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EXPLORING BLOCKCHAIN AND HOSTING A WEB3 APPLICATION FOR NON-FUNGIBLE TOKENS

Thesis

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ABSTRACT

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The goal of this thesis is to explore Blockchain, Smart Contracts and deploy a Web3 application to host NFT Store. Hosting a website will make the process of making NFT for the creators easier, faster and safer compared to an existing method of minting NFTs which can be very complicated, expensive and loss of assets may occur in any errors or wrong input. In this project, Solana blockchain was used as a Blockchain platform since its cheap and fast. The thesis consists of three contents, the first part goes through the introduction on Blockchain. The second part through the tools and platform used in this project report. And the last part explains about the project.

The thesis claims that Blockchain is a revolutionary technology in how data are being stored and will slowly have a very big impact in our lives as we change our traditional methods of database and slowly adapt to this technology. The thesis also claims that hosting a web3 application as a store for creating NFTs will simplify the process of making NFT and help creators sell their assets and make their own smart contracts with GUI rather than CUI.

Key words.

NFT, React, Node-JS, Metaplex, Yarn, SOL, GUI, CUI, DApps

CONCEPT DEFINITIONS

NFT – Non-Fungible Token

SOL – Solana

DE-FI – Decentralized Finance

DLT- Digital Ledger Technology

PoH - Proof of History

GUI- Graphics User Interface

CUI- Character User Interface

BTC - Bitcoin

ETH - Ethereum

PoW - Proof of Work

PoS – Proof of Stake

DApps – Decentralized Applications

ABSTRACT

CONCEPT DEFINITIONS

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1 INTRODUCTION

There has been a lot of hype behind the word ‘NFT’ since Beeple sold his digital artwork "Everydays: The First 500 Days" for 69 million. NFT has been emerging ever since and many people are starting to get involved. NFT stands for Non-Fungible Token. In 2015 the first NFT project was launched on the Ethereum blockchain. Since then, with the rise of interest in crypto currencies the interest in NFT has grown. The total monetary value of NFT grew significantly during the first quarter of 2021, 20 times than that of previous quarter. The sales exceeded 2 billion dollars that quarter. (Kastrenakes 2021.)

NFT has been on hype ever since. Many digital artists, are day by day trying to mint their own NFT and it can be a complicated process for normal everyday people, who do not have any technical background. Minting NFTs can be financially heavy since a small error can make you lose money during transactions or minting process. It can also be time consuming. So, creating an NFT minting website where creators can mint their artwork (gif, jpg, png, svg, wav, ogg, glb, glt, webm, mp3 and mp4) into an NFT and put it up on sale, earn loyalties, create personalized store and auction their NFT without the need of the middleman, can solve the problem for creators and can make the process easier and faster. The aim of this thesis was to make the process of creating and launching NFTs easier by deploying a website. Building website and article to make the everyday process easier, faster, and efficient is popular in today’s world. Minting an NFT can be a hefty process which takes time. In this project various tools such as GitHub, Solana Blockchain, Metaplex and Visual Studio Code are used.

2 BLOCKCHAIN

Blockchain is a technology that fuels all Crypto, NFT and De-Fi revolution in the world. Blockchain is a sort of Digital Ledger Technology (DLT) that is made up of a growing collection of data, known as blocks, that are secretly connected via encryption. Each block includes transaction information, a timestamp, and a cryptographic hash of the preceding block (represented as a Merkle tree, where data nodes are represented by leaves). For usage as a public distributed ledger, blockchains are administered through peer-to-peer networks in which nodes cooperate to follow a protocol to add and validate new transaction blocks. The data in any given block cannot be changed once it has been recorded, blockchain transactions are immutable. (Galaxy of Art 2022)

2.1 Introduction to Blockchain and Its Types

Blockchain is a type of Digital Ledger Technology (DLT) that consists of an increasing list of records, called blocks, that are securely linked using cryptography. Each block consists of a cryptographic hash of the previous block, a timestamp, and transaction data (generally represented as a Merkle tree, where data nodes are represented by leafs). A timestamp proves that the transaction data existed when the block was created. Since each block contains information about the previous block, it effectively forms a chain (compare the linked list data structure), with each subsequent block binding to the blocks before it. As a result, blockchain transactions are irreversible in that once recorded, the data in any given block cannot be reversed without changing all subsequent blocks. (Galaxy of Art 2022)

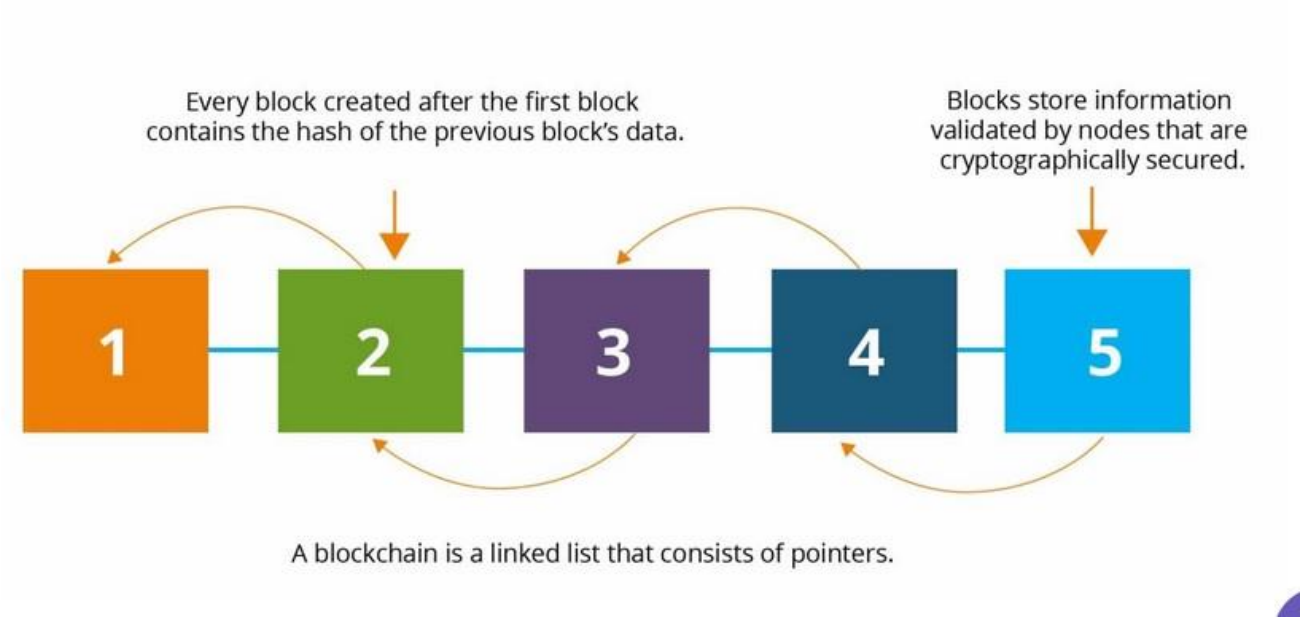

Figure 1. Blockchain linked tree (Raj 2022).

In simple terms, a blockchain is a shared ledger among the nodes of a computer network as can be seen in Figure 1. Like any other database it keeps records of information and its flow. All the information in blockchain is saved in digital format like any other database. The main edge that blockchain has over any other traditional database is that it guarantees the preciseness and security of a transaction of data and generates trust without the need for trusted third party. (Hayes 2022) The major difference in a typical database and blockchain is how the data is structured which is more explained in Figure 2.

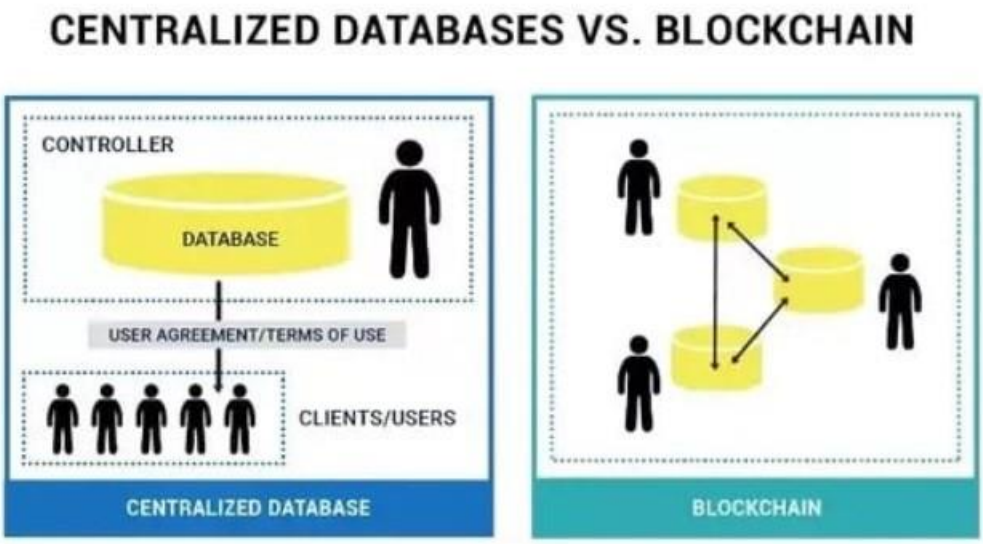

Figure 2. Centralized Database vs Blockchain (Raj 2022).

