce regulations for 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, U8 also uses a hardware wallet for transactions. Later, we asked about the management of the hardware wallet and U8 mentioned: *"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 purchased the NFT, I would disconnect my wallet from the marketplace as it is very easy to reconnect."* Other users provided similar responses, such as keeping passwords and keys safe to protect their NFTs from any kind of damage.

Instilling 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, almost every opinion centered on resolving 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 for 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.

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 and U8 want 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."* 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,"* Later, we asked U8 if this could lead back to the centralized system again and the answer was: *"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 that any regulations are necessary for NFTs. U1 and U12 think 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, that is, they want regulations to stop different fraudulent activities such as putting a much higher price and ideas like re-uploading same NFTs or copied NFTs.

4.3. Discussion

Through this semi-structured interview with NFT user participants, we were able to understand varied perspectives on NFTs. We formulated our set of questions focusing on the

basics of NFTs, the process of NFT transactions, attitudes toward NFT marketplaces and ecosystems, as well as concerns about security and privacy. As we received the responses, we discovered the following:

- 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 or for investment.

- Most participants seldom conduct transactions, with only a small number engaging in them frequently.

- 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.

In the following, we summarize our findings from the interview.

All twelve of them were knowledgeable about cryptocurrencies and NFTs. All of them described NFTs in their own terms and had experience with NFT transactions. Two participants described NFTs with the concept of ERC tokens. Others gave a general overview of NFTs and described them as digital assets. Only one participant gave a detailed description of the NFT protocol. Two participants were not knowledgeable about it, while others did not provide any response to this topic.

Several marketplaces were visited by them. Except for a single participant, everyone visited Opensea. Binance was visited by two of them along with Opensea. Coinbase was visited by two participants. Secret network-based marketplaces were also noted down as two participants used to visit them. Several other marketplaces were also reported. Figure 1 shows the marketplaces visited by the participants.
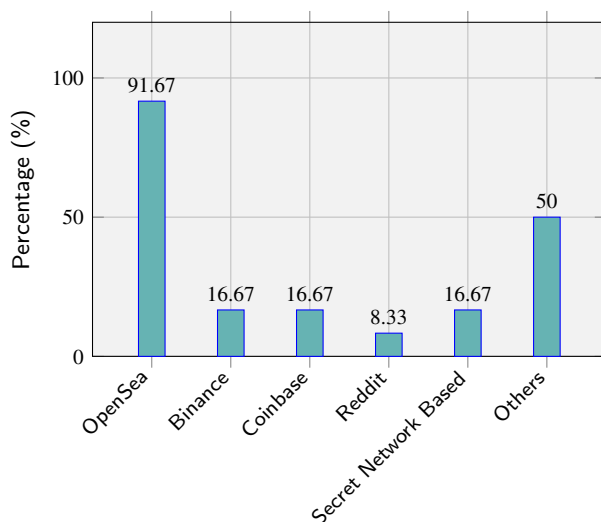

Figure 1: Marketplaces visited by participants

Since all participants were users of NFT marketplaces, they used 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 twelve participants do not use Metamask. Three use Phantom and the other one uses a wallet for a secret network blockchain. Three of them have used the Binance custodial wallet. Some more wallets, namely Coinbase custodial wallet, Tezos, Keplr and some other wallets were also noted down from their usage. Figure 2 shows the preferred wallets of the participants to use in the NFT marketplaces to buy or sell NFTs.
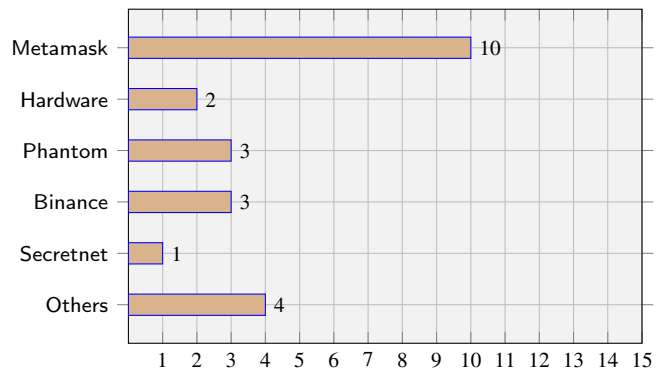

Figure 2: Participants' preferred wallets

Despite being users of NFT marketplaces, there is only one participant making frequent transactions. Most of them rarely make any transactions in the marketplaces. Interestingly, three participants engaged in several transactions. Others bought or sold NFTs for one or two times only. However, 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 participants believe that the user interface of these marketplaces should be improved as they are not so informative and easy to use for a general person. Two participants reported facing difficulties in attaching the purchased NFTs to their wallets. One participant expressed concern about the environmental impact of this technology. One participant proposed implementing an appropriate pricing structure. It was also reported that buying NFTs should be an easier process. One of them has suggested the use of dollars as currency. In addition to these, a common issue can be observed: almost everybody stated facing difficulties because of fake NFTs and worthless collections uploaded in the marketplaces.

