Full Stack NFT Marketplace

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Final Approval

This is to certify that we have read the report submitted by ***Muhammad Afzaal Hameed (23733), Usman Ayyub (27952), Mussab Saeed (27660)***for the partial fulfillment of the requirements for the degree of the Bachelors of Science in Computer Science (BSCS). It is our judgment that this report is of sufficient standard to warrant its acceptance by Riphah International University, Islamabad for the degree of Bachelors of Science in Computer Science (BSCS).

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Declaration

We hereby declare that this document "**Full Stack NFT Marketplace**" neither as a whole nor as a part has been copied out from any source. It is further declared that we have done this project with the accompanied report entirely on the basis of our personal efforts, under the proficient guidance of our teachers especially our supervisor **Mr. Tajamul Shahzad**. If any part of the system is proved to be copied out from any source or found to be reproduction of any project from anywhere else, we shall stand by the consequences.

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Dedication

Our final year project is dedicated to our parents, friends and teachers, whose love and support have been our pillars of strength. To our professors and especially supervisor, Mr. Tajamul Shahzad, whose guidance has shaped our academic journey.

Acknowledgement

First of all we are obliged to Allah Almighty the Merciful, the Beneficent and the source of all Knowledge, for granting us the courage and knowledge to complete this Project.

[Students will acknowledge here anyone who has helped in the project. It can include Supervisor(s), Teachers, Classmates, Friends and Family]

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Abstract

The project, titled “The Full Stack NFT (Non-Fungible Token) Marketplace” is a comprehensive platform for trading digital assets, offering a seamless experience for NFT creators and collectors alike. Modern tools and technologies like Next.js, Solidity, Hardhat, Node.js, and MetaMask are used in the development of this safe, secure, and user-friendly NFT marketplace. Moreover, the platform provides a robust ecosystem for minting, buying, and selling NFTs. The platform prioritizes security, scalability, and user-friendliness, ensuring that users can confidently engage with the marketplace. Innovative features like NFT creation are added into the system to overcome the limitations of the existing NFT marketplaces. The user-friendliness and high security of the full-stack NFT marketplace is meant to encourage more users participate in emerging blockchain technologies and trends like selling and buying NFTs. With the development of this system, it is expected that more work can be done in the future to build an ever and advanced NFT marketplace, so creators can monetize their work and for collectors to discover and acquire unique pieces. With a commitment to excellence and a vision for the future of digital asset trading, the Full Stack NFT Marketplace project represents a significant step forward in the evolution of blockchain-based marketplaces.

Chapter 1:

Introduction

1.1 Introduction

Non-fungible tokens (NFTs) are a product of the blockchain technology. They transformed the way internet users, especially those aware of blockchain, own something in the digital form. The privacy and legitimacy of NFTs are ensured by high security of the blockchain protocols. There are many NFT marketplaces operating at a global scale that promotes international digital assets. So, there is a dire need for a local NFT marketplace in Pakistan that can promote local and national digital assets.

Therefore, a full-stack NFT marketplace has been designed as a source of creating, selling, and buying NFTs with maximum security and privacy. The marketplace allows users to mint their digital works as NFTs, promote them, and sell to a global audience of NFTs enthusiasts.

1.2 Goals and Objectives

1.2.1 Goals

Following are the goals of this project:

- Build a customer friendly platform for selling and purchasing NFTs.
- Use blockchain technology to ensure safety and privacy of transactions.
- Provide a wide range of NFTs options for the customers to explore.
- Provide a safe and user-friendly browsing experience through filters.
- Coordinate with the experts and NFT creators to promote the platform's usage.
- Provide a way to design and organize the NFTs.
- Offer smooth and quick integration with popular cryptocurrency wallets like MetaMask.
- Ensure compliance with the international standards and regulations related to NFTS.
- Develop a responsive platform to ensure users can access it on any device.
- Make sure the acceptance with official and regulatory demands linked with NFTs

1.2.2 Objectives

Following are the objectives of this project:

- Build a user-friendly front-end interface for buying and browsing NFTs
- Apply secure protocols using blockchain technology to control the transactions of NFTs
- Develop a customer verification system for accurate registration and login
- Integrate payment channels for cryptocurrencies to purchase NFTs

- Develop a back end system to control customer account and transactions
- Apply the filter and search utility for NFTs postings
- Provide a dashboard where consumers can manage their transactions and NFT collections.
- Improve the platform for better performance and scalability
- Develop a marketing initiative to publicize the platform and engage the users

1.3 Scope of the Project

The goal of full-stack NFT marketplace project is to create a complete and user-friendly platform by incorporating a wide range of features and functionalities related to buying and selling NFTs.

Other than the primary function of selling and buying NFTs, the full-stack NFT marketplace also allows users to create NFTs and manage them in a user-friendly environment. A strong user registration and authentical system is used to ensure maximum security.

The end-users can browse, search, and filter NFTs using the marketplace feature. They can visit the detailed NFT pages for in-depth details. The process of buying and selling NFTs is made possible through integration with cryptocurrency wallets like MetaMask and secure payment processing.

User-friendliness and responsiveness are an important feature of the NFT marketplace. It is made sure that mobile phone users can have a memorable and comfortable user experience. Moreover, interaction and engagement in the NFT marketplace are encouraged through features like commenting, following creators, and participating in forums.

Since users use buying and selling features in the marketplace, their security is prioritized by ensuring compliance. The database administration and scalability of the backend infrastructure are supported with suitable blockchain APIs. Continuous testing also ensures user-friendly functionality and high security with CI/CD pipelines enabling continuous updates. The future development of this platform can include further advanced features like a variety of digital assets, multi- blockchain interoperability, and fractional ownership and royalties.

This comprehensive report of the full-stack NFT marketplace deals with the importance of needing such platforms in the first place. Moreover, similar platforms and their limitations are thoroughly discussed, along with both the technical and non-technical aspects involved in the development of the NFT marketplace.

Chapter 2:

Literature Review

This chapter deals with a comprehensive review of the existing literature and NFT marketplaces available on the internet. The purpose of this chapter is to analyze the limitations of the existing systems and overcome them with our own full-stack NFT marketplace.

2.1 Introduction

Non-fungible tokens (NFTs) are a revolutionary development in the quickly developing field of blockchain technology. They have altered the way people perceive digital ownership of different types of assets [1].

According to the latest statistics, NFTs are expected to keep becoming more and more popular in various industries, including art, gaming, crypto, collectibles, and business [2]. Since NFTs are strongly associated with decentralized finance (De-Fi), the overall tools and technologies involved in copyright protection, user authentication, and security are also expected to evolve and improve.

Considering the complexity of an NFT marketplace, having a thorough understanding of critical technologies is important to build a user-friendly platform. A dynamic and user-friendly interface is ensured by using frontend frameworks like Next.js and React.js, while the backend is powered by Node.js for scalability and reliable operation.

Solidity makes it easier to create smart contracts, while resources like Hardhat offer a more efficient Ethereum development environment. The full-stack NFT marketplace also involves using libraries like OpenZeppelin to guarantee the dependability and security of smart contracts. Moreover, integration with cryptocurrency wallets like MetaMask improves user accessibility and security. This technological synthesis makes it possible to build a unified and effective platform for the smooth exchange of digital assets within the developing NFT ecosystem.

2.2 Background and Problem Elaboration

2.2.1 Background

The concept of non-fungible tokens (NFTs) has become a game-changing innovation in the digital asset industry with the explosive growth of blockchain technology [3]. NFTs are distinct digital assets, such as virtual real estate, music, artwork, collectibles, or even pieces of material, that signify ownership or provide evidence of their validity.

Since the blockchain technology is decentralized and guarantees immutability, transparency, and security, NFTs are a great option for both creators and collectors. A reliable and user-

friendly platform that makes it easier to create, purchase, sell and trade these digital assets is required with the increasing popularity of NFTs.