The above Figure 2, the data flow in all traditional ledgers, database and blockchain can be seen. It also makes it clear that decentralized blockchain divides authority among all the users when compared to traditional methods of ledger or database. The data in blockchain is stored in blocks which are linked together with the help of cryptography whereas all the data in our traditional practices are saved in a single unit or database or a single authority who has master access to all the information stored in the database. Fresh data in blockchain is filled in a new block and once the block is full the data is chained onto the old block, which makes the data linked together in progressive way. The main edge that blockchain has over the traditional way of ledger or database is that it is decentralized and no one single user/unit has any authority over data stored in the system. But however, not all blockchains is decentralized. (Hayes 2022).

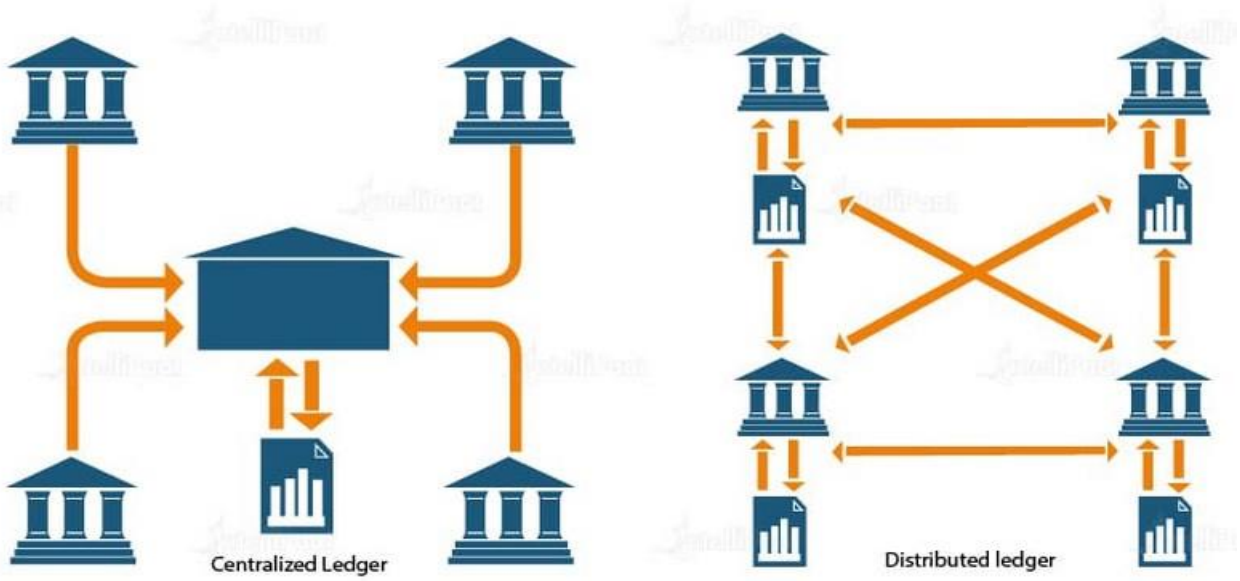

Figure 3. Structural difference in Database and Blockchain (Raj 2022).

Figure 3 explains the structural difference between centralized databases and distributed database or blockchain. Blockchain can be divided into its two main types, permissionless blockchain and permissioned blockchain according to its features. These two primary types can be divided more further into four types, public, private, consortium and hybrid blockchain which the author will explained in later section of this thesis. Both blockchains have their own advantages and disadvantages. However, the most popular blockchain is of permissionless nature and are usually referred to as public blockchain because of their open features. Figure 4 helps to clarify how blockchain is divided. (Raj 2022).

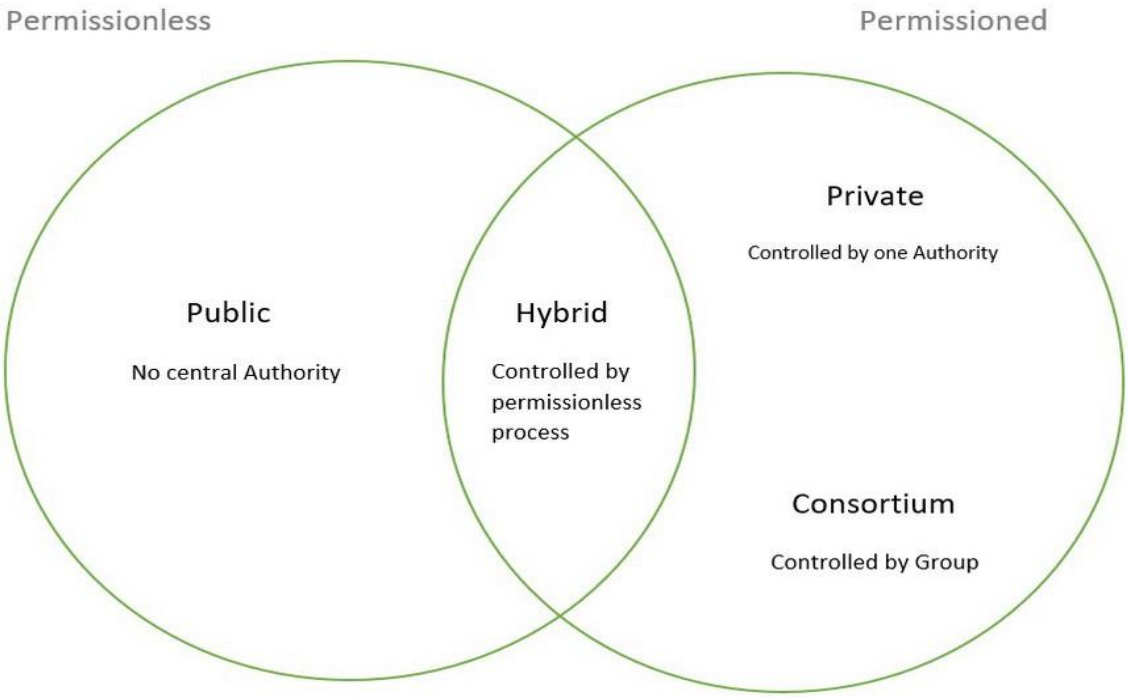

Figure 4. Types of blockchain (GeeksforGeeks 2022)

Permissioned Blockchain consists of ledger which required access from an authority. In this type of blockchain, the access to the divided ledger is only given to few authorized personnel by the administrator. Those who do not have access from administrator cannot access the blockchain/database/ledger publicly. Each individual can be given different roles and different privileges by the administrator according to their needs and plans. Any kinds of changes made in this type of blockchain are easy to track since the access is given only to limited people with unique identification. The identities are generally given through the help of wallets, where the users have their own unique id (identity), which is a set of numbers which acts as a username. Businesses where data security is mostly valued are suitable users for permissioned blockchain. (Sharma 2022)

Difference between Permission and Permissionless Blockchain

	Permissionless	**Permissioned**
Overview	Open Network allowing anyone to interaction consensus validation and ful decentralized	Closed Network with limited Decentralization and designated parties for participation in Consensus Validation
Also Known As	Public, Trustless	Private, Permissioned Sandbox
Key Attributes	1. Full transparency 2. Development in Open Source 3. Mostly Anonymous 4. Privacy dependent on technological limitations 5. No Control Authority 6. Involves digital assets	1. Controlled Transparency 2. Development by Private entities 3. Not anonymous 4. Privacy based on governance decision 5. No Single authority 6. May or May not involve digital assets.
Benefits	1. Brader decentralization 2. Highly transparent 3. Censorship resistant 4. Security resilience	1. Incremental Decentralization 2. Strong privacy 3. Customizable 4. Faster and Scalable.
Drawback	1. Less energy efficient 2. Slow and difficult to scale 3. Less user privacy	1. Limited decentralization 2. Override risk 3. Less transparent
Market Traction	1. P2P 2. B2C 3. Government to Citizens	1. B2B 2. B2C 3. Government to Organizations

Table 1: Difference in permissioned and permisssonless

A permissionless blockchain, also known as public blockchain features permissionless protocol where everything is permitted, and the administrator has no jurisdiction over the users or participants. (Cryptopedia, 2022). Everyone has access to participate in the consensus and validate the data. This type of blockchain has no central administrator or government to give access to manipulate the data because of its fully decentralized blockchain system. Due to its complete no restriction policy and open-source network, transactions made in the system is visible to everyone and they have an easy access to make required modifications. The users have full control over their identity which is anonymous at first and they later they can choose to expose them according to their needs and wills. Tokens and digital assets are given as rewards to the participants after they have done the required amount of work which can lead to an efficient and effective workflow. (Sharma 2022)