Four participants do not consider NFTs as investments for similar reasons. Due to frequent price fluctuations, they perceive it as too risky to invest substantial amounts. In addition, the issue of garbage collection discourages them from viewing it as a viable investment option. Eight participants, on the other hand, believe that NFTs could be considered smart investments. They are confident that prices will rise because the technology is so new and investing in it could be rewarding. Figure 3 shows the opinions of the participants on whether or not to think of NFTs as investments.
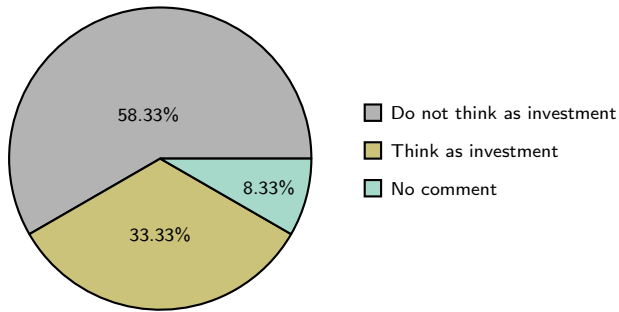
Figure 3: Percentage of participants who think NFT as investment

We have found that the attendees were concerned about the security of NFTs. Three of them did not feel secure in the marketplaces. Their security concerns revolved around the management of the wallet. Almost everyone is concerned about deceptive markets and fraudulent uploads. Some of them feel secure in the renowned marketplaces, however, not in unpopular marketplaces.

Most of the participants want a certain degree of regulation imposed on NFTs to eradicate the ongoing scams. Nine of them are in support of enforcing regulations, where two of them have suggested some kind of automated strategies to reduce fraudulent activities. Only one participant provided a negative response about imposing any regulation. Figure 4 shows the perspectives of the participants on enforcing regulations on NFTs.
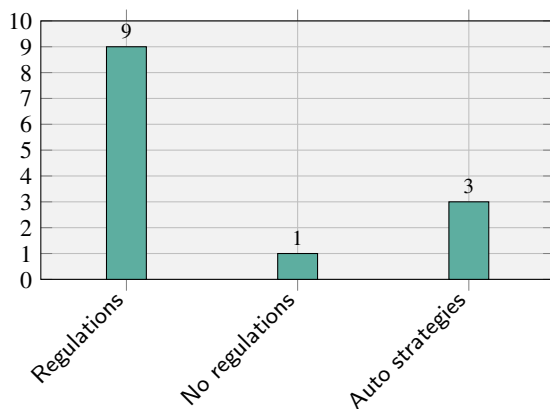

Figure 4: Participants' opinions for enforcing regulations

5. Cognitive Walkthrough with First Time Users of Opensea

In addition to the semi-structured interview with NFT users, we have also conducted cognitive walkthroughs with people who are familiar with NFTs but have never utilized a marketplace. 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 to provide reasons for its simplicity or complexity [9]. The marketplace

that was evaluated for this research is Opensea. To identify potential challenges users might encounter while performing various tasks (outlined in the following section) on Opensea, we carried out a cognitive walkthrough with new users and also assessed Opensea's interface design.

5.1. Methodology

The steps for the cognitive walkthrough are illustrated in Figure 5 and discussed next.

Figure 5: Cognitive Procedure

- **Test Planning:** Test planning for a cognitive walkthrough approach involves preparing a systematic evaluation process where usability experts step through a user interface, simulating a user's thought process while completing specific tasks. The plan outlines the objectives, such as identifying usability issues, and the scope of tasks to be analyzed. The plan also includes the resources needed, such as usability experts, and schedules for conducting the walkthroughs. By careful planning, the cognitive walkthrough can effectively identify potential usability problems early in the design process.

- **Task definition:** Task definition in cognitive walkthrough involves specifying the tasks that users are expected to perform while interacting with a user interface during the evaluation. These tasks are carefully chosen to represent key activities that typical users would attempt to accomplish in the system. The tasks are described in a way that reflects real-world goals without instructing users on how to complete them. This allows evaluators to analyze whether users can understand the interface, navigate it effectively, and achieve their objectives without unnecessary difficulty. Clear and relevant task definitions are essential for identifying potential usability issues during the cognitive walkthrough.