It is also important to note that many countries have their own local NFT marketplaces with international coverage [4]. So, there is also a need of a NFT marketplace developed and implemented in Pakistan that complies with the international standards to provide promote the usage of blockchain technology and facilitate financial transactions through NFTs.

2.2.2 Problem Elaboration

The blockchain technology and NFTs specifically have numerous use cases [5]. However, the NFT industry is fragmented due to which there is lack of a comprehensive and reliable solution that meets the requirements of investors, collectors, and NFT creators.

While there many existing market places, they have the common issues of high transaction costs, restricted scalability, complex user interfaces, and challenges with intellectual property rights and copyright infringement [6].

Furthermore, the lack of a centralized and user-friendly platform hinders the accessibility to NFTs. It makes it difficult for NFT creators to exhibit their work and for consumers to find distinctive and worthwhile digital products [7]. Furthermore, the entire credibility of the NFTs buying and selling ecosystem is damaged by the frequency of fake NFTs and fraudulent activities happening on unsafe platforms, putting creators as well as consumers at serious danger.

The building of a full-stack NFT marketplace that makes use of blockchain technology to offer a safe, open, and effective platform for the creation, exchange, and ownership of digital assets is necessary to address these issues.

This marketplace revolutionizes the creation, purchase, and sale of digital assets by providing features like low transaction fees, strong copyright protection mechanisms, seamless integration with well-known blockchain networks, and user-friendly interfaces. It enables users to take part in the rapidly growing NFT economy and open up new opportunities for creators.

2.3 Detailed Literature Review

NFTs have gotten a lot of attention from well-established businesses as well as complete beginners looking to own digital assets as an investment. As a result, there are many applications and platforms meant to help users in selling and buying NFTs on a global scale. Some of the popular NFT marketplaces currently operating on the internet are Open Sea, Axie Market Place, Rarible, and Super Rare.

However, these platforms primarily focus on promoting international NFT artists [8]. As a result, new NFT creators from countries like Pakistan can lose out on the opportunity to participate in this revolutionizing technology.

Moreover, a common aspect of the existing NFT marketplaces is that they have exorbitant transaction costs, problems with scalability, and issues related to copyright violations. In order to promote broad adoption and guarantee the NFT ecosystem's viability, these issues have been addressed through our NFT marketplace.

2.4 Literature Review Summary Table

The table on the next page summarizes the key journal articles, project reports, and documents analyzed for the development of full-stack NFT marketplace:

Table 1: Literature Review Summary

No.	Title, Reference	Author	Year	Source	Summary
1.	NFT MARKET PLACE, [9]	Chirag Chaudh ari, Kunal Girme	2023	IRJMETS	The paper explains how NFT marketplaces use blockchain to ensure the authenticity and ownership of digital assets, offering secure transactions and monetization opportunities for creators, while also noting challenges like fraud and scalability.
2	NFT Marketplace Design and Market Intelligence, [10]	Pavel Kireyev	2022	Papers SSRN	This paper examines the strategic design and market analysis essential for NFT marketplace success. It delves into user-friendly interfaces, blockchain integration, and market trends, offering valuable insights for developers and analysts.
3	Non-fungible Token(NFT) Markets on the Ethereum Blockchain, [11]	Lennart Ante	2021	Tandfonli ne	This study looks at the NFT market from 2017 to 2021, focusing on 14 major submarkets on Ethereum. It finds that while transaction numbers have dropped, traded value has risen. The research shows interconnectedness among submarkets, indicating ongoing evolution and potential inefficiencies in NFT markets.
4	NFT Marketplace, [12]	Piyush Batra	2023	Arvix	This project report discusses the creation of a dApp for secure NFT management, combining blockchain and deep learning for features like wallet connections, NFT generation, and marketplace, showcasing their potential in digital asset management.