2.1.1 Public Blockchain

A public blockchain is a type of permissionless blockchain where everyone has access to participate in the consensus process and is completely decentralized meaning nobody has any control over it once its online. All the nodes have equal access to the blockchain to create new blocks and validate it. (Wegrzyn and Wang 2022.) Bitcoin (BTC) and Ethereum (ETH) are perfect examples of public blockchain which uses proof-of-work (PoW) and proof-of-stake (PoS) as their verification process respectively. Public blockchain are very secure because it provides safeguarding methods to application users from their developers or creators by demonstrating that specific actions are beyond the scope of even the application developer's authority. The users in the blockchain have total control over his identity meaning the users can choose to stay anonymous or not. However, there are some drawbacks of these blockchains. Computing power is in demand, transactions are totally public even if the identity is not. Security is a concern for everyone, meaning scammers and hackers if they get a hold of your security key or a password you may never get it back or even if you lose it you may never get it back. (CoinTelegraph 2022)

Exchanges and cryptocurrency mining are the two main sectors where public blockchain are primarily being used currently. Generally, in public blockchain such as Bitcoin, Ethereum and Solana, the nodes "mine" for cryptocurrency by generating blocks for the transactions requested on the network by solving cryptographic equations. In return for this hard work, the miner nodes earn a small amount of reward which is also called cryptocurrency. The miners essentially act as a new ear bank teller that formulates a transaction and receive (or "mine") a fee for their effort. Generally, the higher computing power the more reward is reaped. (Wegrzyn and Wang 2022)

2.1.2 Private Blockchain

Private Blockchain is a type of permissioned blockchain which is governed by a one central authority. This blockchain is only decentralized, and only selected participants can participate in the consensus. (CoinTelegraph 2022) The central authority is not required to give everyone equal access to perform certain actions. So, the access may vary from nodes to nodes. Private blockchains are considerably faster than the public blockchains but are significantly more prone to frauds. This blockchain offers high data confidentiality and privacy. Because of its access to few selected participants this blockchain network is more stable. (Wegrzyn and Wang 2022) This blockchain can be a very useful tool for privacy, which the companies can use or their internal auditing, voting and asset managements. Hyperledger, Corda and Ripple are some examples of this blockchain. (GeeksforGeeks 2022)

2.1.3 Consortium Blockchain

Consortium Blockchain is a type of permissioned blockchain which is governed by a group of organization. Unlike private blockchain which is also a part of permissioned blockchain, consortium blockchain has multiple organization acting as a central authority whereas in private blockchain, one single organization acts as a central authority. It is slightly more secured than private blockchain since its more decentralized. (Kathleen, E and Eugenia, W. 2022) This blockchain is also known as Federation Blockchain and it was designed to solve organizational needs and problems. It is supervised by one party who make rules and changes in the balance, also terminate transactions that are proven to be fraud with an agreement with the members and is protected against dominance from one party. (GeeksforGeeks, 2022) Consortium blockchain has no fees to use their service. Consortium blockchain can be used by organizations such as banks, businesses and other payment processors. Tendermint and Multichain are some examples of this blockchain. (Kastrenakes, J. 2021)

2.1.4 Hybrid Blockchain

Hybrid blockchain is a combination of both public blockchain and private blockchain where permissioned-based and permissionless systems are used. Central authority who owns the blockchain cannot manipulate the transactions. Structure of Hybrid blockchain is completely customizable, just like in traditional blockchain, its members can select which transactions are made public and who can participate to access the blockchain. Hybrid blockchain can combine best/required aspects from both approaches which the business can collaborate with its stakeholders in most effective way. IBM Food Trust is an example of this blockchain, which goal is to improve efficiency in the global food supply chain. (Zeeve 2022) Table 2, explains the advatages, diadvantages and uses of all four types of blockchain in order.

Blockchains	Advantages	Disadvantages	Uses
Private	High rate of transaction and fast verifications of nodes. Scalability can be modified. Privacy can be changed per needs. More balanced.	Vulnerable to manipulations. Possibilities of abuse of power by central authority risking trust issues. Few nodes make it more risker to lose the entire system.	Internal auditing Voting Asset managements
Public	Fraud proof algorithm Open to all public Options to stay anonymous. Completely decentralized	Processing time is very slow. Requires huge amount of energy. No central authority to restrict access to frauds or criminals	Exchanges Cryptocurrency mining Smart contracts
Consortium	Fast verifications system Multiple organization can act as central authority Allows privacy More flexible	Approval can take time More chances to be hacked Greater chance of vulnerability	Payment processors Banks Large businesses
Hybrid	Hack proof. Cheap with low fee Customizable Only selected Participants and selected transactions are public	Not very efficient and hard to maintain Not everything is public so there can be trust issues Closed ecosystem	Healthcare industry Government Real estate Finance

Table 2: Types of Blockchain (GeeksforGeeks 2022)

2.2 Crypto Currency

Crypto is a word originated from a Greek word “kruptos” which means hidden. So, in today’s generation crypto means secret or sometime that is concealed. This does not mean crypto currency is a hidden currency, it is rather a digital currency which uses blockchain technology where all the data and information in the system is hidden with cryptographic algorithms and is basically impossible to manipulate. Cryptocurrency are obtained as a form of reward for the participants in the blockchain for doing certain work in the blockchain or one can exchange it with other currencies in a valid exchange. As it uses blockchain technology, it is not dependent on any central authority, such as government or bank to manage it. It was designed to be used over the internet which is completely decentralized. It has a decentralized system for verifying a transaction and their claims, without depending on banks, when the transaction is on the process. (Kerner 2022)

Cryptocurrency is a digital form of currency that uses cryptography to secure the processes involved in generating units, conducting transactions and verifying the exchange of currency ownership. Bitcoin was the first crypto currency ever launched. It was launched in 2008 and is the most known and influential crypto currency. At its peak, its price went above 60,000 euros. This created a lot of hype around crypto world and attracted a lot of investors and miner around the world. This allowed its popularity to increase much more and soon it became a popular alternative for online payments. (Coinbase 2022)

Cryptocurrency is a very soul of NFTs, meaning, to mint an NFT you need to spend some Crypto Currency that the blockchain you are using uses as a minting fee. The rate of fee varies according to the system that the blockchain was developed in. For example, if you need to mint and NFT in Solana Blockchain (like we are about to do in this project) you need to spend some SOL or Solana Cryptocurrency. (Coinbase 2022)

2.3 Smart Contracts

A smart contract is a code that acts as a contract which runs in a blockchain and is usually decentralized. Each contract is hidden in specific address on the blockchain. Smart contracts are self-executing meaning it does not require any middle-man's permission or witness to handle the transaction of an asset if both buyers and sellers willing. The assets are usually digital. The transactions of smart contracts are irreversible and traceable. Nick Szabo, an American computer scientist who invented a virtual currency called "Bit Gold" in 1998, defined smart contracts as computerized transaction protocols that execute terms of a contract. (Frankenfield 2022). Vitalik Buterin, the 28-year-old founder Ethereum, explained it at a DC Blockchain Summit, "In a smart contract approach, an asset or currency is transferred into a program and the program runs this code and at some point it automatically validates a condition and it automatically determines whether the asset should go to one person or back to the other person, or whether it should be immediately refunded to the person who sent it or some combination thereof." (Vitalik Buterin 2021)

By enabling you to transmit and receive money without a "trusted intermediary" like a bank in the middle, smart contracts broaden the idea behind Bitcoin, allowing you to automate and decentralize almost any form of agreement or transaction. (Coinbase, 2022) Smart contracts can automate many operations that would often involve human interaction because they are executed by code rather than people, which eliminates the chance of mishap. One of the best aspects of the blockchain is that there is no need to pay intermediaries and that it saves time and dispute because it is a decentralized system that exists between all permitted participants. Blockchains unquestionably operate faster, cheaper, and more securely than conventional systems, despite their flaws. This explains why more smart contracts are being used to conduct transactions on various blockchain networks, such as Ethereum, Solana, Tezos, Hyperledger, etc. (Zapotochnyi 2022)

Non-Fungible Tokens (NFT) which this report is based upon is a part of Smart Contract which is a part of boarder term "Blockchain." Non-Fungible Token is a type of digital asset which can be minted or created in the blockchain with the help of smart contracts. Smart contracts enable Non-Fungible Tokens to be able to be sold or bought in the Blockchain marketplace without no intermediaries in between. Smart contracts are also known as "Blockchain 2.0," where the blockchain handles more than just monetary value. Non-Fungible Tokens are not the only use of Smart Contracts with the help of Web3 (Web 3.0), people or developers can develop application in the platform where no central government has the

power but rather is decided decentrally which may vary according to what kind of blockchain is the application being built on. (Newburn 2022)

