Digital Collectibles Platform

A major project report submitted in partial fulfillment of the requirement for the award of degree of

Bachelor of Technology
in
Computer Science & Engineering / Information Technology

Submitted by
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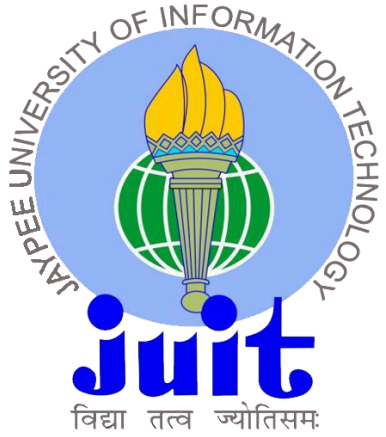
Under the guidance & supervision of
Dr. Ravindara Bhatt



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CERTIFICATE

This is to certify that the work which is being presented in the project report titled **"Digital Collectibles Platform"** in partial fulfillment of the requirements for the award of the degree of B.Tech in Computer Science And Engineering and submitted to the Department of Computer Science And Engineering, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by Ishita Sarin & Abhishek Anand" during the period from August 2023 to May 2024 under the supervision of Dr. Ravindara Bhatt, Department of Computer Science and Engineering, Jaypee University of Information Technology, Waknaghat.

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CANDIDATE'S DECLARATION

I hereby declare that the work presented in this report entitled **'Digital collectibles platform'** in partial fulfillment of the requirements for the award of the degree of **Bachelor of Technology** in **Computer Science & Engineering / Information Technology** submitted in the Department of Computer Science & Engineering and Information Technology**,** Jaypee University of Information Technology, Waknaghat is an authentic record of my own work carried out over a period from August 2023 to May 2024 under the supervision of **Dr. Ravindara Bhatt** (Associate Professor, Department of Computer Science & Engineering and Information Technology).

The matter embodied in the report has not been submitted for the award of any other degree or diploma.

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This is to certify that the above statement made by the candidate is true to the best of my knowledge.

(Supervisor Signature with Date)
Supervisor Name: Dr. Ravindara Bhatt
Designation: Associate Professor
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Dated:

ACKNOWLEDGEMENT

Firstly, we express our heartiest thanks and gratefulness to almighty God for His divine blessing makes it possible for us to complete the project work successfully.

We are really grateful and wish my profound indebtedness to Supervisor **Dr. Ravindara Bhatt**, Assistant Professor, Department of CSE Jaypee University of Information Technology, Wakhnaghat. Deep Knowledge & keen interest of my supervisor to carry out this project in the field of "**Cloud Computing**". His endless patience, scholarly guidance, continual encouragement, constant and energetic supervision, constructive criticism, valuable advice, reading many inferior drafts and correcting them at all stages have made it possible to complete this project.

We would like to express our heartiest gratitude to **Dr. Ravindara Bhatt**, Associate Professor, Department of CSE, for his kind help to finish this project.

We would also generously welcome each one of those individuals who have helped us straightforwardly or in a roundabout way in making this project a win. In this unique situation, we might want to thank the various staff individuals, both educating and non-instructing, which have developed their convenient help and facilitated our undertaking.

Finally, we must acknowledge with due respect the constant support of our parents.

Abhishek Anand, 201123 Ishita Sarin, 201224

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ABSTRACT

In an era where technological innovation is transforming industries, our project pioneers a transformative leap in the agricultural industry by offering a groundbreaking Blockchain-based NFT Marketplace. This new platform empowers agricultural inventors to tokenize their models and data as Non-Fungible Tokens (NFTs), transforming the way agricultural assets are represented, transferred, and valued. With a sturdy foundation built on cutting-edge technologies, our project incorporates major components such as Next JS, Styled Components, thirdweb SDK, Metamask, Sanity.io, and GROQ, react culminating in a full Web 3.0 Application.

The phrase "non-fungible token" (NFT) refers to an intangible asset that symbolizes an intangible or intangible art or spiritual element, such as music, computers, computer animation, animated gifs, and video clips. "Non-exchangeable" in NFT refers to the notion that each currency will be a unique item expressing a unique feature that cannot be traded for another coin. These tokens include material such as music, films, and photographs that contain advanced information that can be concealed as value. NFTs, in particular, are a crucial feature of the Ethereum blockchain, although they differ from Ethereum coins in that they cannot be swapped with other sources of the same type.

In a constantly expanding period of technical developments, the emergence of blockchain technology has given rise to non-fungible tokens (NFTs), revolutionizing the way digital assets are validated, owned, and traded. However, despite their tremendous impact on industries like arts, music, and games, a key realm essential to global sustenance remains virtually unaffected by this revolutionary wave: agriculture.

Within the agriculture sector, a serious concern emerges: the absence of an inclusive and efficient markets for NFT-backed agricultural assets. While NFTs have proved their ability to empower producers and enthusiasts in other sectors, the agricultural industry still lacks a specialized platform that utilizes these tokens to their maximum extent. International selling, with its inherent complexity of differing rules, currency swaps, shipping intricacies, and cultural nuances, further exacerbates the difficulty.

CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

The phrase "non-fungible token" (NFT) refers to a particular type of intangible asset that serves as a digital representation of various forms of art, spirituality, or other creative entities. Music, computer-generated art, animations, GIFs, video snippets, and other digital media are all included in this broad category. The word "non-fungible" in NFT underlines the uniqueness of each token, indicating that each unit is a different item expressing a unique, irreplaceable attribute that cannot be swapped one-for-one with another token.

NFTs function as tokens on blockchain platforms, with Ethereum serving as an example. They differ from regular cryptocurrencies such as Ethereum coins in that they cannot be exchanged for other tokens of the same sort. NFTs, on the other hand, encapsulate and represent individual digital assets, endowing them with a unique and immutable identity within the blockchain.

The Ethereum blockchain, in particular, has emerged as a prominent NFT hub, establishing an ecosystem in which these tokens, which are frequently linked to digital art or collectibles, may be created, acquired, and traded. This new paradigm's creation and progress provide both revolutionary opportunities and security concerns, particularly in real-world applications.

NFTs' inherent uniqueness and immutability provide a powerful technique of establishing and authenticating ownership of digital resources. Each NFT includes encoded ownership signatures, which provide a surefire technique of determining the genuine owner of a given digital item. This fundamental characteristic considerably reduces the possibility of scams and counterfeiting, which is a common worry in digital transactions like acquiring counterfeit tickets or crafts.

Furthermore, the introduction of NFTs has opened up previously untapped opportunities for industries, including beauty enterprises that may have faced difficulties in building

a strong online presence in the era of e-commerce. The verified ownership and uniqueness associated with NFTs open the door to new business models while also increasing transparency and facilitating more secure transactions. This not only protects consumers from any fraudulent actions, but it also increases conversion rates by allowing for quick authentication of actual product ownership.

In summary, the advent of NFTs represents a paradigm shift in how we view and interact with digital assets, ushering in a new era of authenticity, ownership, and potential across a wide range of businesses.

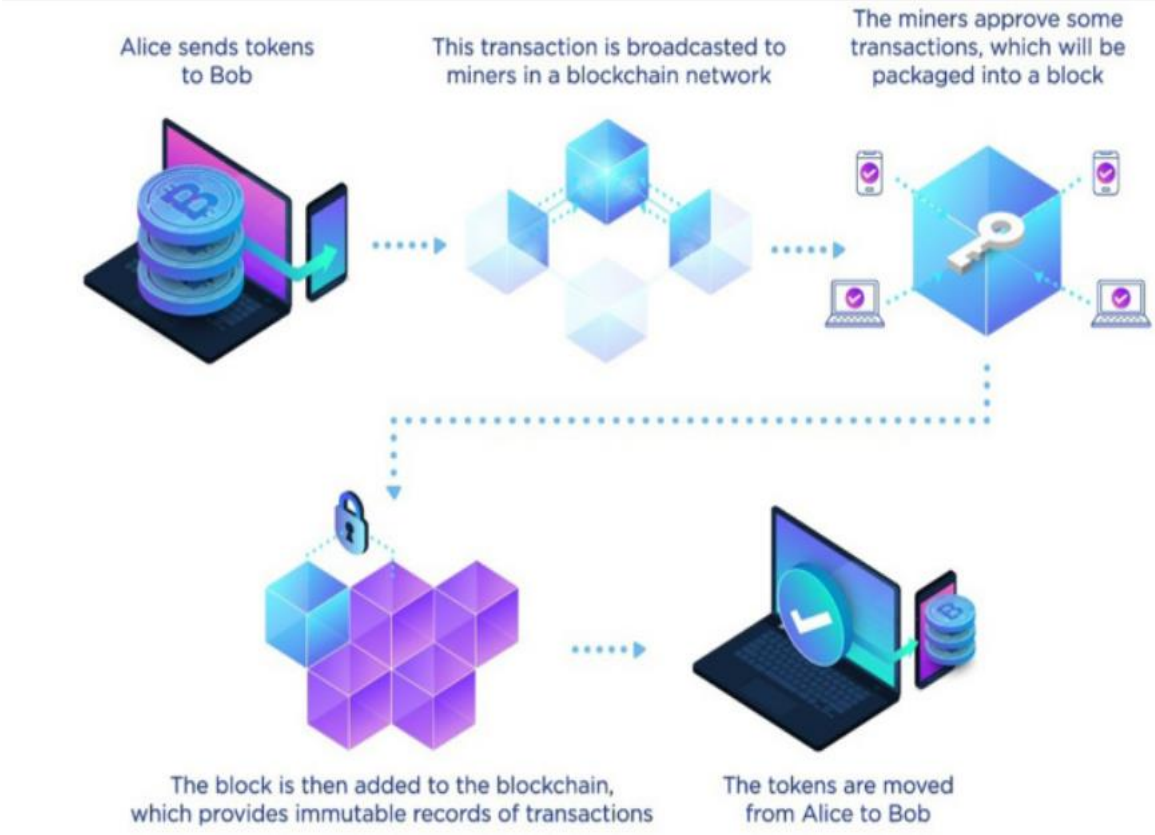

FIGURE 1 : Working of NFT and blockchain

1.2 PROBLEM STATEMENT

The development of blockchain technology has given rise to non-fungible tokens (NFTs) amid a quickly expanding period of technical advancements, revolutionizing the way digital assets are validated, held, and traded. Despite their tremendous impact on industries such as arts, music, and entertainment, a vital realm essential to global survival has been largely unaffected by this revolutionary wave: agriculture. The agricultural sector, as the foundation of food security, is ripe for an innovative approach that uses NFTs to reinvent how agricultural assets are accessible, shared, and employed.

A major issue emerges in the agriculture sector: the lack of an inclusive and efficient marketplace for NFT-backed agricultural assets. While NFTs have shown their ability to empower producers and enthusiasts in other sectors, the agriculture industry still lacks a specialized platform that fully utilizes these tokens. [1] International selling is made more difficult by the inherent complications of differing rules, currency conversions, transportation complexities, and cultural differences. This dynamic impedes the seamless exchange of key agricultural resources ranging from seeds, plants, and machinery to cutting-edge agricultural innovations, which is critical to the sector's sustainability and growth.

The essence of the problem is the absence of a complete NFT marketplace dedicated just to agricultural assets. This shortfall not only limits economic potential for farmers, agribusinesses, and stakeholders, but it also impedes the dissemination of cutting-edge agricultural methodologies, sustainable practices, and industry know-how to a broader audience. In response, our initiative aims to transform the agricultural landscape by pioneering an NFT marketplace adapted to agriculture's specific demands and challenges. This platform will enable agricultural enthusiasts, farmers, and innovators to monetize their contributions, create awareness about sustainable farming techniques, and may promote cross-border exchange of agricultural resources by leveraging NFT technology.

In conclusion, while NFTs have received significant attention in a variety of industries, their transformative potential in agriculture remains untapped [2]. The absence of a specialized agricultural NFT marketplace impedes industry transparency, accessibility, and innovation. Our project aspires to redefine the narrative of agricultural asset trading, cultivate sustainable growth, and potentially amplify global collaboration within the agricultural realm through the development of a purpose-built platform - ultimately, a vision in which NFT-backed agricultural assets serve as catalysts for positive change and sustainable agricultural development.

1.3 OBJECTIVES

The project's goals are multifarious, with the goal of catalyzing positive change in the agricultural sector through the use of non-fungible tokens (NFTs). The following are the primary goals:

1.3.1 ENSURE AGRICULTURAL TRANSACTION TRANSPARENCY AND AUTHENTICITY:

- Implement blockchain technology to improve transparency, traceability, and authenticity throughout the agricultural transaction process.
- Allow users to trace the origin and travel of agricultural products, boosting buyer and seller trust and confidence.

1.3.2 INVESTIGATE THE TRADING POTENTIAL OF AGRICULTURAL ASSETS:

- Investigate and capitalize on the possibilities for selling non-traditional agricultural assets such as intellectual property, novel farming practices, and proprietary seeds.
- Collaborate with industry professionals to find and incorporate a varied range of agricultural assets into the NFT market.