2.5 Research Gap

After thoroughly analyzing the existing NFT marketplaces like OpenSea [13] and relevant literature, it is clear that there is a need of a user-friendly full-stack NFT marketplace that can ensure maximum accessibility, usability, and user engagement.

Moreover, the new platform also needs to have better security and privacy protocols to NFT transactions security and foster user confidence. The current systems often ignore the advanced fraud prevention, data privacy, and safe smart contract development. A scalable NFT marketplace with better performance and higher security is likely to attract more users and encourage more people to create NFTs and sell and buy them.

Another major limitation of the existing NFT marketplaces is most of them only have the option of buying and selling NFTs. They lack built-in tools to create NFTs due to which many users might not even prefer to use them in the first place [14].

Considering these significant limitations and lack of features in the existing NFT marketplaces, a full-stack NFT marketplace is designed to overcome these issues.

2.6 Problem Statement

2.6.1 Security Breaches:

- Unauthorized access to customer accounts, leading to NFTs theft or confidential user information.
- Manipulation of loopholes in the blockchain development technologies to disrupt transactions.

2.6.2 Scalability Issues:

- Lack of scalability can cause the platforms to crash or have poor performance due to the incapacity to manage a large number of transactions during peak hours.
- Difficulty in expanding the platform's user base and meeting the rising demand for NFTs.

2.6.3 User Experience Challenges:

- Complex transaction system and a complex interface for non-technical users, leading to lesser engagement.

- Unavailability of mobile upgradation, makes the customer unsuitable to approach the platforms on tablets and smart phones.

2.6.4 Legal and Regulatory Compliance:

- Unreliability and uncertainty with regard to NFTs legal status and the essential management for controlling an NFT marketplace
- Valid legal argument from ownership disputes, copyright infringement, and non compliance with financial rules

2.6.5 Market Manipulation and Fraud:

- Lack of an internal mechanism to handle NFT prices with the help of artificially inflating demand and fake bids
- Fake or plagiarized NFTs being promoted on the marketplace to cheat the customer and weaken the trust in platforms

2.6.6 Payment and Transaction Problems:

- Delaying and failures in payments leads to ineffective transactions and funds loss
- Insufficient support for various payment process or currencies, causing difficulty for users to approach in different regions.

Chapter 3:

Requirements and

Design

This chapter deals with the detailed requirements and design of the full-stack NFT marketplace, including both technical and non-technical aspects involved in its development.

3.1 Requirements

Comprehensive requirement analysis and engineering is integral for a complex system like NFT marketplace. It is the process of recording, verifying, and overseeing the requirements that specify the capabilities, limitations, and performance of the system.

The first step in this process is to interact with stakeholders— such as artists, collectors, investors, and platform operators—to learn about their requirements and expectations. A wide range of features and functionalities, including the development of NFTs, token standards, smart contract functionality, marketplace user interfaces, search and discovery systems, payment gateways, and security measures, are included in these requirements. Scalability, compatibility with other blockchains, regulatory compliance, and data protection concerns are also taken into account. Flexibility and adaptability are critical in the continuously evolving NFT arena, necessitating a detailed examination of market trends and user input. Obtaining and documenting these requirements is vital to form a solid base for the development process. The overall process of an NFT marketplace's requirement analysis and engineering is an iterative process that makes sure the finished solution satisfies stakeholders' expectations and fits into the dynamic NFT ecosystem.

3.1.1 Functional Requirements

3.1.1.1 User

Following are the functional requirements of the NFT marketplace for the end-user:

Table 2: Functional Requirements (User)

ID	Requirements
1.1	User shall be able to access the platform with MetaMask
1.2	User shall be able to view their profile.
1.3	Securely connect their cryptocurrency wallet (e.g.,MetaMask) to the platform.
1.4	Browse NFTs by category, keyword, or popularity.
1.5	Search for specific NFTs based on their properties or creator.
1.6	Like, comment on, and add NFTs to their favorites list.
1.7	Place bids on NFTs in auctions.