Smart contracts make sure that all essential contractual clauses are captured in minute detail, preventing problems from happening when someone forgets to include a certain piece of information when filling out a template agreement. The same standard used by cryptocurrencies like Bitcoin to secure their extremely valuable blockchains is used by smart contracts, which use the highest level of data encryption currently available on the market making it extremely secure. And the only way hackers or thieves are going to get to your assets or information in the blockchain is if they can get hands on the password of the user or the security key to reset the password. (Newburn 2022) The users only make the contract, there is no need to rely on a broker, attorney, or other middlemen to confirm. Furthermore, the possibility of manipulation by a third party is eliminated because execution is automatically regulated by the network rather than by one or more possibly biased humans who might make mistakes. Smart contracts could provide a way to significantly minimize or altogether remove the need for litigation and courts, which may be its most alluring aspect. This is due to the fact that parties that employ self-executing contracts commit to abiding by the rules and judgments of the underlying code rather than leaving themselves open to interpretations by parties unrelated to the contractual relationship. A shared ledger encrypts your files for security. Nobody could possibly assert that they misplaced it. You save money because smart contracts eliminate the need for a middleman. For instance, it would cost money for a notary public to witness your transaction. (Zapotochnyi 2022)

3 Tools and Platforms Used for The Project

In this project a various tool such as Candy Machine, Metaplex, Visual Studio Code, GitHub and Solana are utilized. Solana network is a platform where users can make smart contracts and use its decentralized finance. The project's main goal is to establish an online platform or a website using blockchain technology. The website primary function is to take any digital asset or a file and turn it into Non-Fungible Token using cryptographic hash function. Candy Machine is utilized for making a smart contract with Solana Blockchain. The website also has a secondary function, which enables users to trade their assets. The website allows users or creators to set their own terms of sales which is irreversible and is not governed by any party.

3.1 Solana Blockchain

Solana Blockchain is a platform for decentralized finance applications and other smart contracts where people can borrow, lend, trade and leverage crypto assets. It is a decentralized computing platform which uses decentralized blockchain technology. It is a highly functional open-source project. SOL is a native token that runs in this blockchain. Solana offers cheapest means of minting an NFTs and takes no fees in trading NFTs. It also allows users or creators to host their own collections by creating their own store. This is the reason that the author of this report has chosen to use this platform for his project. Solana was officially launched in March 2020 by the Solana foundation. It banks on a blockchain technology's permissionless nature to provide decentralized finance (De-Fi) solutions. Its main concept is proof-of history (PoH) which allows for greater scalability of the protocol and boosts usability. PoH was developed by Anatoly Yakovenko. (Adams 2022)

Solana is a crypto-computing platform which was designed for fast transaction speeds without sacrificing decentralization. To make blockchains more scalable, Solana employs a mix of proof of stake consensus and so-called proof of history. Up to 50,000 transactions may be supported per second while still being decentralized. Its major innovation is speed, via a bundle of new technologies including a consensus mechanism called proof of history (PoH). Solana is both a cryptocurrency and a flexible platform for running decentralized apps (DApps). Degenerate Apes is the most known NFT collection which was launched in Solana Blockchain in 2021 summer. It consists of 10,000 NFTs collectibles and was the

whole collection was minted with a surprisingly shocking fee of 6 SOL, which was less than 100$ American dollars at that time. And Serum is the most popular and advanced decentralized exchange (*DEX*) and ecosystem that brings unprecedented speed and low fees. It was built on Solana and is completely permissionless (Coinbase 2022)

	Solana	Ethereum
Launched	2020	2015
Token	SOL	ETH
Max. Supply	N/A	N/A
Platform	Open source	Open source
Smart Contacts	✓	✓
Decentralized Finance Applications (dApps)	✓	✓
NFTs	✓	✓
Number of dApps	More than 350	Close to 3,000

Figure 5. Ethereum vs Solana (Adams 2022).

Figure 5 clarifies the difference and similarities between Solana and Ethereum blockchain. Both networks are an open source and public blockchain. As Ethereum is the most popular blockchain and was the first to introduce smart contracts there are a greater number of decentralized applications built in the system compared to Solana. Almost all the early Blockchain Technologies were using proof-of-work (PoH) method to determine the blocks in their chains using a proof-of-work algorithm. Proof of work's consensus technique depends on miners to select the next block. However, the slow operation and resource usage of this proof-of-work method need a lot of energy. One of the driving forces behind Ethereum's upcoming Merge, in which the network will move to a proof-of-stake algorithm, is this. In contrast to the prior proof-of-work approach, proof of stake uses staking to choose the next block. Staked tokens are held as collateral by the blockchain up until validators concur on the next block of the chain. (Hitbtc 2022)

Solana is designed to tackle two issues: security and scalability. Solana's proof of history technique provides the network with outstanding security. While the increased scalability of the Solana platform is made feasible by how swiftly computations are carried out. Solana is popular for its fast-processing time. The hybrid protocol allows for significantly decreased validation times for both transaction and smart contract execution. Solana protocol directly counters today’s rapidly increasing economy with the

high taxes and fees for its outstanding design to have low transaction costs without compromising scalability fast process. (Adams 2022)

3.2 Metaplex

Metaplex is a protocol built on Solana Blockchain where Non-Fungible Tokens can be created or minted, various auctions can be launched for main or secondary sales, and NFTs can be viewed uniformly across wallets and applications. Metaplex is an Open-Source Platform where developers can use the Open Source Code and modify it as per their will and use. It is free to use and available for every individual or business. Metaplex is built on Solana Blockchain because of its high scalability and PoH. Metaplex is bult for NFT creators and developers, where they can create and open their own store independently without having to rely on anyone or any corporate business. (Metaplex 2022)

Metaplex consist of collection of tools, smart contracts, and other various designs which makes the process of NFT launch easier and simpler. Metaplex is a web3 application. Metaplex helps creators from different backgrounds in NFT launch and set their own store independently. Developers can fork the Open-Source Code from Metaplex GitHub repository to their personal computer and modify the code according to their will. Metaplex community has put up instructions on how to use them in their website. Metaplex is based on Solana due to its scalability, but also because of Solana's many other features, such as "Proof of History." Solana divides logic and data into two distinct components, in contrast to the majority of blockchains. These are Programs and Accounts, respectively. This means that programs now interact with external data saved in accounts with the ability to modify it rather than internally storing it in variables. In short, Programs define Instructions that can be used to interact with external data stores called Accounts. (Metaplex 2022)

3.3 Candy Machine

Candy machine is a smart contract built on Solana Blockchain by their developers to solve many problems related with trading NFTs such as frauds and scams. It is also an open-source code which is modifiable and enables creators to securely and flexibly add their digital assets to the blockchain. Metaplex being a smart contract, it is a contract made in blockchain by two parties involved in trade. Some common contracts in candy machine or its features are that it accepts payments made using Solana token, NFT or SOL. It enables creators to use start and finish dates, number of NFTs being minted and other restriction to limit the launch. A candy machine can be conceived of as a temporary structure that is originally loaded by creators and then discharged by consumers. In Figure 5, the creator's first step is to construct a new Candy Machine and give it the customizations they want. (Metaplex 2022)

Figure 5. Initial candy machine setup (Metaplex, 2022).

In figure 5, the developed Candy Machine records its own settings, which enables blockchain to comprehend how each of its NFTs ought to be produced. For instance, all NFTs produced by this Candy Machine will have a parameter “creators” attached to them. Figure 6 explains what happens when the item/asset is added to the candy machine. In figure 6, every item consists of two parameters: “name” and “URI”. The parameter “name” consists of NFT’s title, or its name and the second “URI” consists of NFT’s JSON metadata. This suggests that the JSON metadata has already been uploaded via an off-chain (such as AWS, your own server) or on-chain (such as Arweave, IPFS) storage provider. To prevent redundancy, all additional options are kept directly in the Candy Machine's settings since they are shared by all NFTs. (Metaplex 2022)

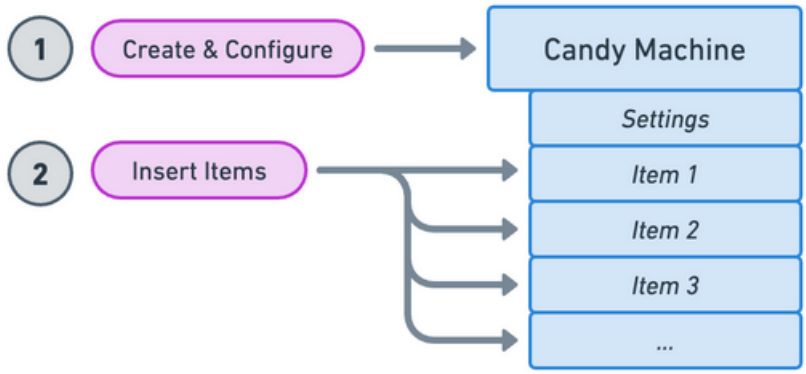

Figure 6. candy machine initialization flow chart (Metaplex 2022).