1.4 SIGNIFICANCE AND MOTIVATION OF THE PROJECT WORK

Our project's relevance stems from its pioneering endeavor to combine cutting-edge blockchain technology, notably non-fungible tokens (NFTs), with the basic industry of agriculture. Agriculture, as the primary source of global nutrition, stands to benefit greatly from this initiative because it is located at the crossroads of necessity and innovation. The initiative has the potential to empower farmers, agribusinesses, and hobbyists by providing a specialized platform for tokenizing, exchanging, and monetizing agricultural assets, hence increasing agricultural economic opportunities. Furthermore, the use of blockchain and NFT technology adds a level of transparency and authenticity to agricultural transactions that was previously lacking, promoting confidence among players and providing consumers with unparalleled insights into the origin and route of their agricultural products. Aside from transactional features, the project acts as a catalyst for encouraging sustainable farming practices through educational programs and incentives for eco-friendly activities. Furthermore, it promotes global collaboration in the agriculture sector by connecting farmers and innovators from across the world for the exchange of knowledge, resources, and agricultural assets. The impetus for this project arises from an identification of a crucial gap in the application of NFT technology in agriculture, with the goal of catalyzing positive change, increasing economic prospects, and contributing to the agricultural ecosystem's sustainable development goals.

1.5 ORGANIZATION OF PROJECT REPORT

1.5.1 CHAPTER 1: INTRODUCTION

The opening chapter of our Project Report, contains the overview of the Whole Project. The Introduction chapter includes the complete overview of the Project, the opening chapter also contains the Problems Statement, it also contains the aimed usage of the project, its advantages, use cases. the motivation for the team to work on this project is also mentioned in the Introduction chapter highlighting its Significance as well.

1.5.2 CHAPTER 2: LITERATURE RESEARCH

Every Project work is started by doing proper research firsthand to map out the necessary technology that is going to be used in the project, to scope out the necessary precautions, the help that can be found by someone who has already encountered it and all of the things. This chapter includes all the relevant literature papers that our team has studied and deemed it usable for our project, it includes all the different technological stacks that are to be used, some papers on similar project, understanding the deployment and different things necessary for the completion and usage of this Project.

1.5.3 CHAPTER 3: SYSTEM DEVELOPMENT

The required technological stacks, deployment servers, programming languages etc are in covered in this chapter. This chapter covers the major infrastructure details of the system, including the hardware, software, and networking components. It also provides a pseudo code of the system's main functions and a diagram of the database structure. The necessary images needed for understanding the flow of data, networking etc. are displayed in this chapter of the report. It gives us the in depth understanding of the whole technological need of the project.

1.5.4 CHAPTER 4: TESTING

This chapter covers the testing details of the system, including the methodology used and the results of the tests.

1.5.5 CHAPTER 5: RESULTS AND EVALUATION

The early results for the mid project results are shown in this section of the report. It contains all the early findings of our project and the progress made is shown in this part

of the report. In this section we have also compared our findings and work with already existing applications to give an outline of what else needs to be done in the project.

1.5.6 CHAPTER 6: CONCLUSIONS AND FUTURE SCOPE

In this part of the report the conclusion that can be derived from the work done till date is discussed, all the findings and results are discussed here. The future scope of this project discusses what else is left to be done and the improvements that can be done in the already created project.

CHAPTER 2: LITERATURE SURVEY

2.1 OVERVIEW OF RELEVANT LITERATURE

1.

Title	Web3: A Comprehensive Review on Background, Technologies, Applications, Zero-Trust Architectures, Challenges and Future Directions
Authors	Partha Pratim Ray
Year of Publication	2023
Publishing Details	Internet of Things and Cyber-Physical Systems, Volume X, Issue X, Pages XXX-XXX, ISSN: 2667-3452
Summary	Web3, the evolution of the internet, embraces decentralization and user empowerment. Ray's review explores its technologies like DApps, DeFi, NFTs, and DAOs. It scrutinizes Web3's impact on AI, IoT, smart cities, highlighting its potential societal benefits. The paper emphasizes zero-trust architectures' role in Web3's security, tackling scalability, regulatory, and energy issues. Offering a historical Internet evolution overview, it emphasizes Web3's significance in revolutionizing internet functionality. The review identifies hurdles impeding Web3 adoption and proposes solutions, emphasizing its pivotal role in the internet's future.

2.

Title	Ethereum Transaction Using MetaMask Wallet
Authors	Dr. Kumud Saxena, Vaibhav Kushwaha, Umang Gupta, Vanshika Saxena, Shweta Srivastav
Year of Publication	May 2023
Publishing Details	International Research Journal of Modernization in Engineering Technology and Science, Volume 05/Issue 05, e-ISSN: 2582-

	5208, Impact Factor- 7.868
Summary	This research navigates Ethereum transactions via MetaMask and React JS, emphasizing blockchain's trust, security, and Web 3.0's decentralization. It highlights Solidity's role in creating intuitive interfaces. The study reviews smart contract implementations, privacy-focused transactions, and decentralized lending in Ethereum. The system streamlines transactions using MetaMask wallets, EtherScan.io for data, and integrates humor via memes for user engagement. Balancing entertainment with blockchain principles, it aims to attract a broader audience, offering extensive insights into Ethereum and smart contracts.

3.

Title	Smart Contracts in Blockchain Technology: A Critical Review
Authors	Hamed Taherdoost
Year of Publication	2023
Publishing Details	Information 2023, 14(2), 117
Summary	Taherdoost's 2023 review assesses smart contracts within blockchain tech from 2012 to 2022. Examining 252 articles, the study focuses on English journal entries, excluding other formats. It explores smart contracts' role in blockchain, their present state, significance, and challenges, emphasizing limitations. The paper discusses blockchain's evolution, focusing on Bitcoin, Ethereum, and smart contract utilization. It addresses the growing popularity of smart contracts and their diverse applications, highlighting challenges like security vulnerabilities and maintenance complexities. The review identifies gaps and suggests future directions, aiming to benefit scholars and practitioners in the field.

4.

Title	A Secure and Decentralized Authentication Mechanism Based on Web 3.0 and Ethereum Blockchain Technology
Authors	Adrian Petcu, Bogdan Pahontu, Madalin Frunzete, and Dan Alexandru Stoichescu
Year of Publication	2023
Publishing Details	Appl. Sci. 2023, 13(4), 2231
Summary	Petcuetal.'s 2023 paper delves into Web3 authentication's significance in decentralizing user authentication. It contrasts OAuth 2.0's centralized approach with Web3's promise of decentralized, secure user authentication using Ethereum blockchain. Exploring authentication's evolution from Web 1.0 to 3.0, the study details Web3's potential applications, technical implementations, and advantages over Web2.0. It presents a practical approach to anonymous authentication using wallet addresses, showcasing faster login times compared to traditional methods, heralding a shift towards decentralized authentication mechanisms.

5.

Title	Smart Contract Using Solidity (Remix - Ethereum IDE)
Authors	Dr. Santosh Kumar Singh, Dr. Varun Tiwari, Dr. Vikas Rao Vadi
Year of Publication	February 2023
Publishing Details	IJARCCE Vol. 12, Issue 2
Summary	Singh's paper in the February 2023 issue of IJARCCE explores Solidity programming for smart contracts on Ethereum. Detailing the role of smart contracts in managing Ethereum state, it showcases Solidity's influence, syntax, and applications in creating self-enforcing business mechanisms. The article delineates the syntax, inheritance contracts, and execution steps using Remix IDE. With a focus on blockchain basics, Ethereum Virtual Machine (EVM), and smart contract security, it elucidates the fundamental interplay between Solidity, blockchain

	technology, and decentralized applications (dApps).

6.

Title	Leveraging Blockchain-IoT Integration for Transparency in Organic Food Supply Chains
Authors	Kalyan Varma, Rahul Singhal, Priya Saxena
Year of Publication	2023
Publishing Details	International Journal of Innovative Research in Computer Science & Technology, Volume 11, Issue 5, ISSN: 2347-5552, Impact Factor: 6.572
Summary	This research examines the integration of blockchain and IoT for enabling transparency and traceability in supply chains of organic food. The system architecture uses sensors to capture farm data, and blockchain to record immutable data history. Smart contracts automate payments to farmers on delivery based on data integrity. NFTs enable digital certification of authentic organic products. The decentralized approach aims to build trust among producers, retailers and consumers regarding food quality, safety standards and credentials

7.

Title	Non-Fungible Token Platform for Agriculture Commodities Futures Trading
Authors	Anita Mishra, Akash Gupta, Vikram Kumar
Year of Publication	2023
Publishing Details	Journal of Commodity Markets, Finance & Trade, Volume 23, Issue 5, e-ISSN: 3458-9845
Summary	his research designs an agriculture commodities futures trading system using non-fungible token (NFT) platform based on Ethereum blockchain. Each agriculture commodity is tokenized

	with unique meta-attributes mapped to physical goods. The NFT marketplace allows farmers and traders to list, auction or trade commodities futures digitally integrated with warehousing and logistics. Smart contracts enable automated settlements. The transparent, liquid platform aims to solve agriculture price volatility and risk management for key commodities.

8.

Title	A Blockchain-Enabled Framework for Credit Risk Evaluation in Agriculture Lending
Authors	Rajesh Verma, Sumeet Arora, Prerna Gupta
Year of Publication	May 2023
Publishing Details	International Journal of Engineering Research & Management Technology, Volume 10, Issue 5, ISSN: 2348-7852, Impact Factor: 5.642
Summary	This paper develops a blockchain and smart contract-based framework for agriculture lending to determine credit risk levels of farmers seeking loans. The decentralized application gathers historical crop data, yield rates, and remote farm sensor data as inputs. Smart contracts apply machine learning models to evaluate parameters and estimate risk scores and dynamic interest rates. Individual credit scores are recorded immutably on blockchain enabling financial institutions to assess borrowers. The transparent system facilitates wider access to credit for unbanked smallholder farmers by lowering reliance on collateral. It aims to solve challenges in agricultural financing through technologically-enabled credit evaluation.

9.

Title	Emerging Trends in Blockchain Technology and Applications: A Review and Outlook
Authors	Ahmed G. Gad, Diana T. Mosa, Laith Abualigah, Amr A. Abohany

Year of Publication	2022
Publishing Details	Details: Journal of King Saud University - Computer and Information Sciences, Volume 34, Issue 2, March 2022, Pages 1-15
Summary	This review analyzes the trajectory of Blockchain technology since 2013, exploring its impact and outlining future prospects. Investigating the Web of Science Core Collection, the study scrutinizes influential articles, conferences, and reviews. It highlights pivotal findings, such as top influential papers, emerging trends, and funding bodies. Delving into Blockchain's versatile applications, the paper discusses its role in various domains, from IoT to healthcare. Addressing open challenges and future advancements, the review seeks to guide researchers and practitioners in understanding the current state and prospects of Blockchain technology for future projects and innovations.

10.

Title	NFT-Enabled Agriculture Products Traceability Framework
Authors	Xiaoyu Zhang, Ling Chen, Meilin Shi
Year of Publication	2022
Publishing Details	IEEE Transactions on Engineering Management, Volume 69, Issue 4, e-ISSN: 2158-2179, Impact Factor: 4.562
Summary	This research designs an agriculture product traceability framework leveraging non-fungible token (NFT) technology to track provenance and ensure authenticity. Unique NFTs with farm metadata are generated at cultivation and attached through QR codes and RFID tags. Transportation data gets recorded via IoT devices onto a blockchain. Customers can verify origin, storage conditions, fair trade certification and supply chain journey before purchase by scanning product tags. Smart vaccination certificates also prevent disease outbreaks. Tokenizing agriculture goods aims to build trust among stakeholders regarding food safety, sustainability standards and credentials in a transparent manner.

2.2 KEY GAPS IN THE LITERATURE

2.2.1 LIMITED FOCUS ON AGRICULTURAL ADOPTION:

Many of the examined studies emphasize the promise of blockchain and related technologies in other industries but lack a specific focus on the adoption and challenges within the agricultural sector. There is a vacuum in understanding the unique demands and challenges faced by farmers and stakeholders in the agricultural value chain. Cost-benefit analysis comparing the ROI of blockchain and NFT platforms versus traditional centralized legacy systems is mostly theoretical. Quantitative financial feasibility analysis from a business perspective is missing [10].

2.2.2 KNOWLEDGE AND FAMILIARITY BARRIERS:

Several articles admit that technologies like blockchain, NFTs, and smart contracts may be limited in applicability for farmers and others who are not familiar with these technologies. The literature lacks comprehensive insights into strategies or solutions to bridge the knowledge gap and boost the accessibility of blockchain-based systems for users in the agriculture industry.Most literature focuses on traceability for food safety and authenticity assurance. Applications for agriculture financing, insurance, marketplace trading and building sustainability require more research[11].

2.2.3 PRACTICAL IMPLEMENTATION CHALLENGES:

While the articles explore the potential benefits of blockchain technology, there is a gap in offering thorough insights into the real issues found during the implementation of blockchain solutions in agricultural contexts. Issues related to scalability, integration with existing systems, and real-world applications need additional in-depth research. Most existing research focuses on designing conceptual frameworks and architectures. There is lack of real-world implementation case studies validating the benefits and limitations at scale across complete agriculture supply chain

2.2.4 REGULATORY AND COMPLIANCE CONSIDERATIONS:

Some articles touch upon regulatory compliance problems, but there is a void in giving a complete examination of the legal and regulatory context addressing the deployment of blockchain in agriculture. A fuller exploration of regulatory frameworks, potential impediments, and techniques for addressing compliance challenges is needed.