1.8	Purchase NFTs using their connected cryptocurrency wallet.
1.9	Follow other users and creators to see their activity and NFT collections.
2.0	Contact platform support with questions or concerns.
2.1	Receive notifications about bids, purchases, and other relevant activities.

3.1.1.2 Admin

Following are the functional requirements of the NFT marketplace for an admin:

Table 3: Functional Requirements (Admin)

ID	Requirements
2.1	Admin shall be able to login into the system.
2.2	Admin shall be able to manage user profiles.
2.3	Admin shall be able to monitor and manage NFT sales and auctions.
2.4	Admin shall be able to track ownership history of NFT.
2.5	Admin shall be able to configure platform settings like fees and security parameters.
2.6	Admin shall be able to manage content and categories on the marketplace.
2.7	Admin shall be able to analyze market trends and user behavior.
2.8	Admin shall be able to implement and maintain robust security measures to protect user data and assets.

3.1.2 Non-Functional Requirements

Following are the non-functional requirements of the full-stack NFT marketplace in terms of its performance and security:

3.1.2.1 Performance

- **Response Time:** The system must check the actions of user (e.g., loading a page, searching for NFTs, placing a bid) within 2 seconds.
- **Transaction Throughput:** The marketplace should control at least 100 transactions per second during peak times.
- **Scalability:** The system should scale to maintain up to 1 million users simultaneously

3.1.2.2 Security

- **Data Encryption:** All sensitive data (e.g., user credentials, transaction details) must be cracked in transit (using SSL/TLS) and at rest.
- **Authentication:** Apply multi- factor attestation (MFA) for user login to increase the security.
- **Authorization:** Ensure role-based access control (RBAC) to stop the access of various parts of the system based on roles of user (e.g., admin, user, seller).
- **Smart Contract Security:** Confirm that all the short contracts are audited for exposure and attend best practices to avoid attacks such as reentrancy, underflow, and unapproved access.

3.1.3 Hardware and Software Requirements

Following are the hardware and software requirements of the NFT marketplace:

3.1.3.1 Hardware

- **Server:** A cloud-based virtual server instance from providers like AWS or Azure. This offers scalability (adjust resources as needed) and avoids upfront hardware costs.
- **Secure Storage:** Utilize a cloud storage solution like Amazon S3 or Google Cloud Storage. This ensures redundancy and easy access to NFT metadata and potentially media files.
- **Reliable Internet Connection:** Invest in a high-bandwidth and stable internet connection to handle user traffic and ensure smooth platform operation.

3.1.3.2 Software

- **Front-End Development Framework:** Choose a popular framework like React or Vue.js. They offer pre-built components, faster development, and easier maintenance compared to building everything from scratch.
- **Back-End Development Framework:** Select a framework like Django (Python) or Spring (Java) based on your team's expertise. Frameworks provide structure and tools for efficient development and API creation.
- **Blockchain SDK Integration:** Integrate the Software Development Kit (SDK) provided by your chosen blockchain platform (e.g., Ethereum, Solana). This allows your application to interact with the blockchain for NFT minting, transfers, and ownership verification.

3.2 Proposed Methodology

The development methodology of the full-stack NFT marketplace includes the usage of modern tools and technologies for successful implementation of crucial components like high security, transaction methods, and crypto wallet integration.

The procedural design methodology is adopted to develop the NFT marketplace. This methodology follows the top-down approach by dividing the functions along with the sequence of actions that needs to follow [15]. The initial planning phase of this methodology focuses on identifying the goals and scope of the project by analyzing the current NFT marketplaces and finding the unique selling propositions of the project.

Moreover, the development phase is made possible with the iterative software process model to ensure it is scalable and more functions can be added in the future. It makes the entire process efficient while also leaving room for further changes [16].

Since NFT marketplace itself is decentralized in nature, the iterative model suits the requirements with continuous improvements through testing and incorporating early users feedback into the development phase. Ultimately, scalability and reliability are ensured by a strong iterative and procedural methodology.