In Figure 7, all the pre-configured conditions are met, and users can begin minting NFTs from the Candy Machine as soon as it is loaded. On the Solana blockchain, an NFT is only created at this moment when all the candy machine conditions are met and metadata for the item is set. Be aware that some users may be required to complete additional verification procedures before minting, such as completing a Captcha or delivering a Merkle Proof. Figure 7 also explains when an item becomes NFT in the blockchain and how smart contracts are made in the blockchain. (Metaplex 2022)

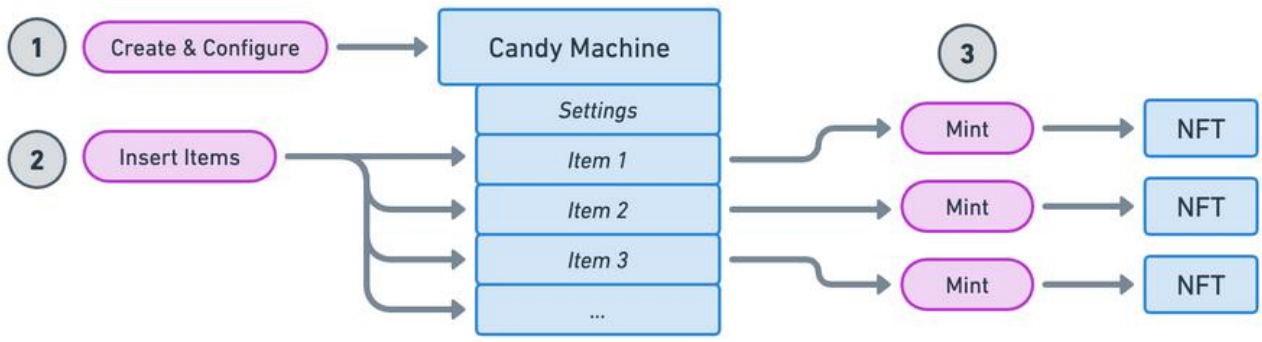

Figure 7. Candy machine flow chart with a successful mint of NFT (Metaplex, 2022).

4 THE PROJECT

For this project Metaplex, an open-source framework has been utilized to deploy a web3 website for Non-Fungible Tokens. Along with Metaplex other essential tools like Phantom wallet, Node JS, Visual Studio and GitHub have been used for this project. All the project has been done in Solana's dev-net, which is a separate platform for developers where developers don't need to use real currency text their projects, develop and troubleshoot complex problems. This is a simple project of a complex and new system where the author has utilized tools available on the internet for this project.

4.1 Installation of Framework

Metaplex is an open-source framework. The creators of this project have given public access to modify and develop this project further. There are many ways to copy Metaplex's source code and edit it but among them forking the project from GitHub is the fastest and advanced way to do it since it gives us version control system and every work done in this repository is public. The source code of Metaplex project is public in GitHub. It can be forked into anyone's own GitHub repository. Forking is a term used when developers copy source code of a project and then starts independent development in it.

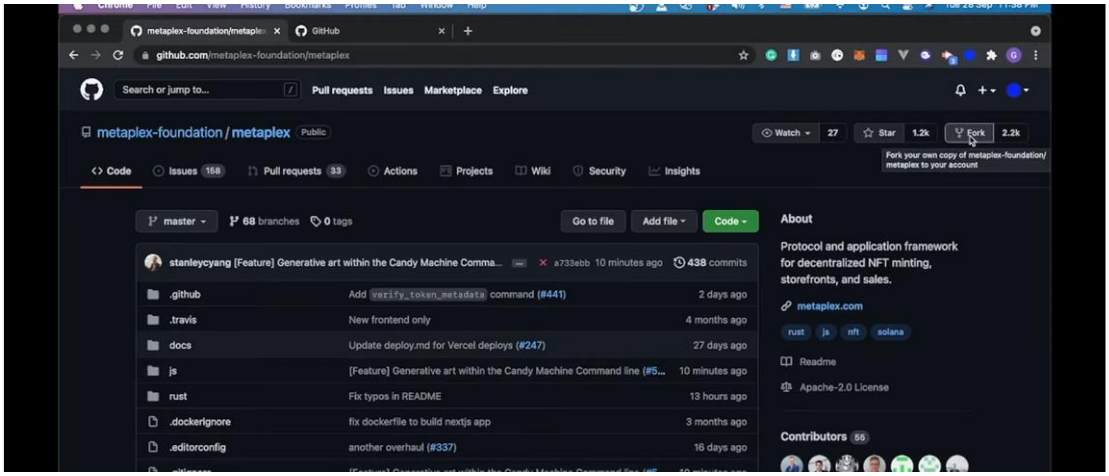

Figure 8. Forking Metaplex from GitHub Repository

In figure 8, GitHub repository of Metaplex source code is opened and it shows the process of forking repository. The next step is to clone the repository (Source code) into your computer which can be done by either downloading the zip file directly into your computer or you can use terminal to download the file with specific command “git clone” and then pasting the link provided in GitHub. The easiest and most advance way to do it will be using GitHub desktop. Metaplex’s platform open-source code comes with default address and setting which we need to change personally with the help of any code editor, here visual studio has been utilized for the process.

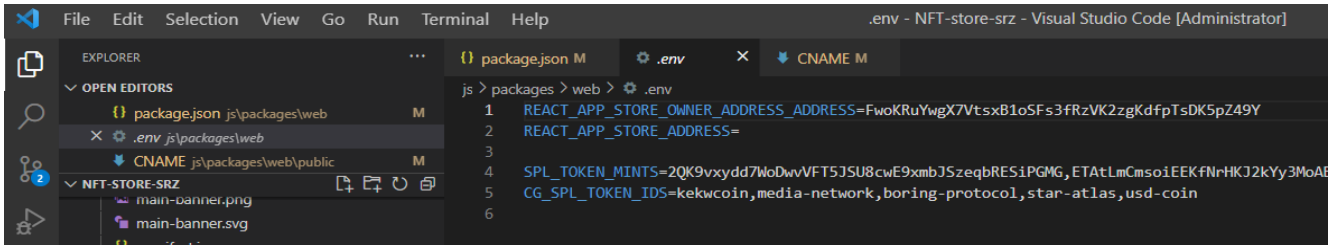

Figure 9. Setting up store owners wallet address

Metaplex requires to set up a store owner’s wallet address where all the fees for transaction goes to the store owner wallet address. In figure 9, in .env file “REACT_APP_STORE_OWNER_ADDRESS_ADDRESS” contains the crypto wallet address of a store owner which is required for the store to identify the creator of the store. The wallet address set here acts as an admin for the store and has access to commission on every sale. This allows the store owner to get some reward for each transaction made in the store if the seller agrees, however the seller has full authority about how much he wants to give or none. The store owner in this case is the author or somebody who deploys the store. There are other changes which can be made for the visual representation of the store, which is optional for this project since this report focuses more on blockchain technology and smart contracts and not on web development.

4.2 Deployment and Initialization of the Store

After all the changes are made, we need to install all dependencies which can be done using command on the terminal in JS directory of the project using command “yarn install”. This command is used to install all the required dependencies in the project. This is most used when you have just checked out code for a project, or when another developer on the project has added a new dependency that you need to pick up. After this command is used all the necessary dependencies will be installed that are required for the project that are listed in “package.json” file to the local folder “node_modules”. After all the dependencies are installed. The next remaining thing is to deploy the store and it can be done using following command “yarn deploy” in the terminal in directory “js/packages/web”. Figure 10 shows the process of when the command “yarn deploy” used in the terminal in the same directory “js/packages/web”.

```
C:\Users\srzgr\Documents\GitHub\Thesis project NFT STORE\NFT-store-srz\js>cd packages

C:\Users\srzgr\Documents\GitHub\Thesis project NFT STORE\NFT-store-srz\js\packages>cd web

C:\Users\srzgr\Documents\GitHub\Thesis project NFT STORE\NFT-store-srz\js\packages\web>yarn deploy
yarn run v1.22.17
$ cross-env ASSET_PREFIX=/metaplex/ yarn build && yarn deploy:gh
$ next build
info  - Loaded env from C:\Users\srzgr\Documents\GitHub\Thesis project NFT STORE\NFT-store-srz\js\packages\web\.env.production
info  - Loaded env from C:\Users\srzgr\Documents\GitHub\Thesis project NFT STORE\NFT-store-srz\js\packages\web\.env
info  - Using webpack 5. Reason: Enabled by default https://nextjs.org/docs/messages/webpack5
info  - Checking validity of types ..
```

Figure 10. creating a build directory with yarn deploy.

After this process in figure 10 is completed, the store will be successfully deployed in the URL link generated in GitHub. A custom URL can also be used to deploy the store but in this project a default GitHub hosting page is used. The store will be now accessible by the public from any updated browser which supports crypto wallet or web3 applications. The store of our project can be accessed by the URL “https://suroz7.github.io/metaplex#/”. Phantom wallet is required to access the store, since it acts as identity of a user in the blockchain. Note that all the transactions on the project here are done in “-devnet” which is a separate working environment which uses mock-up currency/token which has no value in the real world but acts as one in devnet. All the real-world transactions are made in “Mainnet” in the blockchain.