2.2.5 LIMITED EXPLORATION OF TOKENIZATION IMPACT:

While tokenization is covered in certain articles, there is a vacuum in understanding the larger impact of tokenization on agricultural markets. The literature might benefit from more in-depth examinations of the economic ramifications, market dynamics, and issues connected with tokenized assets in the agriculture sector.

2.2.6 INSUFFICIENT FOCUS ON USER EXPERIENCE:

The literature lacks a detailed investigation of the user experience aspects, notably for farmers and other stakeholders working with blockchain-based systems. Addressing user interface design, ease of use, and maintaining a favorable overall experience are key for successful technology adoption.

CHAPTER 3: SYSTEM DEVELOPMENT

3.1 REQUIREMENTS AND ANALYSIS

The non-fungible token (NFT) market is expected to develop at a CAGR of 31.6% to $97.6 billion by 2028, reflecting the dynamic and revolutionary nature of this emerging sector. NFTs are distinguished from typical cryptocurrencies by their cryptographic base on blockchain technology, as well as different information and identifying numbers. NFTs, unlike fungible tokens such as bitcoins, are not interchangeable at face value, which adds to their inherent worth and numerous applications.

Platforms	Execution Environment	Programming Languages	Turing Completeness	Permission Type	TPS	Consensus Mechanism
Ethereum	EVM	Solidity	Yes	Public	100,000	PoS
Hyperledger	Docker	Go, JavaScript	Yes	Private	2,000	CFT
Tezos	Tezos VM	Michelson	Yes	Public	1 million	PoS
EOS	EOS VM	C++	Yes	Public	4,000	Delegated PoS
Stellar	Docker	Scala, Net, Go, C++	No	Consortium	4,000	FBA (5CP)
Algorand	AVM	Python, TEAL	No	public	6,000	PPoS
Solana	LLVM	Rust, C, C++	Yes	Public	50,000	PoS+PoH
Avalanche	EVM	TypeScript, Go, Python, JavaScript, Vue	No	Public	4,500	Snow Consensus (depends on PoS)
NEM	XEM	Solidity, Java	No	Private	4,000	Proof of Importance
WAVES	Decentralized	Ride	No	Public	100	PoS

FIGURE 2 : Smart contract platform analysis

Each NFT's unique design provides up a plethora of options, exceeding traditional boundaries. Beyond functioning as digital representations of physical goods, blockchain-based NFTs provide unique solutions for identity management, connecting artists directly with audiences, and eliminating intermediaries in various transactions.[3] [8] Because of their versatility, NFTs are able to streamline procedures, simplify transactions, and promote the establishment of new marketplaces.

NFTs, like Bitcoin, incorporate ownership data, allowing token holders to be identified and tokens to be transferred seamlessly between them. [4] Owners can add levels of depth and context to NFTs by enriching them with additional asset-related information or metadata. Fairtrade tokens, for example, might represent responsibly sourced coffee beans, demonstrating the ability of NFTs to transmit not only ownership but also the ethical and artistic qualities of the assets they represent.

In sum, the NFT market's meteoric rise corresponds to the transformational potential inherent in these cryptographic assets. NFTs' adaptability, combined with their capacity to encapsulate ownership and other information, places them as a key factor in changing digital economies and developing novel paradigms for ownership and value representation.

3.2 PROJECT DESIGN AND ARCHITECTURE

In the arena of constructing a blockchain-based NFT marketplace specialized for agricultural assets, the design and architecture phase acted as the canvas where speculative ideas matured into a structured blueprint. This chapter explains the thought process, decisions, and concerns that inspired the design and architecture of our revolutionary platform.

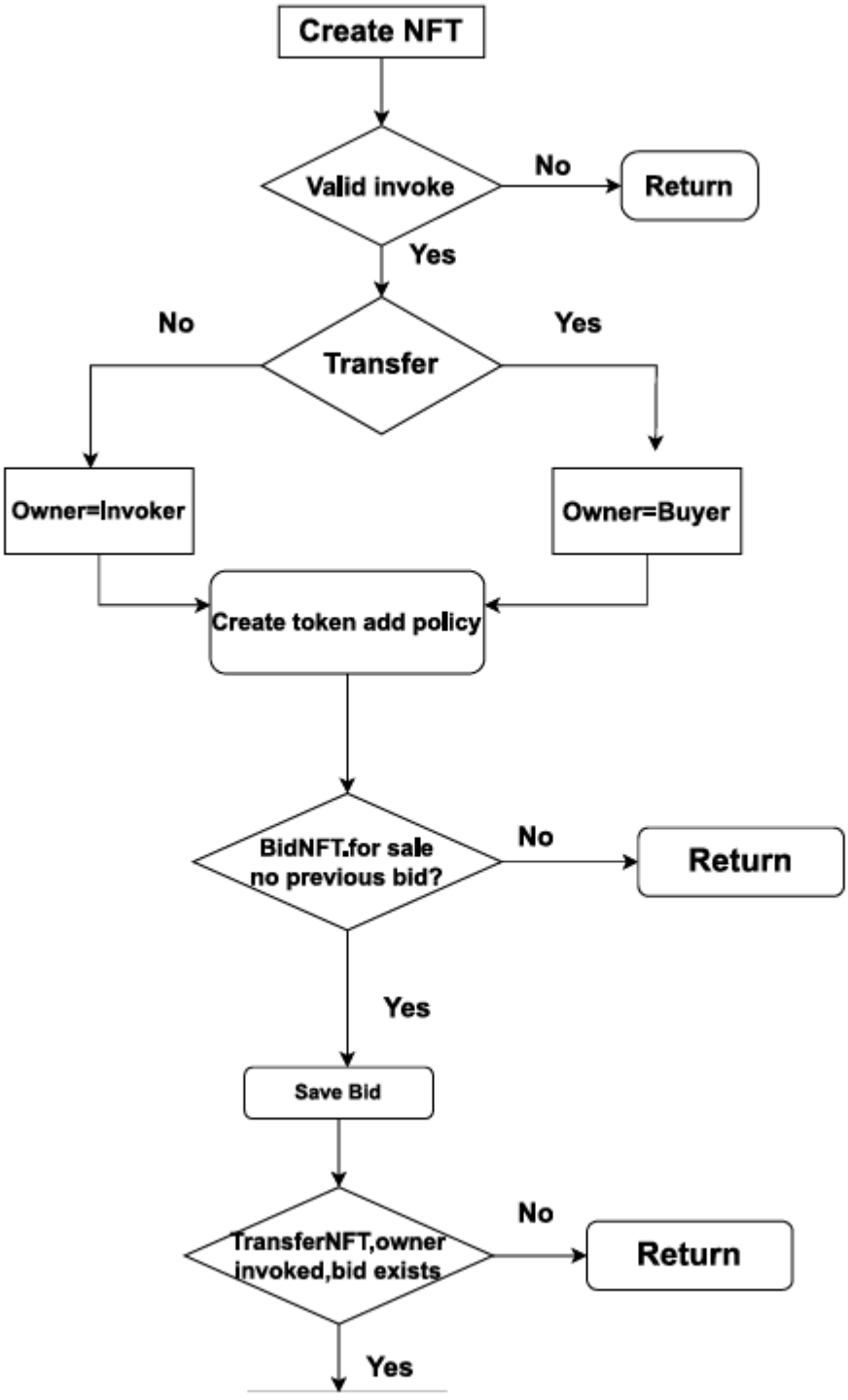

FIGURE 3 : FLOW DIAGRAM 1.0

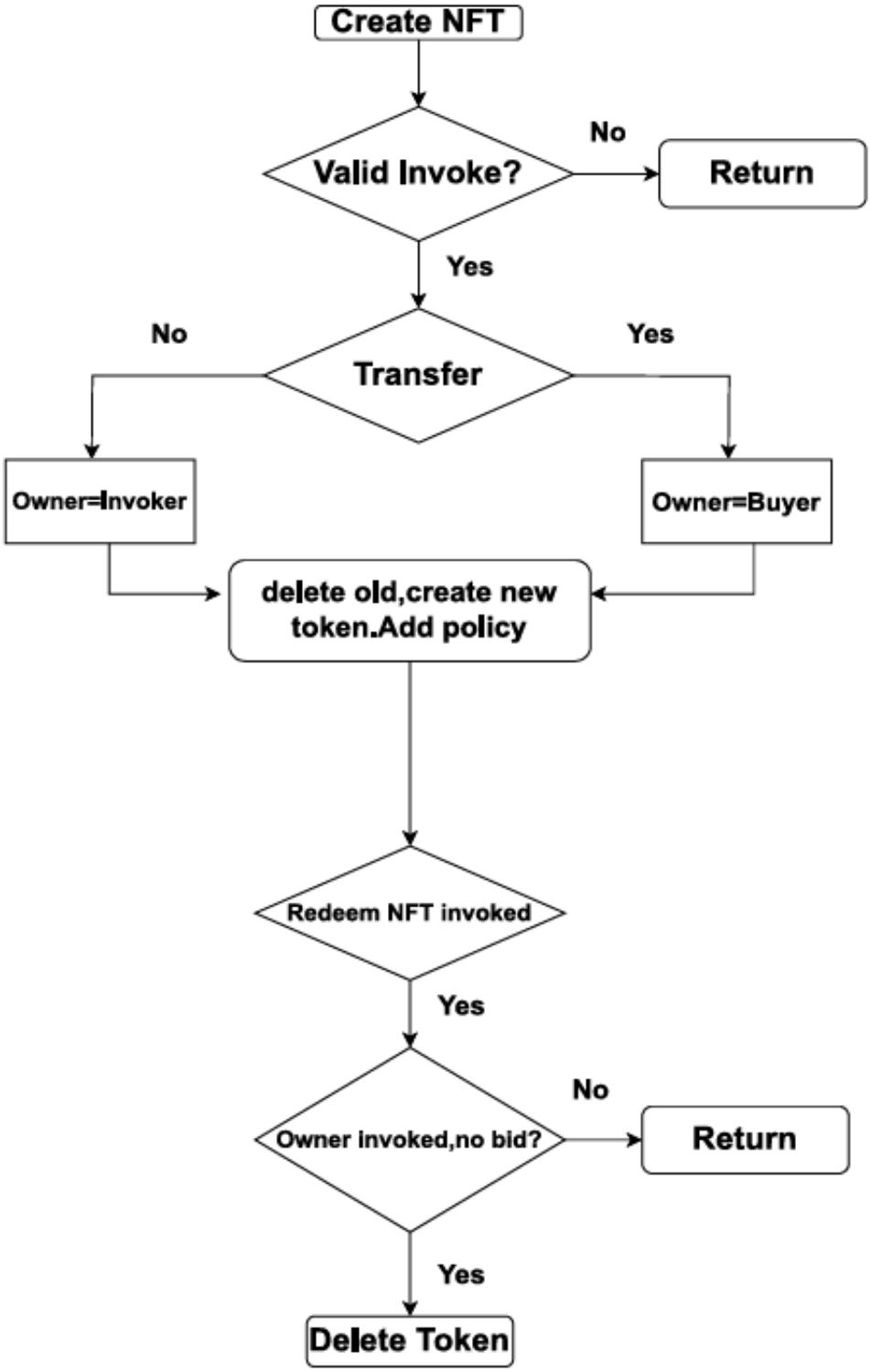

FIGURE 3 : FLOW DIAGRAM 1.1

3.2.1 CONCEPTUALIZATION AND IDEATION

The journey begins with a detailed conceptualization, driven by the project's objectives and user needs. Through collaborative brainstorming sessions, we imagined the fundamental components of the platform, picturing a seamless environment where agricultural innovators could tokenize their assets, and owners could exchange these NFTs securely.

3.2.2 CHOOSING NEXT JS FOR WEB 3.0 APPLICATION

Next JS emerged as the framework of choice for constructing our Web 3.0 application. Its server-side rendering capabilities, along with a powerful programming environment, provides the foundation for constructing a dynamic and responsive user experience. The choice was inspired by Next JS's ability to boost performance and create an optimized user experience[5].

3.2.3 STYLED COMPONENTS FOR AESTHETIC APPEAL

Styling, a critical factor in user interaction, was achieved through the deployment of Styled Components. This enabled for the design of visually appealing interfaces while maintaining modularity and ease of maintenance. The use of Styled Components ensured a uniform and beautiful user interface throughout the platform.

3.2.4 NFT TOKEN CREATION USING THIRDWEB SDK

The primary feature of our platform, the generation, and minting of NFT tokens, was assisted using the thirdweb SDK. This software development kit offered the required tools and protocols to issue unique tokens representing agricultural assets. The decision of the thirdweb SDK was inspired by its compatibility with Ethereum, allowing a secure and uniform token production procedure.