- **Participants recruitment:** Participants recruitment in cognitive walkthrough involves selecting and inviting individuals who represent the target user base to evaluate a system or application. This process includes identifying participants who fit specific criteria relevant to the system's intended users. Participants are recruited to simulate real user behavior and provide feedback on their experiences with the interface. Proper recruitment ensures that the cognitive walkthrough accurately reflects the perspectives of actual or potential users. This leads to valuable insights into usability issues, helping to refine the system and better meet user needs.

- **Conducting tests:** Conducting tests in a cognitive walkthrough study involves evaluators simulating a user's experience by stepping through predefined tasks within a system or application, while articulating their thought process and decision-making. Evaluators follow specific task descriptions to assess how easily a typical user can accomplish goals, focusing on learning and understanding the interface. Observers document any difficulties or usability issues encountered, which are then analyzed to identify common problems and areas for improvement. The findings are summarized in a report, detailing usability concerns and providing actionable recommendations to enhance the system's user experience. This approach helps identify and address potential issues early in the design process.

- **Analysis and report:** In a cognitive walkthrough approach, analysis and report involve evaluating the findings from the walkthrough sessions to identify usability issues and their causes. During analysis, evaluators review observations to assess how effectively users completed tasks, pinpointing difficulties or errors related to the interface's design. The subsequent report details these issues, highlighting the impact on user experience and providing specific recommendations for improvements. This report serves as a crucial document, offering actionable insights and visual aids to guide design refinements and enhance overall usability.

We chose Opensea as the platform for our cognitive walkthrough approach because it is one of the most well-known NFT markets. We intended to investigate this platform's usability problems. We had previously created a set of assignments that were broken down into smaller tasks for our cognitive walkthrough. Along with the assignments, a set of pertinent questions was included to get participant responses regarding their experiences. Regarding participants, we asked if they had some understanding of cryptocurrencies and NFTs, however, no prior experience with NFT marketplaces was necessary. Each participant completed the tasks in the presence of the two authors of this article. Guidelines and required materials were supplied. While the participants completed these tasks, two of the authors remained present to provide any further guidelines. In order to prevent bias in the results, the participants were not provided the accompanying questionnaire beforehand.

We conducted a pilot study with one participant in December 2023. It took around 75 minutes.

5.2. 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 includes NFTs, digital arts, virtual real estates, gaming items and other virtual goods backed by a blockchain [53]. As one of the first marketplaces to facilitate the trading of NFTs, OpenSea gained a significant first-mover advantage. This allowed it to establish a loyal and robust user base early on. The platform has continuously innovated, introducing features like lazy minting, which allows users to create NFTs without upfront costs, reducing barriers to entry for new creators [3]. It also accepts over 150 different cryptocurrencies, making it highly accessible to a diverse range of users [68]. OpenSea uses self-executing smart contracts to ensure secure and transparent transactions. The platform also supports hardware wallets for enhanced security, ensuring that the digital assets of users are protected against potential cyber threats [29]. Opensea provides both the main network and test network facilities. The main network is used for real transactions with real cryptocurrencies while the 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 cryptocurrencies. In both Opensea main and test networks, a crypto wallet needs to be set up. For our evaluation, we used the Opensea test network for demo transactions with demo cryptocurrencies. As for the wallet, we selected Metamask [46] which is one of the most popular crypto wallets and is based on the Ethereum blockchain [27]. Users can utilize a browser extension or a mobile app to access their wallet, which can then be used to connect to decentralized applications. Among many test networks available, our selected test network is the Ethereum Goerli test network [69].

5.3. Tasks

For our cognitive walkthrough evaluation, we defined a set of tasks. There were six tasks that ranged from basic actions necessary for any NFT-related processes, such as minting NFTs, to more complex operations such as wallet recovery. Some of the tasks also had several sub-tasks. Information related to the walkthrough procedure was provided to the participants. A series of questions accompanied each task to gather their feedback along with recommendations for potential enhancements. The walkthrough took place in January 2023, with each participant spending between 60 and 90 minutes. Next, we present these six tasks.

T1. Installing Metamask and connecting it to Opensea: This task requires the installation of Metamask and linking it to Opensea. The fundamental requirement for participating in the marketplace is to set up a wallet and establish the connection. This task has the following Sub-tasks.

- **Sub-task 1. Installing Metamask:** The user needs to install Metamask and complete all the steps required to complete the installation process. For installation, users should search for the available Metamask extension for the particular web browser used. If needed, 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 the creation of an account, they should

be able to check a balance of 0.00 Eth. To perform further tasks, users need to switch to a Goerli test network from the Metamask wallet. On the test network, the coordinators will provide the required GEth (dummy Eth used for the Goerli test network) 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:** Next, the users need to create an account on 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 involves examining Opensea. Opensea offers a variety of resources for its users. Users should identify the section where these resources are shared. They need to navigate through Opensea to determine if there is sufficient information to understand the processes of minting, buying, selling, and bidding NFTs. In addition, they should look for the categories of NFTs supported and listed on the site. It is up to the users if they want to learn more from these resources.