4.3 Initializing the Store

Once the store is deployed the next step is to initialize the store with the store owner's crypto wallet address which is a simple act of telling the blockchain who owns the store and gets the royalties and fees for the sales and transactions made in the store. To connect, the connect button must be pressed and proceed as instructed. When connected, the store will check to determine if you've previously created a store by doing a few checks. A welcome screen with an Init Store button is displayed after around a minute. A dev-net is selected for this project as a working environment since it allows developers to test and run things without having to use real world currency. Figure 19 explains the process of selecting devnet form the network selection section.

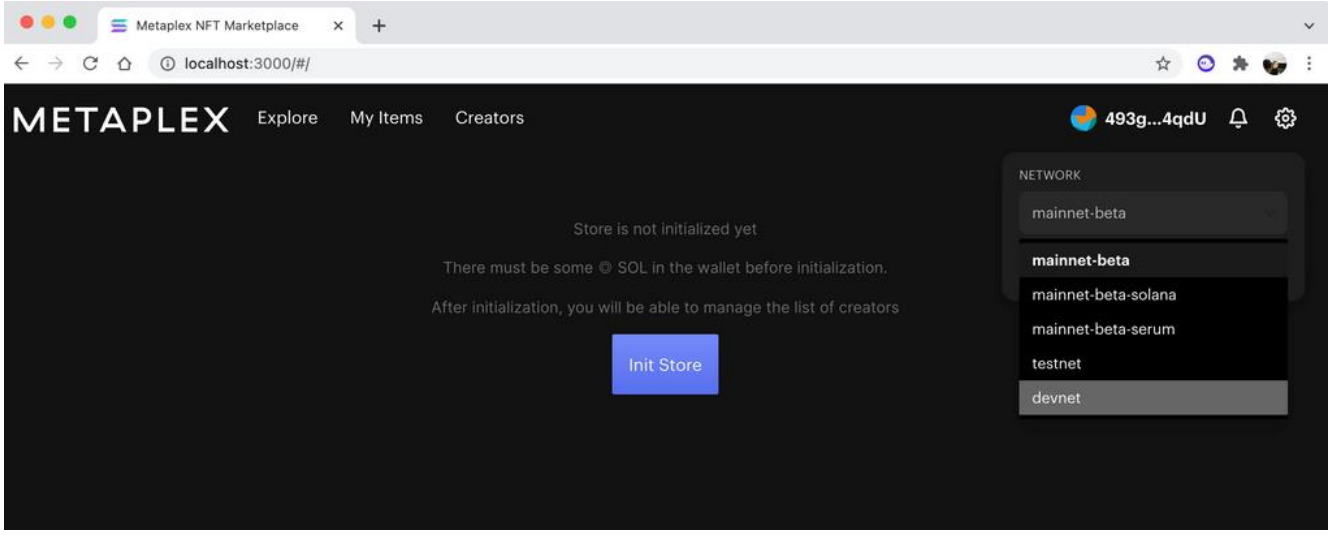

Figure 11. wallet drop down menu to select working platform.

After the wallet is connected to the store, platform for development can be selected by accessing drop down menu in the wallet icon. "Main-net" is used for real world production, test-net or dev-net is used for development and practice. In test-net and dev-net a user does not have to buy Solana token (SOL) using real money/currency. Simply, Airdrop of any amount can be requested with the server. All the UI in the project is default which can be modified according to needs. As this project is authors solo work for educational purpose and no companies or other person are involved no changes were made to default UI.

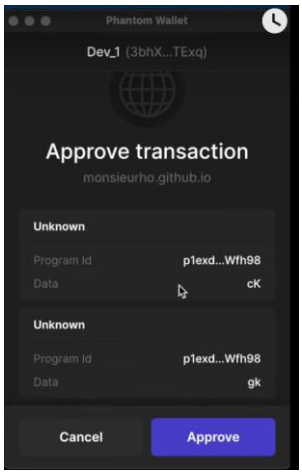

Figure 12. Signing a contract in blockchain with phantom wallet.

Every transaction must be validated by the user in the blockchain and every validated transaction act like a smart contract which is saved in blockchain and is irreversible or unchangeable. Figure 12 shows what it looks like when a user is asked to validate the transactions in the blockchain. The address set in the initialization of the store is the wallet address of an admin of the store and is the first wallet address you used to connect to the store. The address acts as a store admin. After this process the store should be successfully deployed and creating and selling NFT should be possible. Figure 13 captures the page where store admin address is inserted in the first initialization process of the store. It is possible to have more than one store owner.

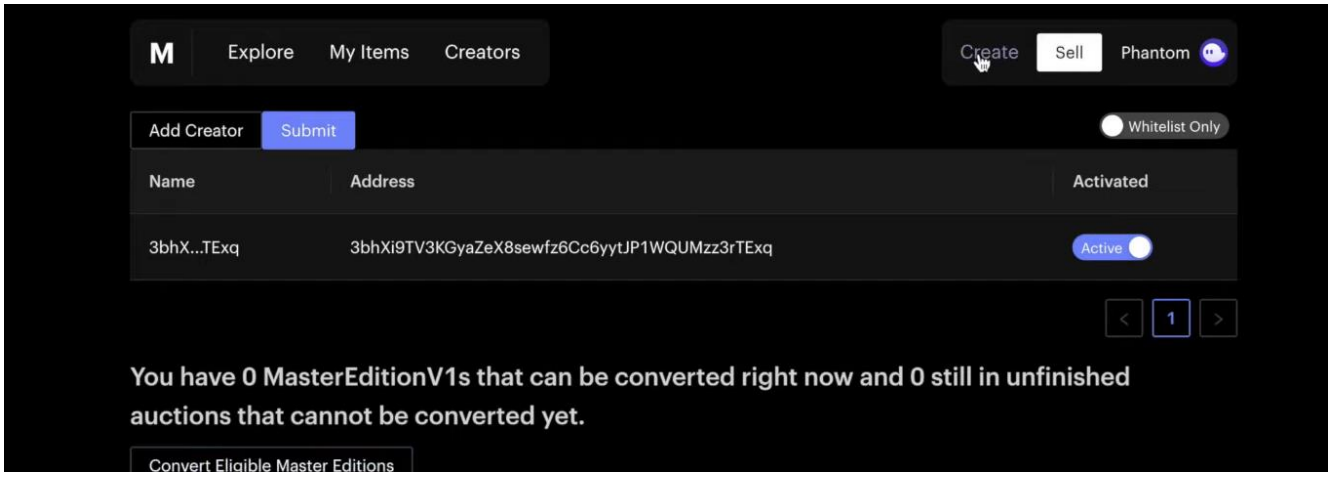

Figure 13. Store admin wallet address.

4.4 Creating a Non-Fungible Token in The Store

To create NFT in the deployed store. You can click “Create” button on the top right corner of the page. If the button is not there, then it should be in the drag down menu in the wallet section. All electronic files or data in any format can be converted into an NFT and many varieties of digital files are supported by Metaplex to be minted as NFT. We'll be using an image asset or “.jpeg” file in this project. There is a .gif file below in Figure 14 to further clarify the above passage.