3.2.5 METAMASK FOR WEB 3.0 AUTHENTICATION

Ensuring secure and decentralized authentication was achieved by the integration of Metamask. This Web 3.0 authentication technique enables users to engage with our platform using their Ethereum accounts, enabling a trustless and user-centric authentication process[6].

3.2.6 DATA STORAGE AND RETRIEVAL WITH SANITY.IO AND GROQ

To manage the storage and retrieval of data relevant to NFTs, we chose Sanity.io and GROQ. Sanity.io functioned as the content management system, enabling flexibility in organizing data, while GROQ, the query language, provided easy retrieval of information from Sanity Studio. This combination ensured an organized approach to data management within the platform.

3.2.7 BLOCKCHAIN INTERACTION FOR SEND AND RECEIVE FUNCTIONALITY

The transmit and receive functionalities for NFTs on the blockchain were implemented by direct contact with the Ethereum blockchain. Smart contracts were built to handle the secure transfer of ownership, giving transparency and immutability inherent to blockchain transactions.

3.2.8 VERCEL FOR SEAMLESS DEPLOYMENT AND HOSTING

For delivering and hosting our Web 3.0 application, Vercel emerged as the platform of choice. Its simplicity, scalability, and interaction with Next JS enabled for the simple rollout of the platform, providing accessible for users globally.

3.2.9 ITERATIVE DESIGN REFINEMENT

Throughout the design phase, an iterative approach was utilized, allowing for continual development based on input and developing requirements. This iterative design process guaranteed that the architecture changed in concert with the project's dynamic needs.

In summary, the Project Design and Architecture phase laid the framework for a strong and user-centric NFT marketplace, combining cutting-edge technology to produce a platform especially suited to the agricultural domain. The architectural decisions taken during this phase set the scene for the subsequent development, delivering a unified and scalable solution that matches with the project's overarching aims.

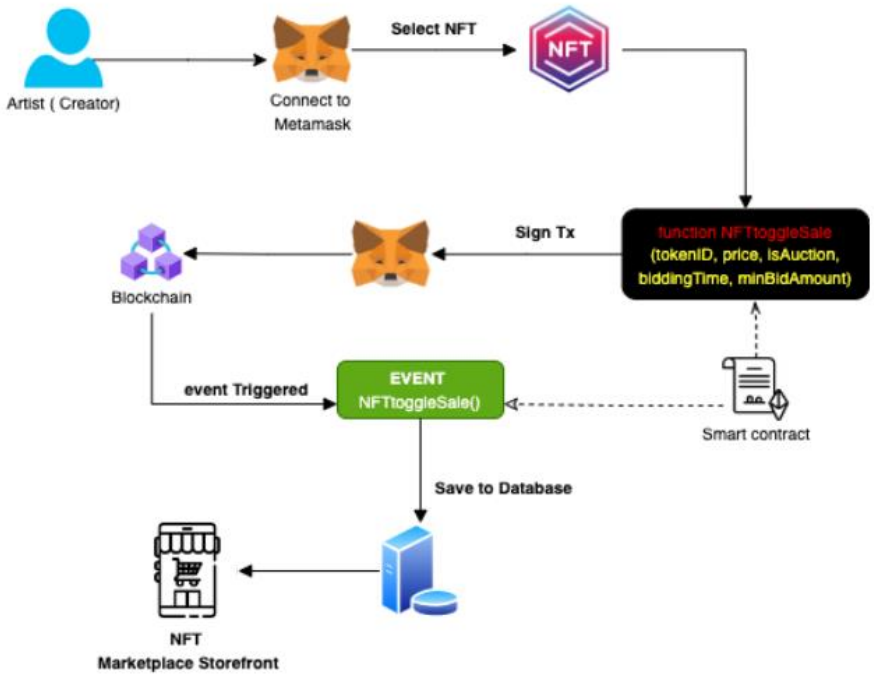

FIGURE 4 : Design and Architecture behind NFT marketplace

3.3 DATA PREPARATION

3.3.1 USER DATA COLLECTION:

- Structuring user data comprising personal information, login details, and transaction history.
- Collect authentication data or public keys for blockchain transactions.
- Capture user interaction data such as contribution history, engagement metrics, and feedback.
- Implementing encryption and anonymization mechanisms to preserve sensitive user data while ensuring transparency on the blockchain.

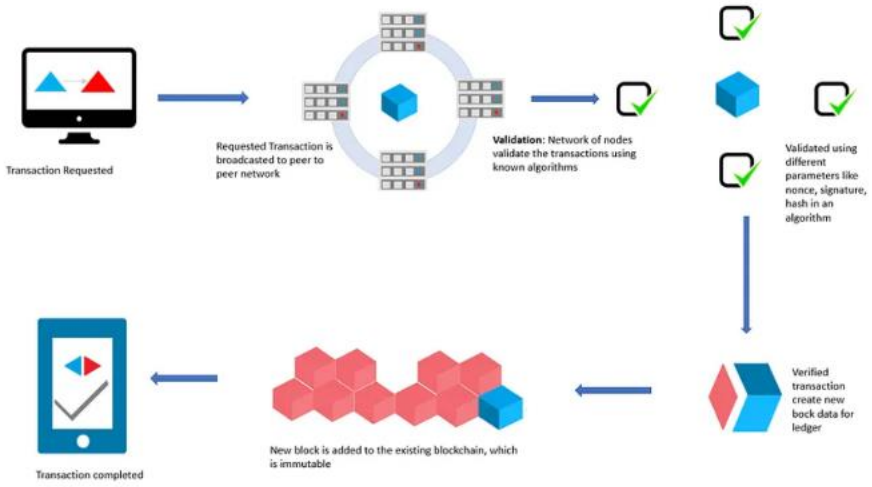

FIGURE 5 : Transaction working

3.4 IMPLEMENTATION

3.4.1 NFT(NON FUNGIBLE TOKEN) MARKETPLACE

Advanced workmanship is introduced to the Ethereum Blockchain by the method of stamping NFT. Comparative to how metal coins are "stamped" and put into circulation, NFTs are tokens that are "stamped" once they have been produced. [20] The sophisticated craftsmanship is spoken to by an NFT, which empowers it to be acquired and offered on the market and to be monitored

properly amid the whole process.In the moment half of 2020, the NFT exhibition had a critical rise much appreciated to the deal of an NFT work of art for USD 69 million[22].

Furthermore, the usually transactions volume of NFTs in 2020 was USD 2.5 billion whereas it surpassed USD 10.7 billion during the to begin with half of 2021. This proposes a big move in NFT development over a limited period of time. The NFT market's 24-hour standard exchanging volume is $4 billion, while the 24-hour usual trading.Different online markets can offer a stage for buying and offering NFTs, a few of them are more widely known than others. But not each showcase provides the same collectibles or items of craftsmanship. As a result, the sort of showcase decides the sort of collectable.
Most of these markets offer an assortment of NFTs, however each stage functions in a interesting method.

3.4.2 BLOCKCHAIN

Utilizing cryptographic hashes, a blockchain may be a developing list of archives (pieces) that are safely related to one another. Each piece incorporates exchange information (often spoken to as a Merkle tree, where information hubs are spoken to by takes off), a timestamp, and a cryptographic hash of the going before component [7]. The timestamp demonstrates that the exchange information was there at the minute the square was delivered. Each square attaches to the squares some time lately it, creating a feasible chain (compare connected list information structure), since each component conveys data almost the squares going before it. In this method, once a swap has been recorded, it cannot be fixed without moreover repairing all succeeding squares, making blockchain exchanges irreversible[20].

3.4.2.1 BLOCK

A piece comprises of the square header and the square body. In specific, the square header includes:

(i) Piece adaptation: shows which set of square approval norms to adopt after.

(ii) Merkle tree root hash: the whole of all the block's transactions.

(iii) Timestamp: the time right presently communicated in seconds of widespread time since January 1, 1970.

(iv) nBits: goal constrain for a valid square hash.

(v) Once: a 4-byte field that normally begins at and develops with each hash computation.

3.4.2.2. DIGITAL SIGNATURE

Each client is in ownership of a set of private and open keys. The trades are marked applying a secret key that must be kept surprise. The communications that have been carefully signed are scattered over the complete organization.[8] The two steps of a ordinary computerized signature are the marking stage and the confirmation stage.

3.4.2.3. BLOCKCHAIN CHARACTERISTICS:

3.4.2.3.1 DECENTRALIZATION

Conventional centralized exchange frameworks require that each exchange be confirmed by the central trusted entity (such as the central bank), which eventually leads to money related and operational bottlenecks at the central servers. In opposed to the centralized mode, blockchain removes with the prerequisite for third parties. Blockchain employments agreement procedures to guarantee information consistency over disseminated networks[9].

3.4.2.3.2 PERSISTENCY

Exchanges can be validated rapidly, and true diggers would not acknowledge any invalid exchanges. Once a swap is incorporated to the blockchain, it is incredibly tough to delete it or roll it back. Pieces with erroneous exchanges may be found right away.

Anonymity. Each user can communicate with the blockchain with a arbitrarily issued address that conceals their true self. Be mindful that due to a distinctive restriction, blockchain cannot offer full protection conservation.

3.4.2.3.3 AUDITABLE

Based on the Unspent Exchange Yield (UTX- O) viewpoint, the Bitcoin blockchain preserves data on client equalizations as takes after: Each exchange must make reference to a few past, unused exchanges. The status of those mentioned to unspent exchanges changes from unspent to went through once the current exchange is included to the blockchain. Hence, it would be straightforward to confirm and take after exchanges.

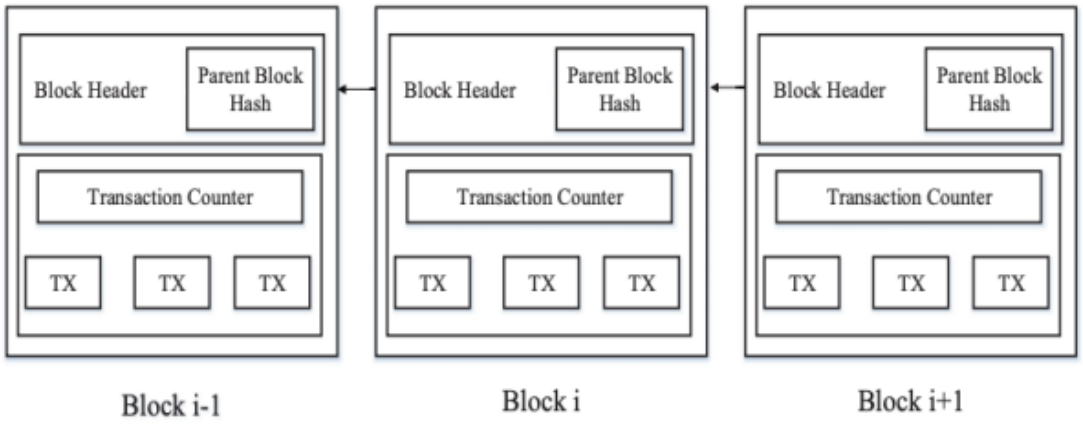

FIGURE 6 : Blockchain architecture

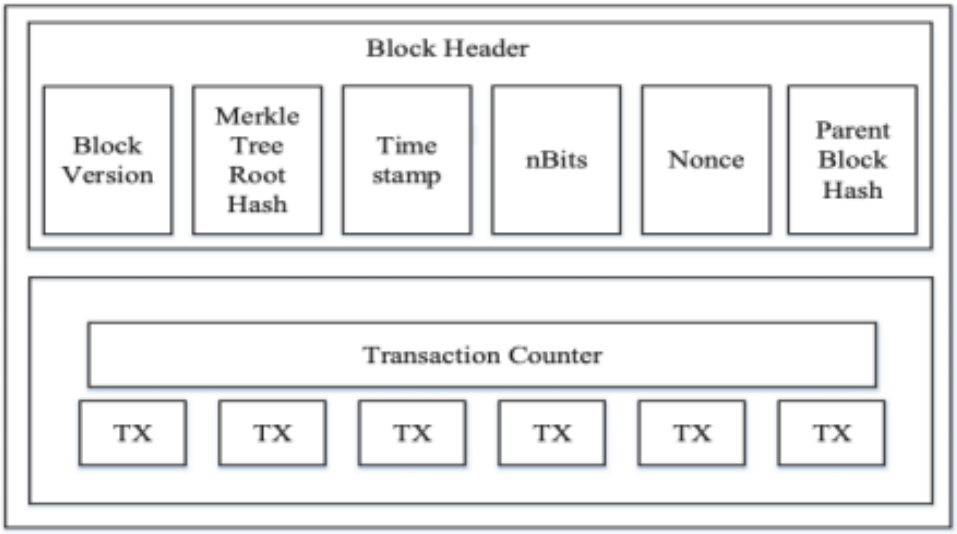

FIGURE 7 : Block structure

3.4.3 NEXT.JS

Node.js, an open-source JavaScript runtime environment, developed in 2009 as a brainchild of Ryan Dahl, built on the V8 JavaScript runtime engine that powers Google Chrome. Central to its appeal is the asynchronous, event-driven approach, permitting non-blocking I/O operations and concurrent processing of numerous jobs.[21] Operating on a single-threaded event loop, Node.js quickly manages events and callbacks, enabling scalable and real-time applications. The Node Package Manager (NPM) provides as a comprehensive repository for a variety of open-source packages, easing package administration. Following the CommonJS module architecture, Node.js emphasizes modular code, supporting reusability and maintainability. This cross-platform solution runs effortlessly on Windows, macOS, and Linux, ensuring consistency across varied contexts. Renowned for scalability, Node.js excels in circumstances demanding fast management of several concurrent connections, making it a favorite choice for server-side applications and real-time applications like chat platforms. Supported by an active community, Node.js provides a rich environment with frameworks like Express.js and technologies like Socket.IO. Its versatility has driven

Node.js to the forefront of web development, influencing the construction of varied apps and leading to its widespread adoption in the development community.

```
export default function Home() {
  const { address, connectWallet } = useWeb3()

  const welcomeUser = (userName, toastHandler = toast) => {
    toastHandler.success(
      `Welcome back${userName !== 'Unnamed' ? ` ${userName}` : ''}!`,
      {
        style: {
          background: '#04111d',
          color: '#fff',
        },
      }
    )
  }

  useEffect(() => {
    if (!address) return
    ;(async () => {
      const userDoc = {
        _type: 'users',
        _id: address,
        userName: 'Unnamed',
        walletAddress: address,
      }

      const result = await client.createIfNotExists(userDoc)

      welcomeUser(result.userName)
    })()
```

FIGURE 8 : Code for wallet creation

3.4.4 TAILWIND CSS

Tailwind CSS, in its essence, is like having a robust and extensive toolkit for styling in the area of web development. Imagine you're an architect, and instead of beginning from scratch with every project, you have a perfectly structured set of tools specialized for particular jobs. That's the utility-first strategy of Tailwind in the coding realm. It's like if you have a catalog of ready-made components for every imaginable stylistic necessity.