T3. Minting an NFT: Minting is the process of creating a new NFT. Opensea has a built-in minting process. This task requires minting and listing of an NFT.

- **Sub-task 1. Minting an NFT:** The users should look for a "Create" option on 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 on Opensea.

T4. Performing an NFT transaction: This task involves buying an NFT listed on the coordinators' profile. Here coordinators are who directed the tasks and two authors of this research played the role of coordinators. 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 coordinators 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 transactions. 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 phones, computers, browsers or any other device different from the previous one can be used as a new device. Should the wallet not be installed, users will need to install it and subsequently ensure they can access the wallet using the 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 the Goerli test network from "Settings" one more time. This step follows the same procedure of the Sub-task 1 from Task 1. It is also required to check the information needed to log into the account when the device is switched.

- **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. A collection is made up of one or more NFTs, and each collection has its own ID and this ID is called the 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, the wallet needs to be restored. This task involves restoring the wallet. The password has been chosen as a lost credential because misplacing the "secret key" will result in the wallet being permanently lost.

- **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.

Evaluation Heuristic: A cognitive walkthrough requires to utilize a number of heuristics to its evaluation. Accordingly, we used a set of heuristics developed for usability evaluation in [16]. The list of these heuristics 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 that novice users will not identify the key information stored on the application. It is possible that overlooking this information will lead to critical errors. 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.

5.4. Participants

We recruited five participants [33] [41] for our cognitive walkthrough evaluation. All of them had experience with usability studies with prior knowledge of blockchain, wallets and NFTs. The ages of the participants ranged from 24 to 50 years and included individuals from various professions such as undergraduate students, software developers, and professors. They were recruited through our personal network and had no prior experience using Opensea. Of the five participants, two were female and three were male. We refer to these five participants as P1 to P5. Each of the six defined tasks was performed independently by the five participants to evaluate Opensea.

5.5. Result

In this section, we present the results of our cognitive walkthrough experiment. The participants took different amounts of time to perform the assigned tasks. Table 3 shows the time taken by the participants to perform each task and their Sub-task.

By analyzing the results from our walkthrough procedure, we briefly describe our findings below.

T1: 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 for connecting their wallets to Opensea (Sub-task 3). P1, P2 and P4 faced difficulties to understand that connecting the wallet is the process of creating an account in Opensea. With minimal assistance from the coordinators, they were able to successfully finish 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.

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 shows a message when an account is successfully created. It uses the term "Secret key" which may sound unfamiliar to a novice user (fails G6). Metamask interface does not show all available test networks at first (fails G2). Goerli test network becomes 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).

Tasks	Sub-tasks	P1	P2	P3	P4	P5	Average	Standard Deviation
T1	Sub-task 1	8.54 min	1.38 min	5.02 min	5.35 min	3.35 min	4.73 min	2.65
	Sub-task 2	6.57 min	1.06 min	0.26 min	3.20 min	0.50 min	2.32 min	2.64
	Sub-task 3	1.32 min	1.44 min	1.26 min	1.42 min	1.39 min	1.37 min	0.07
T2	No Sub-task	38.29 min	17.42 min	10.56 min	26.27 min	21.23 min	22.75 min	10.41
T3	Sub-task 1	5.14 min	2.12 min	2.31 min	8.50 min	2.12 min	4.04 min	2.80
	Sub-task 2	1.52 min	1.44 min	1.27 min	0.52 min	1.12 min	1.17 min	0.40
T4	Sub-task 1	0.33 min	0.22 min	1.40 min	0.47 min	0.51 min	0.59 min	0.46
	Sub-task 2	0.31 min	1.20 min	1.05 min	1.10 min	0.44 min	0.82 min	0.40
	Sub-task 3	0.24 min	1.09 min	1.48 min	1.24 min	0.37 min	0.88 min	0.49
T5	Sub-task 1	2.55 min	3.57 min	2.40 min	4.10 min	7.29 min	3.98 min	1.89
	Sub-task 2	1.03 min	0.53 min	1.20 min	0.30 min	0.42 min	0.70 min	0.36
	Sub-task 3	1.09 min	3.28 min	5.17 min	5.01 min	1.29 min	3.17 min	1.94
T6	Sub-task 1	2.32 min	4.35 min	1.44 min	3.25 min	1.18 min	2.51 min	1.34
	Sub-task 1	2.32 min	4.35 min	1.44 min	3.25 min	1.18 min	2.51 min	1.34
	Sub-task 2	0.29 min	0.17 min	0.24 min	0.14 min	0.12 min	0.19 min	0.06

Table 3
Time taken by participants while performing the tasks

T2: 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, utility. P5 explored the trending and top items on 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 processes. 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: 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 on 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: 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 the wallet after the transaction, but others checked it as well. Following their purchase transactions, they all verified that the NFTs were 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). The 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 about the buying process is shown in the wallet in detail (achieves G5). The NFT has to be added to the cart at first and then it has to be bought from there, which is considered redundancy (fails G7). A straightforward "Buy now" option would be more user-friendly.