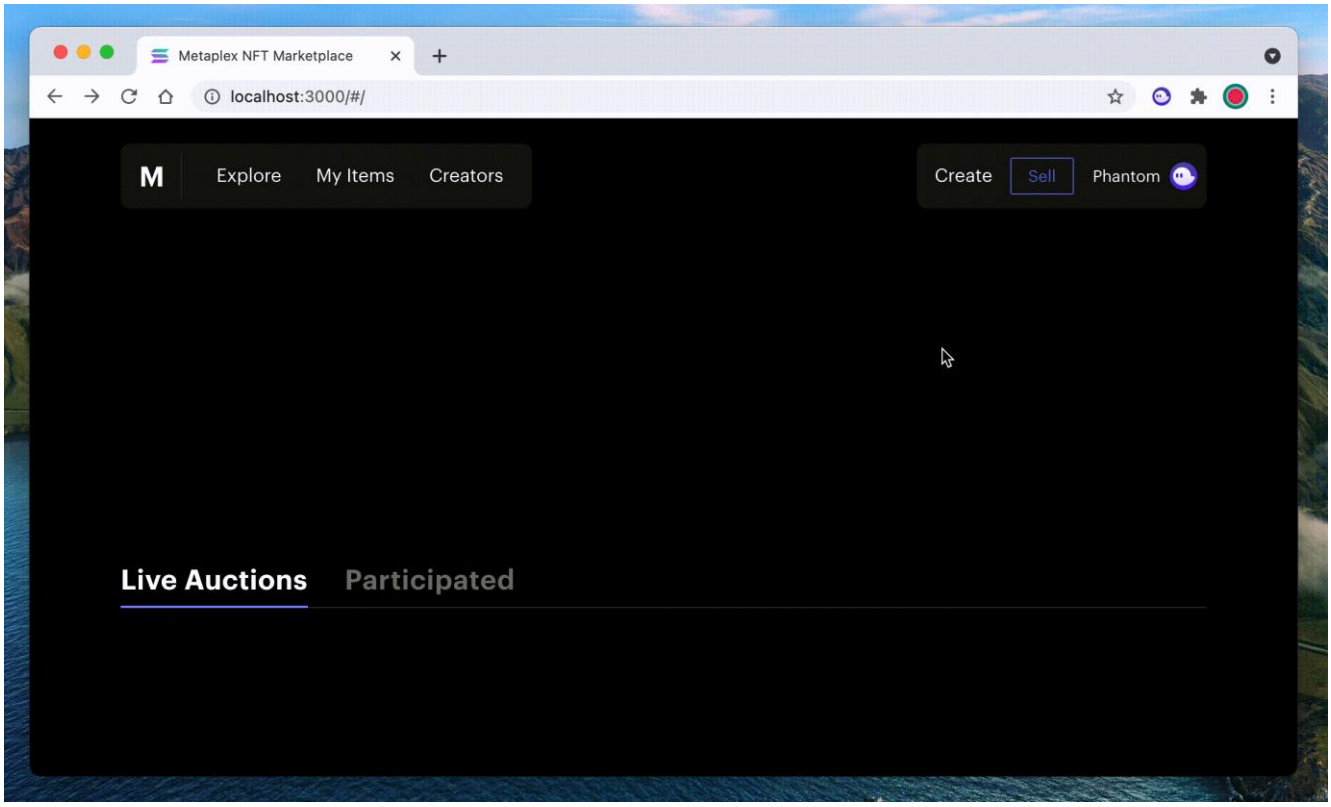

Figure 14. Creating NFT in the store front (Metaplex 2022)

Next step is to provide an asset to the blockchain, so it turns it into a cryptographic set of code, or a crypto token also known as Non-Fungible token. All the uploaded file is uploaded in Arweave, which is a decentralized storage service that backs data with sustainable and perpetual endowments, allowing users and developers to truly store data forever. You can upload a file directly from your hardware or you can paste a URL link from the internet. (Metaplex 2022)

After uploading the asset, description, title, maximum supply and attributes can be added for the asset. This process gives the asset a unique identifier for viewers, description about the asset or a message from the creators. Maximum Supply gives the option of owning a single NFT or numerous copies (prints) of this master edition asset. Each print is a numbered edition made from a master edition, which is the primary distinction between a master edition and a print. The numbering system in this case starts form zero, so if a maximum supply of ”1” is selected 2 NFTs can be minted or created from the asset. Attributes allow you to define custom properties (key/value pairs) that describe your asset. These attributes are later displayed when viewing the NFT in your wallet or marketplace of choice. For “display type”, the default is “string” but you can also set this to “date” to hint to downstream tools to format this appropriately. It is also the properties that gives different identifier for multiple same assets. Figure 15 explains the process of uploading an item for minting an NFT after all the conditions are set. (Metaplex 2022)

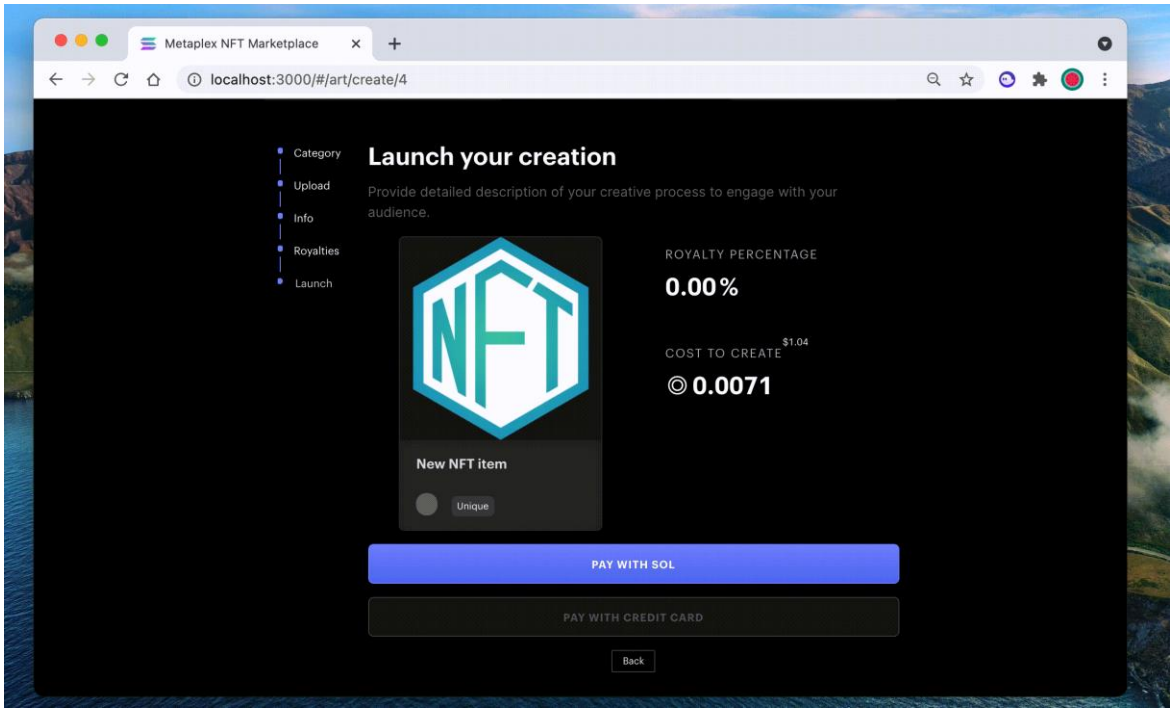

Figure 15. Final process of creation and authorization of the process via wallet (Metaplex, 2022)

Setting up royalities and creator splits falls under the category of candy machine, which is the protocol to make smart contracts in the blockchain. The royalities and creators split set here acts as a a smart contract which is visbile by everyone in the block and is ireversible. Royalities are the fee for the creator

of the asset, it declares how creators are compensated for their work. Similarly, creators split is a function for splitting reward or fee between creators. Creators can be added to the store in admin page.

To launch the asset as an NFT, which is also the final step in creating Non-Fungible Token in this store. A small amount of fee which is 0,01 SOL, must be paid to Mint the NFT into the blockchain. The payment is made by from the User wallet connected to the store and must be approved. The next process is to pay a transaction fee to finalize the minting process by paying the small, required amount of fee. The process cannot be undone so the creators need to be extra careful before finalizing the process. After all the process is finalized the minted NFT are displayed in the store as shown in figure 16. Now the NFT is minted the creator has full access to it and can set up its own price and conditions for its sales or can choose to put it up as a display or send it as a gift to other users.

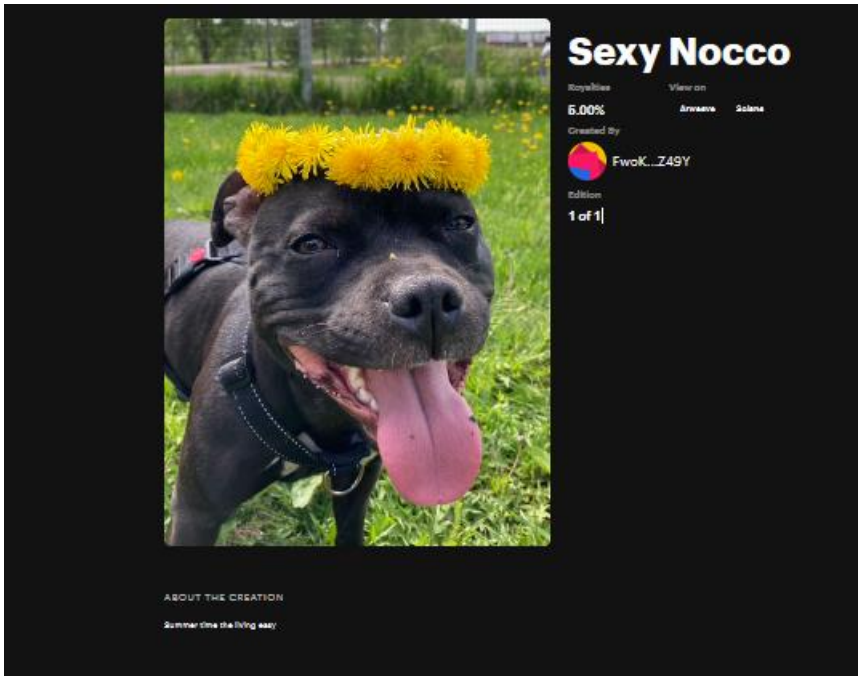

Figure 16. NFT after launch visually displayed in the store.

4.5 Selling NFT

The store not only helps creators mint/make Non-Fungible Token but also gives them options to buy or sale the asset. Various options can be explored by the creators from which they can select how they want to sell their assets. Instant Sale, Limited Edition, Open Edition and Tired Auction are some options for sales in the deployed site in the project. NFTs minted in other blockchains such as ERC20 tokens can also be sold in this store. All these options are default in the Metaplex store front. The store owner can modify or add or remove sales options whenever required. Instant Sale is the option that we are going to explore in this project. The process can be started by clicking on the sell icon in the top right corner of the home page. All the available sales options can be seen in figure 17 as displayed on the store front.