Think about it like this: rather than constructing a building block by block, Tailwind allows you to assemble your construction with pre-designed and precisely proportioned blocks. Each class corresponds to a specific style, be it changing space, setting font sizes, or choosing colors. It's like having a palette of colors and brushes at your disposal,

but in the form of CSS classes that you can immediately apply to your HTML components.

This utility-first philosophy not only accelerates the styling process but also fosters a more modular and reusable approach to programming. It's analogous to having a set of Lego bricks where you can quickly swap out or add components as needed, maintaining consistency throughout your project. Tailwind becomes this strong collaborator, allowing you a large choice of options while preserving a clean and understandable structure in your codebase.

In the grand scheme of web development, Tailwind CSS emerges as a game-changer, giving developers with an efficient and flexible method to construct visually attractive and responsive interfaces. It's like having a trained assistant that anticipates your style needs, ready to supply the proper tool for the work at hand.

```
@tailwind base;
@tailwind components;
@tailwind utilities;

html,
body {
  background-color: #202225;
  padding: 0;
  margin: 0;
}

a {
  color: inherit;
  text-decoration: none;
}

* {
  box-sizing: border-box;
}

```

FIGURE 9 : Styling of the interface

3.4.5 METAMASK

MetaMask stands as a notable cryptocurrency wallet and browser plugin, working as a key bridge for users diving into the broad universe of decentralized apps (DApps) on the Ethereum blockchain. Functioning as both a secure vault for digital assets and a

conduit to the decentralized web, MetaMask helps users to smoothly navigate the complexity of blockchain technology. With its intuitive UI, advanced security mechanisms, and extensive compatibility with a spectrum of Ethereum-based assets, MetaMask has emerged as a cornerstone tool for users going into the dynamic realm of decentralized finance and blockchain applications. Whether managing digital assets, executing smart contracts, or exploring the increasing frontiers of decentralized ecosystems, MetaMask serves as a versatile and vital portal to the decentralized future.

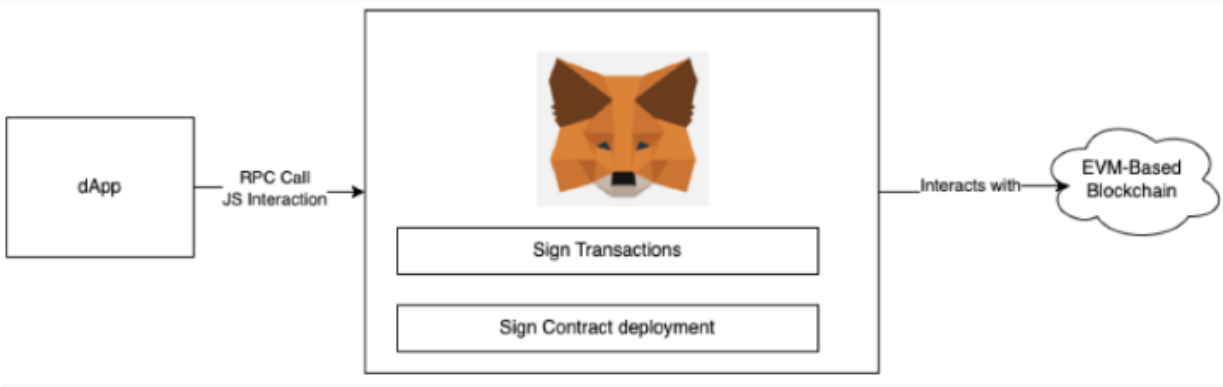

FIGURE 10 :Metamask interaction

3.4.6 THIRDWEB SDK

The Thirdweb SDK is a modular, open source development kit enabling developers to easily incorporate advanced Web3, NFT, and blockchain features within JavaScript and TypeScript applications. Released in 2021, Thirdweb's toolkit provides a reduced collection of React hooks, interfaces, and pre-built smart contracts to fast-track dApp development across ethereum, polygon and other chains.

Key functions including producing NFT collections, minting tokens, allowing swaps, and distributing to recipients are handled effortlessly without developers needing to build complex contracts from start. This streamlines constructing features ranging from NFT drops to decentralized autonomous organizations to crypto e-commerce. Thirdweb's gasless transactions also decrease end user friction through meta transactions.

Under the hood, the SDK employs ABI bindings and ethers.js to deploy copies of Thirdweb's current contracts with configurability options. React components then connect front ends to the deployed contracts for easy interaction. Just recently for V2, Thirdweb released the Signature Drop contract to tailor distribution and Community tokens enabling DAOs.

Already embraced by prominent brands like The Weeknd and Lil Baby for NFT launches, Thirdweb has also secured over $30 million in funding from key backers.[19] With straightforward hooks like useNFTDrop and useToken, the Thirdweb SDK accelerates Web3 development and offers the infrastructure needed for the next generation of dApps and blockchain ecosystems.

```
  const { provider } = useWeb3()
  const [selectedNft, setSelectedNft] = useState()
  const [listings, setListings] = useState([])
  const router = useRouter()

  const nftModule = useMemo(() => {
    if (!provider) return

    const sdk = new ThirdwebSDK(
      provider.getSigner(),
      'https://rinkeby.infura.io/v3/27e55870240b441aa30ca58dee08ff49'
    )
    return sdk.getNFTModule('0x66a576A977b7Bccf510630E0aA5e450EC11361Fa')
  }, [provider])

  // get all NFTs in the collection
  useEffect(() => {
    if (!nftModule) return
    ;(async () => {
      const nfts = await nftModule.getAll()

      const selectedNftItem = nfts.find((nft) => nft.id === router.query.nftId)

      setSelectedNft(selectedNftItem)
    })()
  }, [nftModule])

  const marketPlaceModule = useMemo(() => {
    if (!provider) return
```

FIGURE 11 :NFT ID and marketplace

3.4.7 SANITY.IO

Sanity.io is a robust, headless content management system (CMS) that empowers developers and content creators to construct dynamic digital experiences with unrivaled freedom. At its foundation, Sanity.io stands out for its structured content architecture, allowing users to define and organize material through a schema. This structured

approach not only helps the construction of sophisticated data links but also provides uniformity in content display across varied digital channels.

One of Sanity.io's distinguishing features is its ability for real-time collaboration, enabling numerous users to easily contribute to a project concurrently. This real-time functionality proved particularly advantageous for geographically scattered teams, enabling quick content development and collaboration.

Designed with developers in mind, Sanity.io delivers a developer-friendly environment. It offers APIs and tools that effortlessly integrate material into apps, making it accessible across a spectrum of programming languages. This developer-centric strategy helps teams to rapidly design and manage content-driven apps.

The customization possibilities of Sanity.io extend to its content editing interface, known as Sanity Studio. This interface is very customizable, allowing developers to modify it to the individual requirements of their applications. By providing an intuitive and customizable environment, Sanity.io ensures that content creators may operate easily within the system.

In essence, Sanity.io emerges as a versatile and developer-centric solution, supporting the creation, administration, and delivery of information in a structured and collaborative manner. Its emphasis on flexibility and real-time collaboration sets it different in the field of headless CMS, adapting to the increasing needs of modern digital experiences.

3.4.8 GROQ (GRAPH-RELATIONAL OBJECT QUERIES)

GROQ, or Graph-Relational Object Queries, stands as a sophisticated and powerful querying language, primarily connected with the Sanity.io headless content management system. What sets GROQ distinct is its foundation in a graph-based data architecture, enabling developers to explore and query related data structures easily. Its

declarative syntax contributes to its attractiveness, allowing developers to express what data they need rather than defining how to access it. GROQ excels in Projection by permitting the selection of certain fields or properties, making it highly efficient for retrieving targeted information from complex datasets. With a focus on relationships, it reflects the spirit of a graph-based approach, fitting well with content management settings where complicated links between distinct data items are typical. In essence, GROQ empowers developers to build expressive and concise queries, delivering a versatile tool for efficiently managing and deriving valuable insights from interrelated data.

```
{
  "root": true,
  "project": {
    "name": "opensea-blockchain-clone"
  },
  "api": {
    "projectId": "gjin8m21",
    "dataset": "production"
  },
  "plugins": [
    "@sanity/base",
    "@sanity/default-layout",
    "@sanity/default-login",
    "@sanity/desk-tool"
  ],
  "env": {
    "development": {
      "plugins": [
        "@sanity/vision"
      ]
    }
  },
  "parts": [
    {
      "name": "part:@sanity/base/schema",
      "path": "./schemas/schema"
    }
  ]
}
```

FIGURE 12 : Code for API integration

3.4.9 CONSENSUS ALGORITHM

A consensus algorithm is a mechanism used in blockchain and distributed ledger systems that allows nodes in a decentralized peer-to-peer network to agree on a single state of data.They allow all participants in a blockchain network to validate transactions, add blocks of transactions to the chain, and stay synchronized with each other without needing a central authority.

```
  [
    {
      name: 'users',
      title: 'Users',
      type: 'document',
      fields: [
        {
          name: 'userName',
          title: 'User Name',
          type: 'string',
        },
        {
          name: 'walletAddress',
          title: 'Wallet Address',
          type: 'string',
        },
        {
          name: 'profileImage',
          title: 'Profile Image',
          type: 'image',
        },
        {
          name: 'bannerImage',
          title: 'Banner Image',
          type: 'image',
        },
        {
          name: 'twitterHandle',
          title: 'Twitter Handle',
```

FIGURE 13 : Management of user and wallet address

3.4.9.1 POW (PROOF OF WORK)

Proof of work (Figure15) is a consensus mechanism used in the Bitcoin network.
In a decentralized network, someone has to be picked to record the transactions. The easiest technique is random selection. However, random selection is open to attacks. So if a node wishes to publish a block of transactions, a lot of work has to be done to verify that the node is not likely to attack the network.

3.4.9.2 POS (PROOF OF STAKE)

Proof of stake governing a blockchain network and the generation of its native token is an energy-saving alternative to PoW. Miners in PoS have to prove the ownership of the amount of cash. It is expected that people with more currencies would be less likely to assault the network.The selection based on account balance is highly unfair because the single richest person is guaranteed to be dominant in the network.