P3 found a supposed bug on Opensea that allowed P3 to find that after creating an NFT and listing that NFT for sale in their personal account, P3 can still change the image of the

Tasks	Sub-Tasks	Status (Complete/Incomplete)	Difficulties Encountered (Yes/No)
1	Sub-task 1	Complete	No
	Sub-task 2	Complete	No
	Sub-task 3	Complete	Yes (Difficulty while connecting the wallet to OpenSea)
2	No sub-task	Complete	No
3	Sub-task 1	Complete	Yes (One failure creating NFT first time)
	Sub-task 2	Complete	Yes (Needed help starting subtasks by one participant)
4	Sub-task 1	Complete	No
	Sub-task 2	Complete	Yes (Uncertainty adding NFT to cart)
5	Sub-task 1	Complete	No
	Sub-task 2	Complete	No
	Sub-task 3	Complete	No
6	Sub-task 1	Complete	No
	Sub-task 2	Complete	No

Table 4
Status of task completion and occurrence of difficulties

NFT. In P3's opinion, this should not be possible because if someone creates and lists an NFT and changes the image of the NFT before selling, it violates the rules of authenticity for the NFT.

T5: 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 from task 1. 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 cause 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

Tasks	Achieved Heuristics	Failed Heuristics
1	G2, G3, G5 (partially)	G6, G7, G1 (partially), G2 (partially)
2	G2 (partially), G6	G2 (partially)
3	G1, G2	G3, G8, G6
4	G1, G2, G5	G8, G7
5	G5	G7
6	G4	G7, G8

Table 5
Heuristic evaluation

no message is shown about the confirmation of the updated password (fails G8).

A summary for completion of the tasks and encountered difficulties has been presented in Table 4.

A collection of heuristics were applied in our cognitive walkthrough process. Each task contains a collection of heuristics that can be used to determine which heuristics are successful and which are unsuccessful. Table 5 represents the achieved and failed heuristics for each task.

5.6. Discussion

Six tasks were broken down into smaller sub-tasks in our cognitive walkthrough study. The 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 on 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 users had some difficulty 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 Metamask installation process and the creation of an account are not complex tasks. However, the creation of an account on Opensea is a tricky process. 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 that 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. A better approach could be to add a pop-up window to advise them to create an account. Moreover, providing a detailed instruction about using wallets linked with Opensea would help the users a lot. On Opensea, the wallet icon is not so clear to users. To make the design simpler and more user-friendly, a more straightforward icon might be used. Although Opensea has resources that define various terminologies associated with NFTs, a more thorough explanation would be more beneficial for those with less experience. Opensea provides 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 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 than reading written documents. Also, two of our participants encountered 404 errors while trying to examine distinct categories which need to be solved for a better user experience.

Since creating NFTs is a primary task in using these marketplaces, a "Create" icon on 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 at first. During the creation of NFTs, an approximate price suggested by the marketplace would help stabilize the prices of NFTs. In addition, 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 to ensure them regarding their created NFTs.

After creating an NFT, the owner may list it for sale. 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 listing step might become challenging for users with less technical knowledge. A small tooltip would help the users understand this part better. A success message could also be shown here to confirm that the users have successfully listed the NFT for sale. We asked our participants to buy at least one NFT from a particular collection ID. We have noticed that NFTs display in the order of creation rather than the ones that are now accessible first, which caused customers' frustration since NFTs that have already been sold cannot be bought. In our opinion, if newly created NFTs are shown first and sold NFTs are shown later, then it would be helpful to the users.

In the 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, which could lead to massive errors in time of real transactions. One participant wanted to bid, but was not successful. When purchasing 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 takes a long time to complete, a notification would reassure users that their funds are safe. The same goes on with the completion of the transaction. A success message would ensure users about their bought NFTs. We have spotted a redundancy in the buying process. The user needs to first add the selected NFT to the cart, and from the cart, further actions can be taken to complete the purchase. A straight "Buy now" option would help eliminate this redundancy. The total time for each task was calculated by summing the durations of its sub-tasks, as illustrated in figure 6.