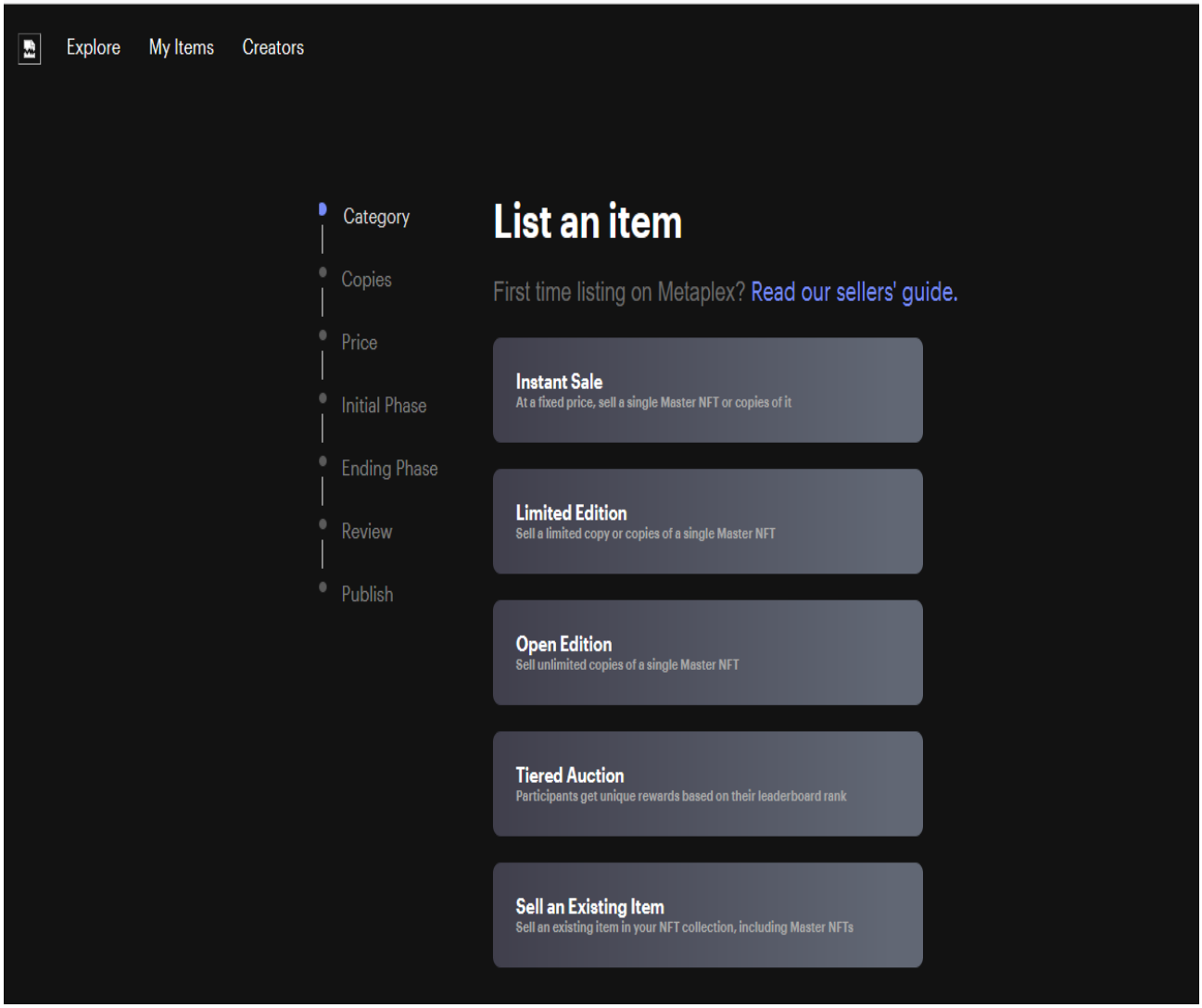

Figure 17. Selling an item in the deployed store in the project.

A single master Non-Fungible Tokens or copies of it can be sold for a single price when using the instant selling option. It is the fastest and easiest way to sell the NFT in the store. The buyer immediately can claim the item in instant sales option in the blockchain to their wallet. The other sales options are almost the same as this one except for some more functions like auctions and limited sales. The store provides options for appropriate sales of the assets minted in the blockchain. Options such as price and number of copies are provided in the limited sales section, whereas options such as auction duration, start of sales, bidding options and other sales related options are provided in various sections.

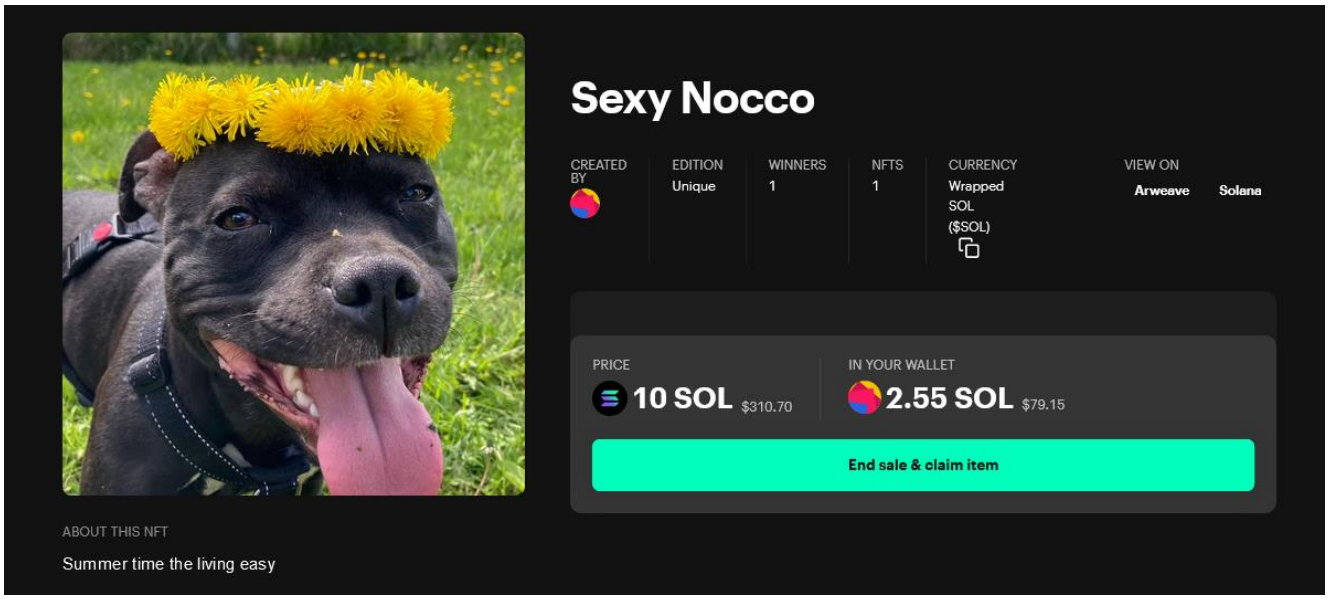

Figure 18. Item listed for sale

The final step for setting up a sale for the minted Non-Fungible Token, is to approve the transaction in the blockchain via crypto wallet. After the transaction is approved, the given asset can be found on the homepage of the store and is up for sales as shown in figure 18. If a buyer buys the Non-Fungible Token asset, the asset is transferred into the wallet of the buyer. In the store front all the Non-Fungible Token for sales are displayed on the front page with their price and type of sale. Transactions on instant sales are made immediately after purchases while auction sales take time, and the sale is only finalized upon given time or given conditions. The creators have full access to set up a contract as per their requirements. The store owner has no access to manipulate sales except for NFTs minted with the store owner's address.

5 CONCLUSION

Technologies and system that are being built around Blockchain Technology are increasing every day. As it is a new kind of system for storing data and ledgers, the general mass public has very few understandings on the topic. Mostly it is recognized as currency for trading where users can make a good number of profits. Distributed ledger technology is the best technology for ledgering and databases which promises security and trust, which is an issue for all organizations or individuals today. Similarly, smart contracts are also revolutionary technology built in Blockchain which is going to have a big impact in how we do deals in future and make contracts. It promises almost zero chances of fraud and abuse of power since there is no central government controlling and giving access.

NFTs has been acting as a showcase for the general public features of blockchain. There are so many 3D museums in the Metaverse that some real-world companies are building, where users and creators can showcase their NFTs. It has not only acted as a showcase but also given platform to many creators out there who are eager to publish on their own art and do not necessarily have to be dependent on a central party who governs all the transactions and controls the sales.

The store deployed in this project was done in dev-net. No real money was used, or NFTs were minted in this project but the dev-net and main-net works similarly only real currency is not used in dev-net since every action needs permission in blockchain and some requires fee which can be costly for developers. All the assets minted were owned by the author. The store also functions in mobile browser. The store is able to mint NFT and create a platform for creators to put up an auction or sales on display in a regular website which most people are familiar with. It can also handle transactions and fees for both creators and buyers.

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