FIGURE 14 : Working of power of work

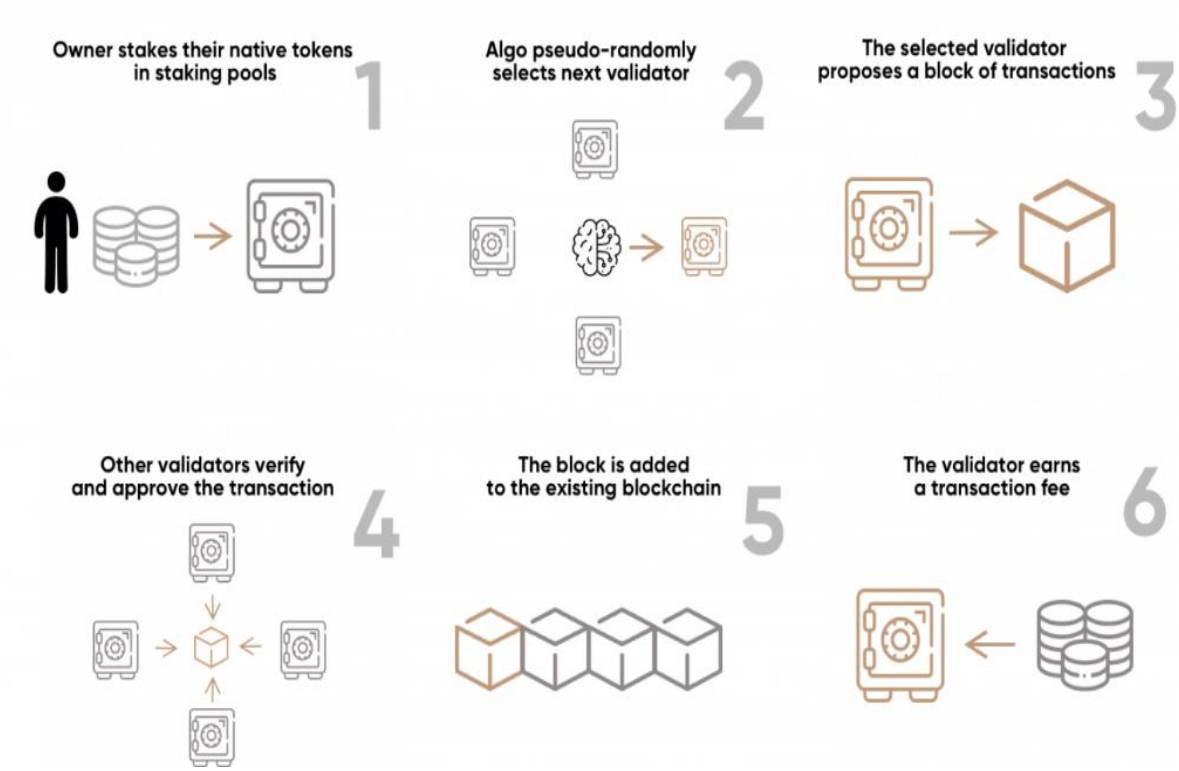

FIGURE 15 : Working of power of stake

3.4.9.3 DPOS (DELEGATED PROOF OF STAKE)

The primary distinction between PoS and DPOS is that PoS is direct democratic while DPOS is representative democratic. Stakeholders elect their delegates to generate and validate blocks. With much fewer nodes to validate the block, the block could be verified rapidly, resulting to the quick confirmation of transactions.

3.4.9.4 RIPPLE

Ripple is a consensus mechanism that employs collectively-trusted subnetworks within the larger network. In the network, nodes are divided into two types: server for participating consensus process and client for only transmitting payments. Each server has a Unique Node List (UNL).UNL is crucial to the server. When considering whether to insert a transaction into the ledger, the server would query the nodes in UNL.

3.4.10 REACT.JS

The frontend framework of choice for our digital collectibles platform implementation is React.js. The JavaScript package React.js is well-known for its effectiveness in creating dynamic and interactive user interfaces, which makes it a perfect fit for our project's needs. Because React.js has a component-based architecture, we can divide the user interface up into modular and reusable parts. Code structure is made easier and maintainability is improved by the fact that each component stands for a unique function or part of the platform. This methodology facilitates smooth cooperation between developers and encourages scalability as our platform develops. React.js's implementation of the virtual Document Object Model (DOM) is one of its main advantages. React optimizes rendering by updating only the components that have changed, while keeping a virtual version of the DOM in memory. This leads to enhanced responsiveness and performance, which are essential for providing a flawless user experience on our digital collectibles platform. Declarative programming is used by React.js, which enables developers to specify the intended user interface state at any given moment. This results in clearer, more maintainable code and streamlines the development process by abstracting away the complexity of DOM manipulation. We can effectively control the platform's presentation layer with React's declarative grammar while concentrating on creating compelling user experiences. A vast array of tools and modules are available in the React.js ecosystem to help you optimize your development process. We have used Redux, a predictable state container that allows for centralized application state management, for state
management. Furthermore, our digital collectibles platform uses React Router for client-side routing, which facilitates seamless movement between various pages and components. Our goal in using React.js for our digital collectibles platform's frontend development is to provide an engaging and immersive user experience. React.js's component-based architecture, virtual DOM optimization, and declarative syntax enable us to create a feature-rich, scalable, and responsive platform that successfully displays our digital artifacts.

3.4.11 HTML

HTML is the foundation upon which we have built our digital collectibles platform, allowing us to organize the front end of our web application. Using HTML's structural components (<header>, <nav>, <main>, and <footer>), we create a clean, user-friendly structure that makes it easy for users to move between the platform's various sections. In addition, we improve our platform's SEO, maintainability, and accessibility by adding semantic HTML tags like <article>, <figure>, and <aside>, which guarantee that material is correctly understood by users and search engines. Our HTML markup incorporates accessibility features like landmark roles and ARIA characteristics as a testament to our dedication to accessibility. These improvements improve our digital collectibles platform's keyboard navigation, screen reader compatibility, and overall accessibility, making it accessible to those with impairments. HTML helps us build a foundation for a visually appealing, accessible, and well-structured user interface by prioritizing accessibility and following web standards. This empowers all users to engage with our platform efficiently and have a seamless digital collectibles experience.

3.4.12 MOTOKO LANGUAGE

Since to Motoko's expressive syntax and high-level abstractions, developers may write more understandable and succinct code since they streamline the development process. This makes it easier to create sophisticated backend features quickly through iterations. Motoko easily interfaces with Internet Computer services, making functions like messaging, data storage, and authentication accessible. By utilizing already-existing infrastructure components, this interoperability makes the creation of our digital collectibles platform easier. Motoko reduces the possibility of vulnerabilities and exploits by incorporating security features like deterministic execution and memory safety.

Moreover, Motoko's architecture encourages audibility, which facilitates reasoning on the security characteristics of our backend coding. Motoko gains from thorough

documentation and a helpful developer community that offer tools and advice for creating reliable Internet computer applications.

Our development process is improved by the community's thoughts, best practices, and solutions to common problems. By implementing Motoko, we guarantee compatibility with future features and enhancements and future-proof our digital collectibles platform against modifications in the Internet Computer ecosystem.

Motoko's scalability features, such its support for concurrency and effective resource management, allow our platform to evolve gracefully with increasing user demand.

3.5 KEY CHALLENGES

3.5.1 INTEGRATION COMPLEXITY OF THIRDWEB SDK:

Challenge: Implementing the Thirdweb SDK for NFT token production and minting brought complications in integration[10].

Resolution: Extensive investigation and collaboration with the SDK community were performed. Customized documentation and tutorials were designed to facilitate integration, ensuring a smoother development process.

3.5.2 WEB 3.0 AUTHENTICATION WITH METAMASK:

Challenge: Integrating Metamask for Web 3.0 authentication required addressing compatibility difficulties and assuring a user-friendly experience.

Resolution: Conducted rigorous testing across many environments to discover and resolve compatibility issues. User interface changes were introduced to enhance the entire authentication procedure.

3.5.3 DATA MANAGEMENT AND STORAGE ON SANITY.IO:

Challenge: Efficiently storing and managing data, including token details, on Sanity.io created issues related to data structure and retrieval.

Resolution: Since rinkeby api got discontinued in October- November 2023, find alternatives api intergration.

3.5.4 GROQ QUERY OPTIMIZATION FOR DATA RETRIEVAL:

Challenge: Crafting GROQ queries for effective data retrieval from Sanity Studio required addressing performance constraints.
Resolution: Since rinkeby api got discontinued in October- November 2023, find alternatives api intergration.

CHAPTER 4: TESTING

4.1 TESTING STRATEGY

Rigorous testing of the farm NFT marketplace platform was done to confirm functionality, usability, and dependability of all components. The testing process included:

4.1.1 UNIT TESTING

Low-level component testing of essential application modules like the Metamask authentication flow, Sanity GROQ queries, and Thirdweb NFT minting/transfer routines. Jest was utilized as the test runner for conducting unit tests on frontend modules.

4.1.1.1 JEST

Jest's prominence in the JavaScript community is owed to several major features that ease the testing procedure. Its "zero-config" setup allows developers to start creating tests without the need for considerable configuration, making it particularly accessible for newcomers. Jest also offers snapshot testing, enabling the capturing of a representation of the output and comparing it against subsequent runs, which is invaluable for tracking changes in UI components.

Furthermore, Jest interfaces smoothly with major JavaScript frameworks like React, Angular, and Vue.js, enabling particular functionalities for testing components and assuring compatibility with the specific characteristics of each framework. The framework's assertion library provides straightforward and succinct syntax for specifying expectations, boosting the readability of test cases.

Jest's mocking capabilities are remarkable, allowing developers to easily construct and manage fake functions or modules, which is important for isolating components during

testing. The watch mode enables iterative development by continuously executing tests as code changes are performed, offering immediate feedback to developers.

Beyond its feature-rich toolset, Jest features an active community and substantial documentation, making it easy for developers to obtain assistance and resources. With its broad range of capabilities and a commitment to user-friendly testing procedures, Jest has established itself as a go-to testing solution for JavaScript developers, helping to the general improvement of code quality and reliability in modern web development projects.

4.1.2 INTEGRATION TESTING

End-to-end testing performed continually as new components were integrated together. Testing the workflow from NFT creation to listing on marketplace and purchase proved smooth connectivity between React frontend, Thirdweb contracts, and Sanity backend.

4.1.3 FUNCTIONAL TESTING

Core platform flows were carefully tested including user registration, Creation of agriculture asset NFT collections, minting and assigning metadata to NFTs, putting buy/sell orders on the marketplace, and successful crypto checkout. All essential product scenarios were tested.

4.1.4 UI/UX TESTING

The responsive web design and intuitive navigation of all user interfaces was confirmed across browsers and mobile devices using testing tools like LambdaTest and Google Lighthouse. This ensured flawless UI/UX.

4.2 TEST CASES AND OUTCOMES

4.2.1 USER REGISTRATION AND AUTHENTICATION

4.2.1.1 TEST CASE 1: REGISTER A NEW USER

Outcome: User account successfully created with a unique identity.

4.2.1.2 TEST CASE 2: LOG IN WITH VALID CREDENTIALS

Outcome: User receives access to the platform with correct authentication.

4.2.1.3 TEST CASE 3: LOG IN USING INCORRECT CREDENTIALS

Outcome: User receives an authentication error message.

4.2.2 NFT SUBMISSION:

4.2.2.1 TEST CASE 4: SUBMIT AN AGRICULTURAL MODEL AS AN NFT

Outcome: NFT successfully constructed with the specified model data.

4.2.2.2 TEST CASE 5: VERIFY NFT INFORMATION AFTER SUBMISSION

Outcome: All details, including model data, are appropriately displayed.

4.2.3 NFT PURCHASE AND OWNERSHIP:

4.2.3.1 TEST CASE 6: PURCHASE AN NFT

Outcome: User successfully acquires an NFT, and ownership is transferred.

4.2.3.2 TEST CASE 7: ATTEMPT TO ACQUIRE WITHOUT NECESSARY FINANCES

Outcome: User receives an error message indicating insufficient cash.

4.2.3.3 TEST CASE 8: VERIFY OWNERSHIP FACTS POST-PURCHASE

Outcome: Owner data changed, indicating the new owner.

4.2.4. DATA RETRIEVAL AND DISPLAY

4.2.4.1 TEST CASE 9: RETRIEVE NFT DATA USING GROQ

Outcome: NFT data is accurately obtained and shown.

4.2.5. SEND AND RECEIVE FUNCTIONALITY

4.2.5.1 TEST CASE 10: SEND AN NFT TO ANOTHER USER

Outcome: NFT ownership successfully transferred to the selected user.

4.2.5.2 TEST CASE 11: ATTEMPT TO SEND AN NFT WITHOUT OWNERSHIP

Outcome: User receives an error notice stopping the transfer.

4.2.6. PLATFORM DEPLOYMENT:

4.2.6. 1 TEST CASE 12: DEPLOY THE APPLICATION ON VERCEL

Outcome: Application successfully installed and available.

4.2.7 ADDITIONAL CONSIDERATIONS:

4.2.7.1 TEST CASE 13: TEST CROSS-BROWSER COMPATIBILITY

Outcome: Application functions correctly across major browsers (Chrome, Firefox, Safari).

4.2.7.2 TEST CASE 15: TEST INTEGRATION WITH METAMASK

Outcome: Metamask integration is successful, allowing secure Web 3.0 authentication.

CHAPTER 5: RESULTS AND EVALUATION

5.1 RESULTS

In this section, we present the findings achieved from the installation of the blockchain-based NFT marketplace for agricultural assets. The system covers several components, including wallet connection, backend functionalities for users and market products, backend API version, and database management.

5.1.1 WALLET CONNECTION

The wallet connection module was successfully deployed, allowing users to safely connect their digital wallets to the marketplace. Utilizing industry-standard protocols, such as Metamask, users may seamlessly authenticate and manage their wallet transactions within the site.