Since NFT marketplaces are connected to crypto wallets, we also have some tasks related to wallet management. The improper handling of wallets can cause permanent financial damage to a user. We have noticed that if users try to change their previous devices and access their wallets from new devices, they will have to enter their secret key. Every time the device is changed, a new password must 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 a new password every time seems unnecessary as more new passwords are difficult to remember and difficult to set. If the device is changed and the password is reset, then all previous logins with old passwords should be logged out for security purposes. But to our surprise, we have noticed that previous logins do not get logged out, which may lead to huge security breaches. To attract more users and gain more trust, these issues need to be resolved in a short time. 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 entire secret key at once would be more efficient. However, if the secret key is lost, the user cannot recover the wallet. Therefore, an additional layer of security might be considered here.

6. Proposed design for an ideal marketplace

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
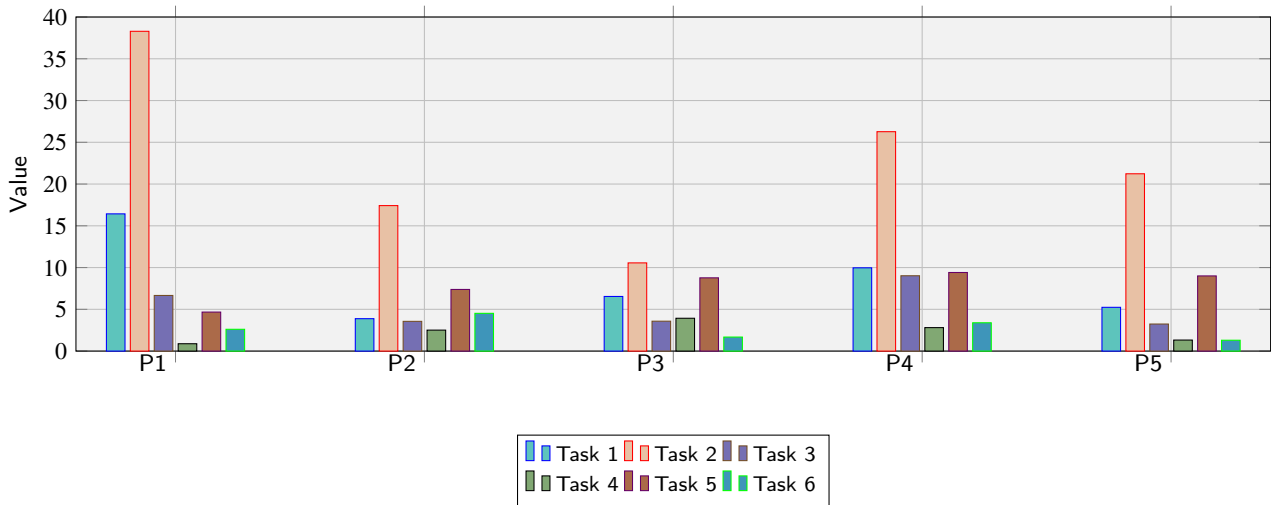
Figure 6: Time taken by participants to perform the tasks

adoption of NFTs will increase dramatically once these problems are fixed.

In the following, we provide a summary of all the responses from the semi-structured interview and the cognitive walkthrough. Then, in Section 6.1, we present a series of improved design recommendations for an NFT marketplace to resolve some of the identified issues and be more user-friendly to use.

Creating a cryptocurrency wallet, adding cryptocurrency to the wallet, and connecting the cryptocurrency wallet to NFT markets are some of the obstacles that come with dealing with NFT marketplaces. To make it simpler for nontechnical users to create NFTs, educational resources devoted to blockchain principles and how-to guides can be included as built-in resources in NFT marketplaces. Scam and low-quality NFT detection systems should be integrated into the marketplaces. In these marketplaces, a member verification procedure should also be in place to guarantee security and prevent fraud. In this section, we present a design outline that can be considered as a suggestion for building an ideal NFT marketplace. The recommendation is based on an analysis of the findings from user interviews and takes into account the most important improvement suggestions raised by the participants during the cognitive walkthrough study.

6.1. Proposed design recommendation

In order to visualize the recommendations, the majority of the Opensea interface has been duplicated in the new UI, with the recommended improvements. Several improvements derived from the fresh information discovered while conducting the study and the participant recommendations.

Opensea home: P1 suggested to have a "Create" button in the homepage. She also had difficulty finding the "NFT 101" section, so suggested having 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 the 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 7 shows the suggested homepage for Opensea.

Figure 8 shows the homepage for the users whose wallets have not been connected to the marketplaces yet.