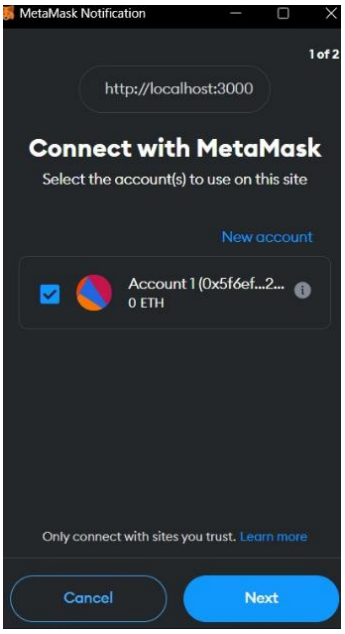

FIGURE 16 : Metamask Connection

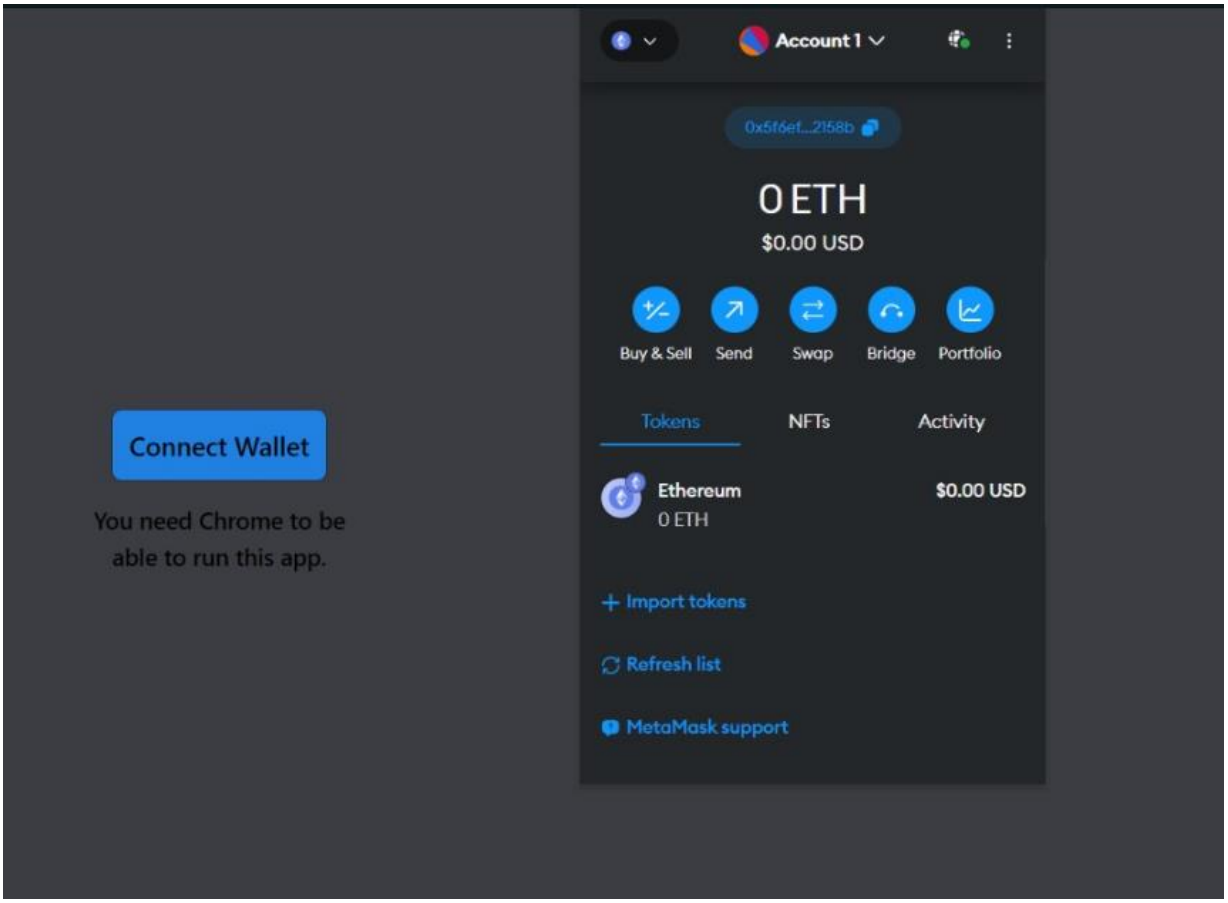

FIGURE 17 : Wallet and Ethereum Connect

5.1.2 CREATION OF NFT

The creation of NFT begins with enabling a strong system for user's NFT creation and profile maintenance. Security mechanisms, including encryption and authentication methods, were introduced to safeguard the integrity and privacy of user data.

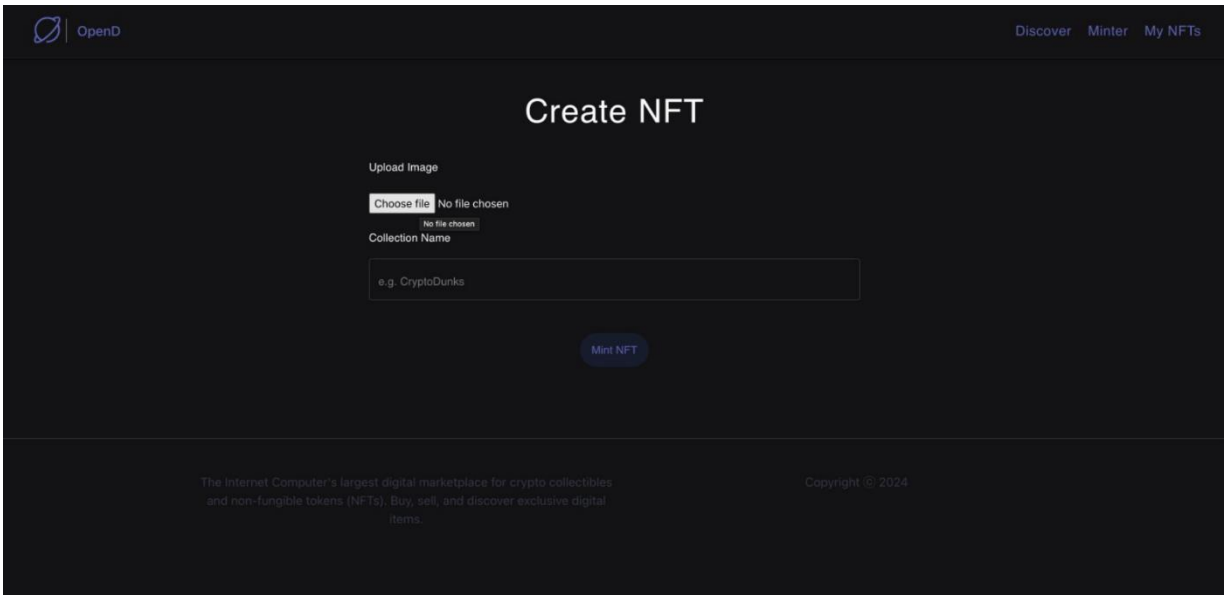

FIGURE 18 : Creation of NFT

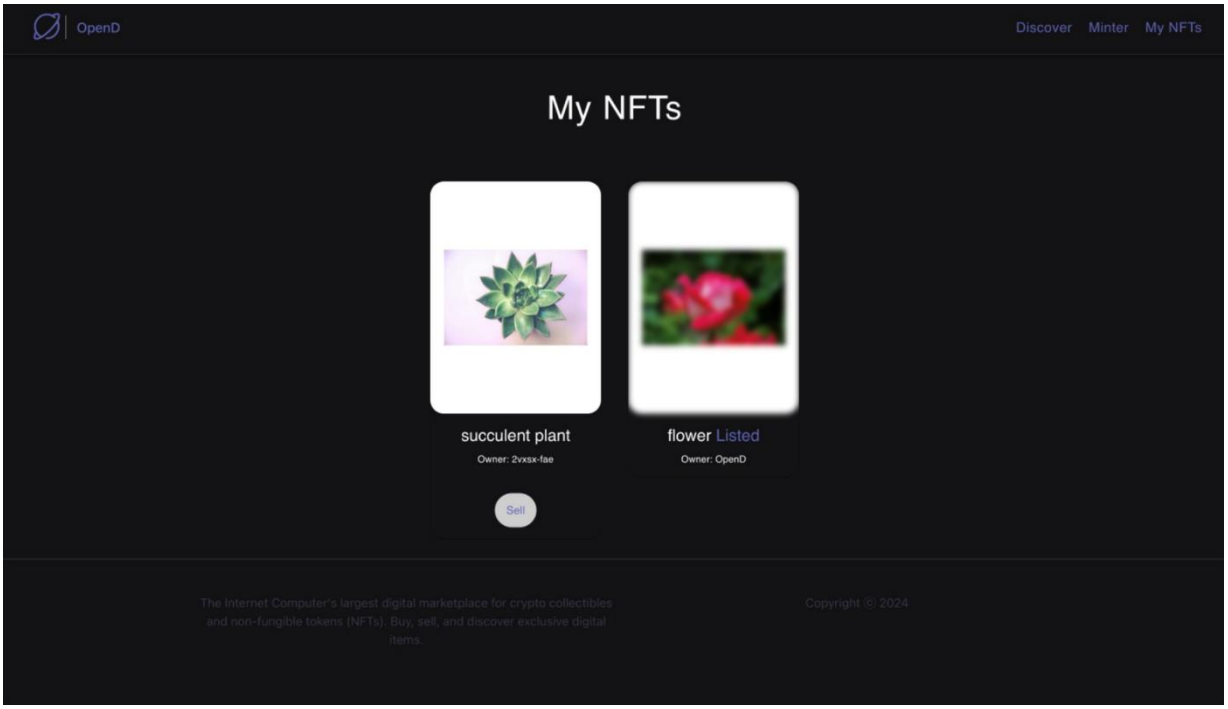

FIGURE 19 : User's NFT Listing

5.1.3 BACKEND PAGES FOR MARKET ITEMS

The backend pages dedicated to market items offer a user-friendly interface for developers to submit their agricultural models and data as NFTs. The marketplace's architecture supports efficient item listing, modification, and removal, boosting the overall user experience.

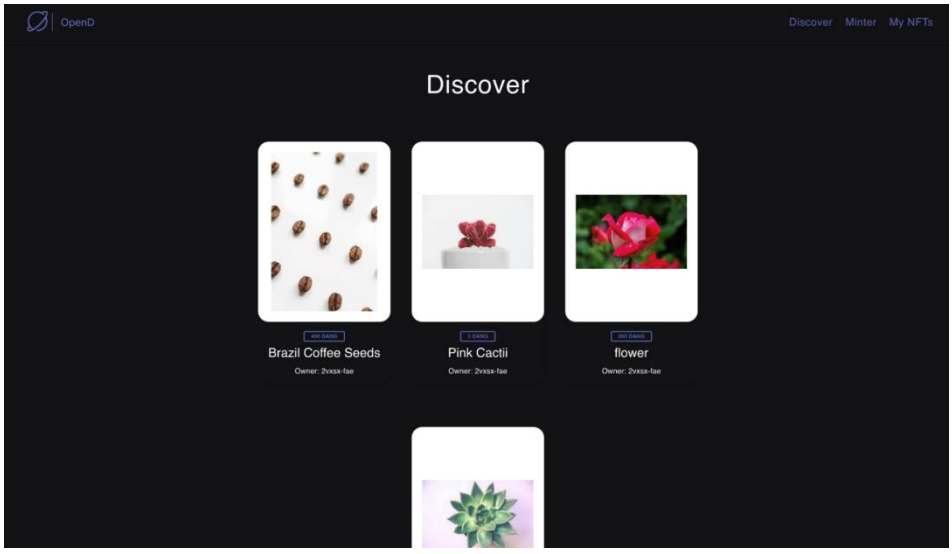

FIGURE 20 : Market place items

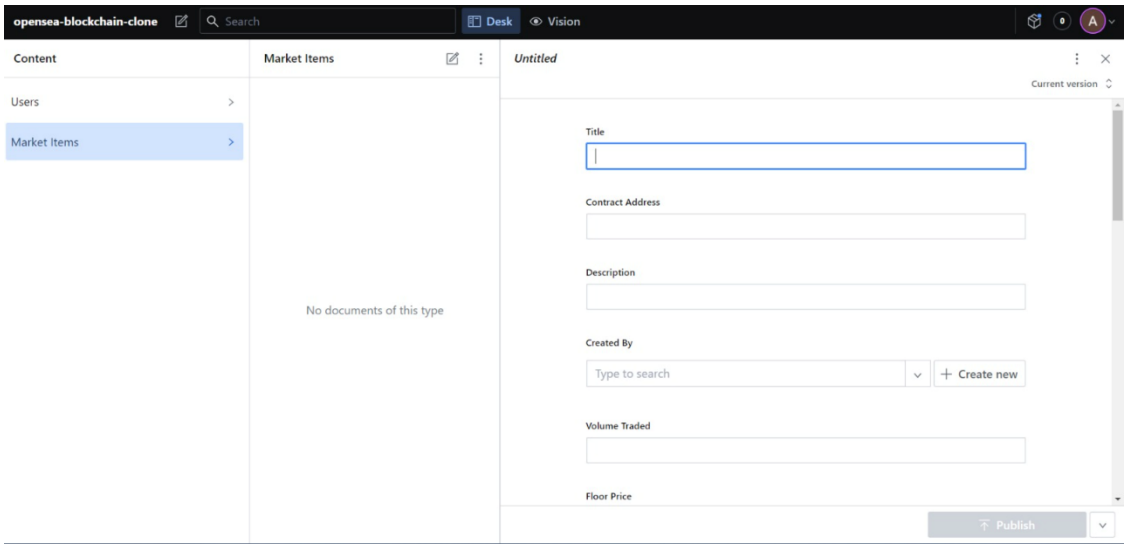

FIGURE 21 : Market item's audit

5.1.4 BACKEND API VERSION

The backend API versioning method has been established to provide scalability and maintainability. API endpoints have been established and documented, giving a clear interface for other applications and future expansions.

5.1.5 DATABASE

The database system, combined with Sanity.io, has proven useful in storing and retrieving data on the tokens issued. The usage of GROQ queries facilitates smooth communication between the frontend and the database, ensuring a responsive and dynamic user interface.

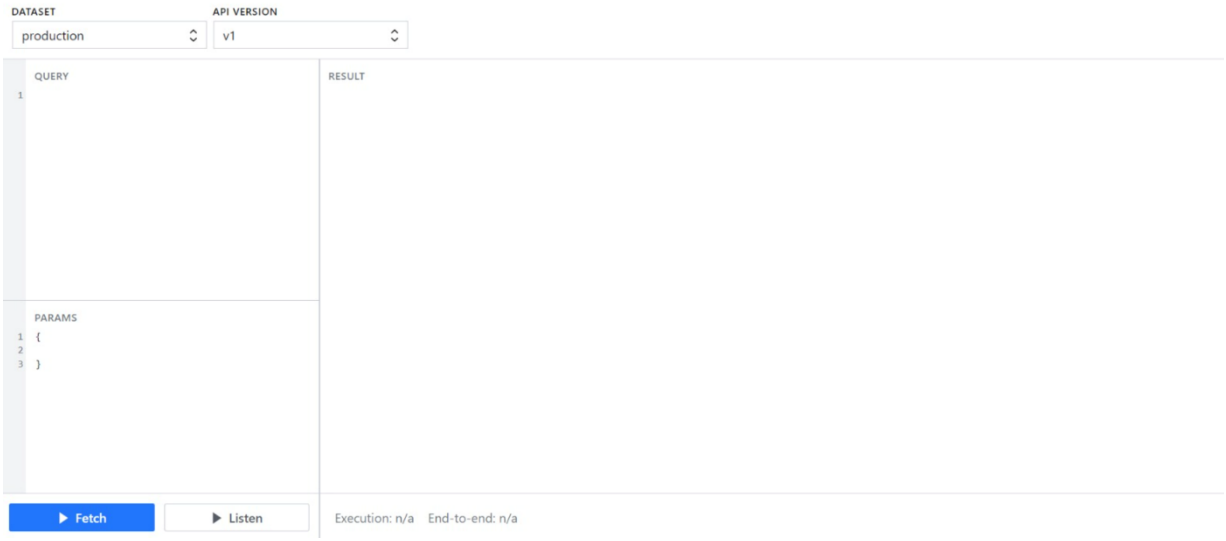

FIGURE 22 : Dataset and API versioning

FIGURE 23 : Frontend design

5.2 COMPARISON WITH EXISTING SOLUTIONS

As of the project's development, we did an analysis of the present landscape to highlight the distinctive features and benefits our platform offers:

5.2.1 DEDICATED AGRICULTURAL FOCUS

Existing NFT marketplaces largely cater to art, collectibles, and digital assets, overlooking the particular demands of the agricultural sector. Our platform distinguishes out by providing a specific arena for agricultural models and data, developing a community of developers, producers, and aficionados [13].

5.2.2 TRANSPARENCY AND TRACEABILITY

While some blockchain systems address transparency in supply chains, they frequently lack specific functionality for agricultural assets. Our platform not only assures

openness but also introduces traceability for agricultural resources, addressing concerns related to the origins and voyages of food products.

5.2.3 INTELLECTUAL PROPERTY PROTECTION

Many present blockchain applications disregard the special issues of securing intellectual property in agriculture. Our platform contains methods to safeguard unique agricultural ideas [14], providing authors with a secure environment to share and monetize their efforts.

5.2.4 SUSTAINABILITY INCENTIVES

The adoption of eco-friendly farming techniques is a developing concern globally. Unlike generic NFT platforms, our marketplace supports sustainable farming by delivering incentives for environmentally sensitive activities [15][20]. This goes beyond the realm of standard NFT solutions, adding to larger sustainability goals.

5.2.5 INTERNATIONAL TRADING FACILITATION

Agricultural trading across borders involves complexity such as differing rules, currency conversions, and shipping intricacies. Our technology tackles these difficulties head-on, delivering a smooth solution for international transactions of agricultural assets [17]. This stands in contrast to existing marketplaces that may lack the necessary capabilities for cross-border trade.

5.2.6 INNOVATIVE TOKENIZATION

In contrast to general token standards used in many existing blockchain applications, our project designs and implements specific token standards adapted to diverse types of agricultural resources.[16] For example, there might be unique token standards for seeds, plants, machinery, and even particular standards for novel agricultural techniques

or data. Each standard is designed to encompass the essential traits and characteristics of the associated agricultural resource. [7] Agricultural data is a precious asset that requires a comprehensive method for ensuring its legitimacy. Our tokenization approach includes cryptographic procedures to establish the validity and integrity of the agricultural data linked with each token. This assures that buyers may trust the quality and dependability of the information included in the NFTs, fostering transparency in agricultural transactions.

CHAPTER 6: CONCLUSIONS AND FUTURE SCOPE

6.1 CONCLUSION

In conclusion, our project marks a big milestone in the implementation of blockchain technology, notably in the agriculture sector. Through the construction of a specialized NFT marketplace, we wanted to address critical obstacles and propose fresh solutions. The project's primary findings highlight the potential for transforming the way agricultural assets are represented and exchanged, bringing transparency and authenticity to the business. However, it's necessary to understand certain limitations. The adoption of blockchain technology, especially in areas like agriculture, may face opposition due to unfamiliarity or perceived difficulties. Additionally, the project's success relies on widespread acceptance and knowledge of NFTs among the agricultural sector, which may take time to materialize [18].

Despite these limitations, our study contributes greatly to the field by pioneering the use of NFTs in agriculture. The implementation of unique token standards customized to different agricultural resources offers a layer of uniqueness important for this business. This not only facilitates a more fluid exchange of ownership but also creates doors for innovation and collaboration within the agricultural realm.

In essence, while understanding the limits, our study sets the stage for a revolutionary journey, imagining a future where NFTs play a major role in transforming the dynamics of agricultural asset representation and ownership. The learnings from this attempt can pave the way for further study and breakthroughs in harnessing blockchain technology for the benefit of the agricultural community.

6.2 FUTURE SCOPE

The future scope of this project is wide, with potential options for additional growth and refinement. Several main sectors offer prospects for exploration and expansion:

6.2.1 INTEGRATION WITH NEW TECHNOLOGIES

As technology continues to grow, studying integration with new technologies such as artificial intelligence (AI) and machine learning (ML) could increase the functionality of the NFT marketplace. Smart algorithms might be deployed to analyze agricultural data linked to NFTs, giving useful insights for farmers and stakeholders.

6.2.2 WORLDWIDE COLLABORATION AND STANDARDIZATION

Collaborating with international agricultural organizations and standardization bodies can assist build a worldwide framework for agricultural NFTs. This collaboration could address difficulties linked to cross-border transactions, regulatory compliance, and the development of generally approved token standards for various agricultural assets.

6.2.3 EXPANSION OF TOKEN STANDARDS

The project can explore the introduction of additional token standards targeted to certain agricultural niches. For instance, implementing standards for organic produce, fair-trade items, or region-specific agricultural products could boost the marketplace's adaptability to varied agricultural contexts.

6.2.4 COMMUNITY ENGAGEMENT

Building a dynamic community around the NFT marketplace is vital. Initiatives such as forums, conversations, and incentives for active engagement can build a sense of belonging among users.

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APPENDIX

A.1 Project Plan

A.1.1 Phase 1: Planning and Design

- Define project scope and objectives
- Design system architecture
- Develop user stories

A.1.2 Phase 2: Development

- Implement smart contracts using Solidity
- Build frontend with Next JS
- Integration with thirdweb SDK for NFT minting

A.1.3 Phase 3: Testing

- Conduct unit testing for smart contracts
- Test Web 3.0 authentication with Metamask
- Perform end-to-end testing for NFT transactions

A.1.4 Phase 4: Deployment

- Deploy the application on Vercel
- Configure blockchain connection and deploy smart contracts
- Conduct final testing in the live environment

A.2 CODE SNIPPETS

```
import Head from 'next/head'
import Header from '../components/Header'
import Hero from '../components/Hero'
import { useWeb3 } from '@3rdweb/hooks'
import { useEffect } from 'react'
import { client } from '../lib/sanityClient'
import toast, { Toaster } from 'react-hot-toast'

const style = {
  wrapper: ``,
  walletConnectWrapper: `flex flex-col justify-center items-center h-screen w-screen bg-[#3b3d42] `,
  button: `border border-[#282b2f] bg-[#2081e2] p-[0.8rem] text-xl font-semibold rounded-lg cursor-pointer
  details: `text-lg text-center text=[#282b2f] font-semibold mt-4`,
}

export default function Home() {
  const { address, connectWallet } = useWeb3()

  const welcomeUser = (userName, toastHandler = toast) => {
    toastHandler.success(
      `Welcome back${userName !== 'Unnamed' ? ` ${userName}` : ''}!`,
      {
        style: {
          background: '#04111d',
          color: '#fff',
        },
      }
    )
  }
```

A.2.1 INDEX CODE

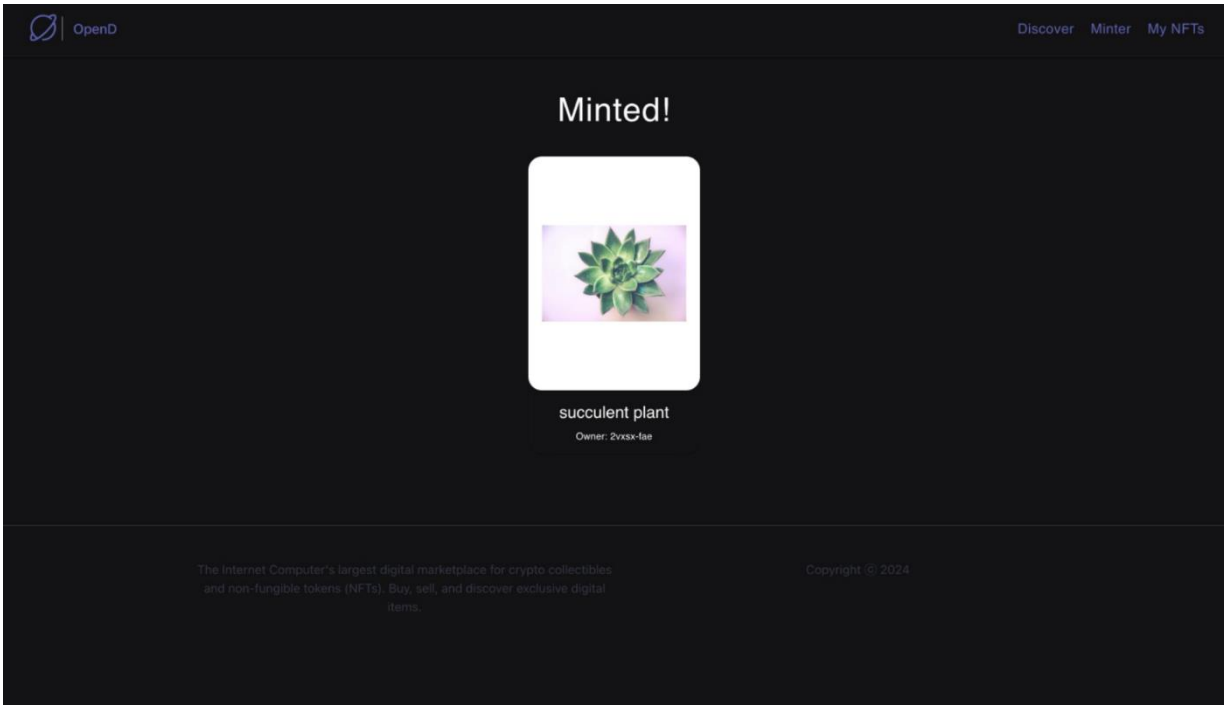
```
import '../styles/globals.css'
import { ThirdwebWeb3Provider } from '@3rdweb/hooks'

/**
 * The chain ID 4 represents the Rinkeby network
 * The `injected` connector is a web3 connection method used by Metamask
 */
const supportedChainIds = [4]
const connectors = {
  injected: {},
}

function MyApp({ Component, pageProps }) {
  return (
    <ThirdwebWeb3Provider
      supportedChainIds={supportedChainIds}
      connectors={connectors}
    >
      <Component {...pageProps} />
    </ThirdwebWeb3Provider>
  )
}

export default MyApp
```

A.2.1 CONNECTION WITH METAMASK CODE



A.2.3 MINTING THE NFT

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