Resources: The entire "Resources" section has remained unchanged with one single 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 Opensea bidding process will be much easier to understand. Figure 9 shows the suggested resources section for Opensea with a new tutorial.

Purchases: A "Buy now" option has been added along with the "Add to cart" option. Figure 10 shows the buying page designed based on the comments of the participants. 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.

Figure 11 presents a pop up window with the status of the buying process.

Previously, when a transaction was made, it was not clear that the transaction is still ongoing; however, now with a pop-up window, it is much more clear to understand that after submitting the transaction, the transaction is still on progress. Therefore, a user will not get confused if the transaction has already been done or not.

Account recovery: 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 job. Following this suggestion, we propose to keep
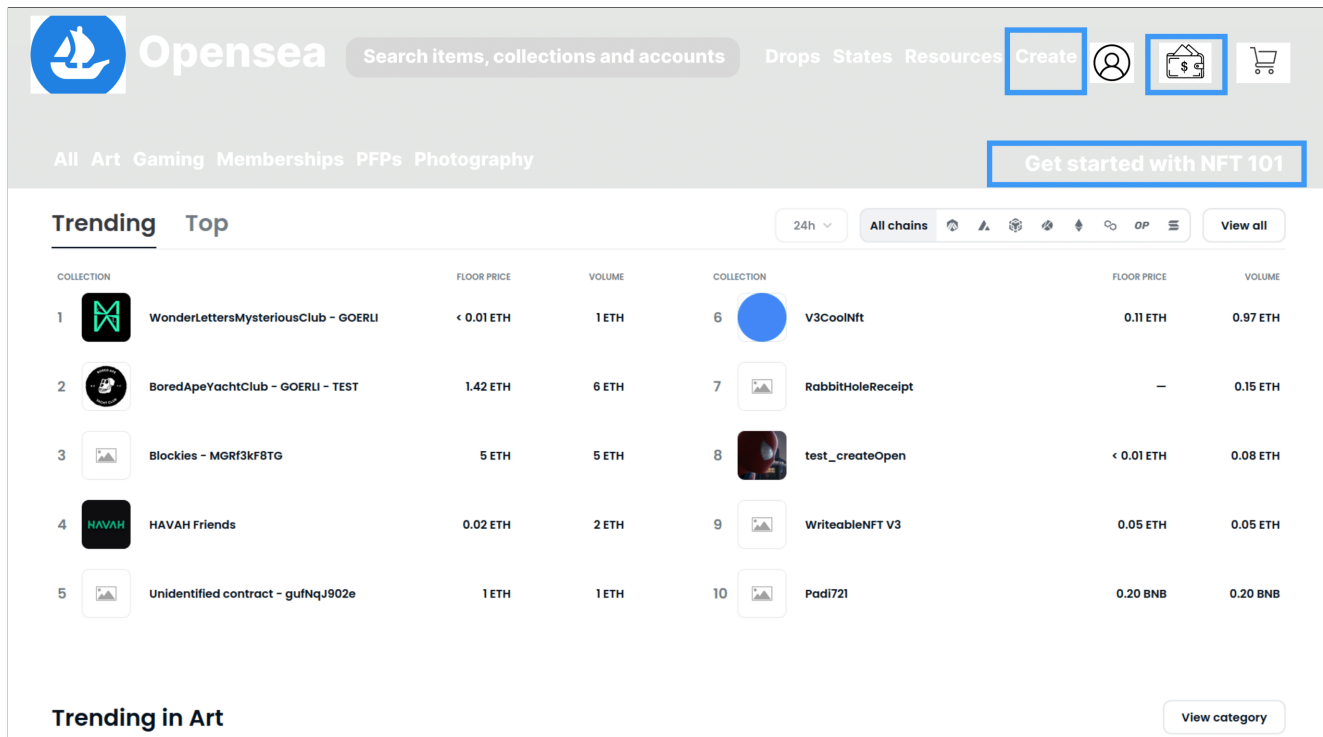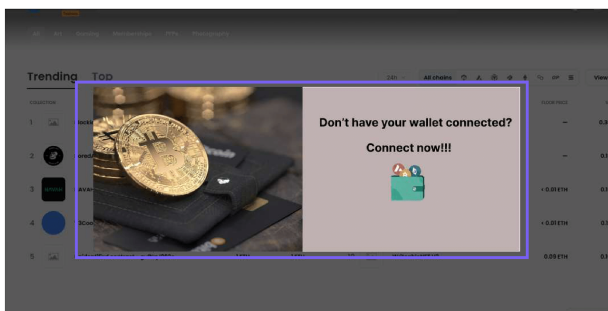
Figure 7: Suggested homepage
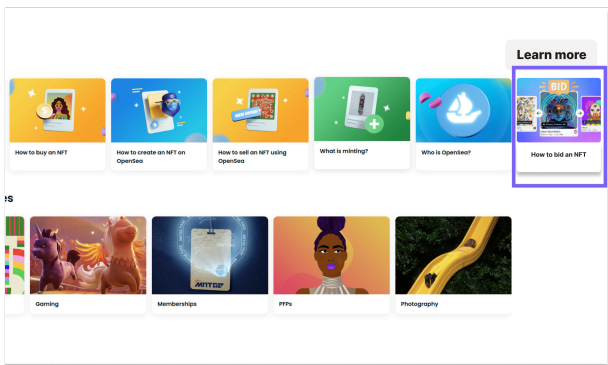

Figure 8: Pop up window
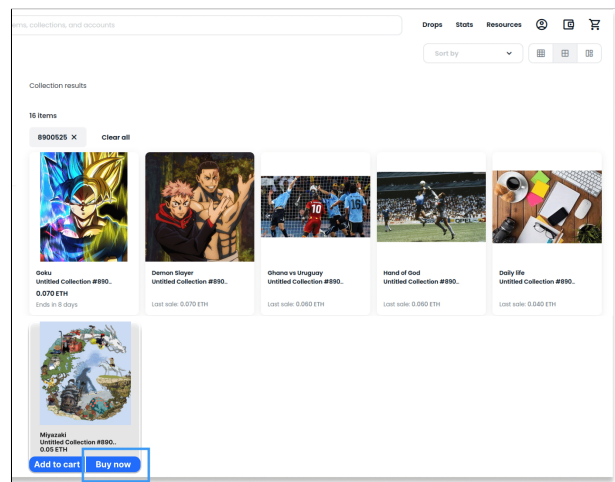

Figure 9: Resources page

Figure 10: Buy now page

only one input box where the whole secret key can be copied and pasted at once. Figure 12 shows the suggested page for recovering accounts with secret keys.

7. Conclusion

NFTs have the potential to provide 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, however, there remains risks that
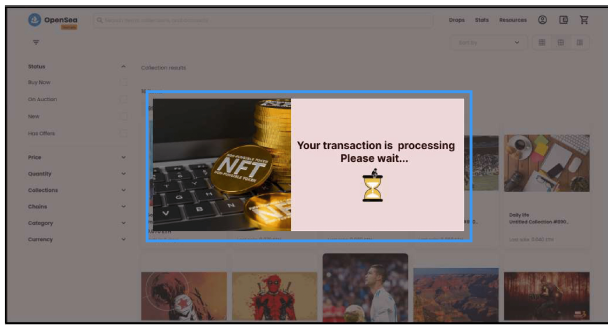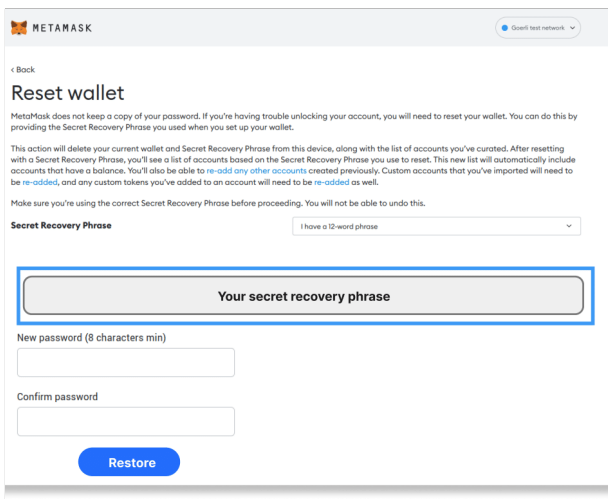
Figure 11: Pop up window

Figure 12: Recovery page

they will also cause a great deal of additional difficulties. The purpose of this article is to examine the true causes of the lack of widespread acceptance of NFTs, as seen from the perspectives of those who are familiar with cryptocurrencies and NFTs but have never used a marketplace, as well as those who have traded NFTs before.

Throughout the course of this research, we have used interviews to determine the key issues presented by the NFTs. The questionnaire used for the interview was split into five sections, which were as follows: NFT fundamentals, NFT transactions, security and privacy, and attitude towards NFT marketplaces. In addition, we have conducted a cognitive walkthrough to investigate usability problems that are associated with the NFT marketplaces. Based on the findings of the interview and they cognitive walkthrough study, we have suggested a few changes for the NFT marketplaces to improve the overall user experience. Finally, we have reached the conclusion that the entire technology that underpins NFTs needs more research and development. It is necessary to make it feasible for a collection of materials that show more potential to be adopted by a wider number of people.

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