3.3 System Architecture

The following image depicts the overall structure, components, and their interactions to ensure the effective implementation of a full-stack NFT marketplace:

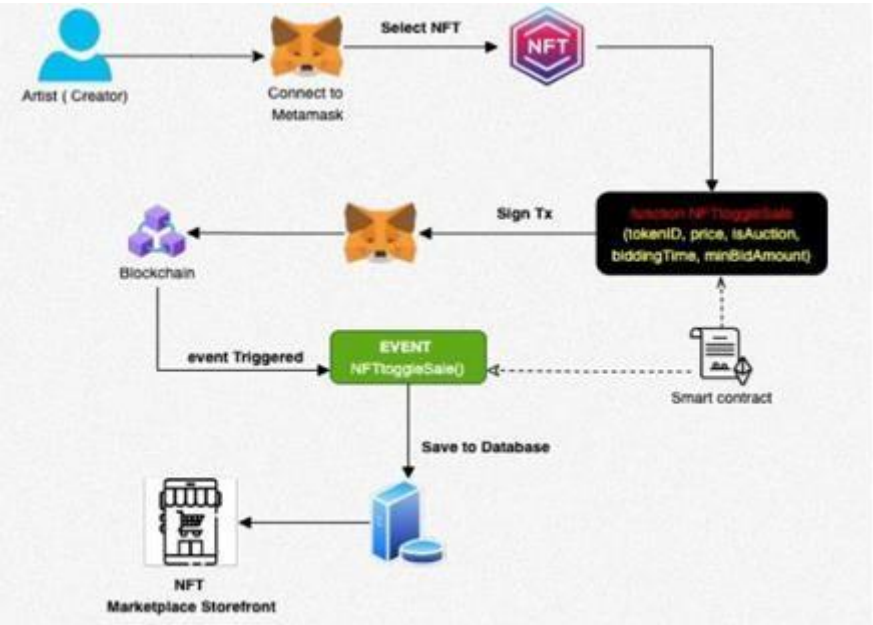

Figure 1: System Architecture Diagram

3.4 Use Cases

The following diagram summarizes the use cases of the full-stack NFT marketplace:

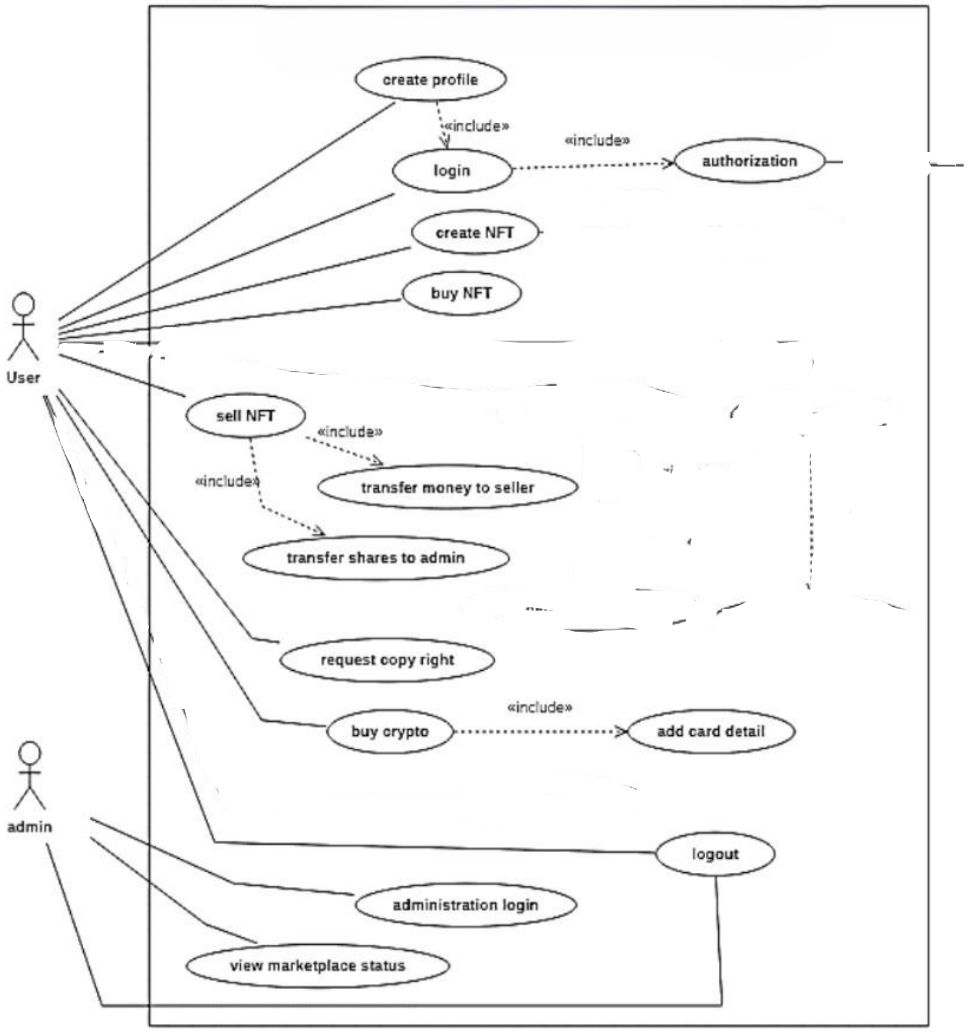

Figure 2: Use Cases

3.4.1 Generate NFT Listing

Table 4: UC: 01 – Generate NFT Listing

Name	Generate NFT Listing		
Actors	Seller		
Summary	Sellers, Buyers, Platform Administrators want to generate NFT listing		
Pre-Conditions	Seller is validated and has digital resources for listing.		
Post-Conditions	Create NFT listing which is visible on the marketplace.		
Special Requirements	None		
Basic Flow			
Actor Action		**System Response**	
1	Seller login to the system	2	NFT creation tools and features are displayed to the user
3	User chooses to create a new NFT	4	The system provides the option to upload digital resources
5	Seller uploads the digital assets	6	System stores the files.
7	Seller fix the price and submit listing	8	Database is updated to show NFT to new users
Alternative Flow			
5-A	The user uploads invalid data	6-A	The system produces an error and prompt the user to submit correct data files.

3.4.2 Search NFTs

Table 5: UC: 02 – Search NFTs

Name	Search NFTs		
Actors	User		
Summary	Users (need to search the particular NFT), Artists (Want their NFTs to be discoverable)		
Pre-Conditions	User is on the NFT marketplace page.		
Post-Conditions	Specific search results are presented to User.		
Special Requirements	None		
Basic Flow			
Actor Action		**System Response**	
1	User enters a search query	2	System filters the query
3	NA	3	The system displays the filtered result
Alternative Flow			
	NA		NA

3.4.3 Add to Favorites

Table 6: UC: 03 – Add to Favorites

Name	Add to Favorites		
Actors	User		
Summary	Users (need a bookmark NFTs), Artists (Want their NFTs to be favorite)		
Pre-Conditions	User is logged in and looking an NFT.		
Post-Conditions	NFT is added to the favorite list of User.		
Special Requirements	None		
Basic Flow			
Actor Action		**System Response**	
1	User chooses the 'Add to Favorites' button	2	System adds the NFT to the user's favorite lists.
Alternative Flow			
1-A	User adds an NFT to favorite that is already present in the list.	1-A	The system produces an error that the NFT is already added to the favorites list.

3.4.4 Remove NFT from Favorites

Table 7: UC: 04 – Remove from Favorites

Name	Remove from Favorites		
Actors	User		
Summary	User wants to remove an NFT from their favorite collection.		
Pre-Conditions	User is logged in and looking their favorites list.		
Post-Conditions	NFT is removed from the favorite list of user.		
Special Requirements	None		
Basic Flow			
Actor Action		**System Response**	
1	User chooses an NFT to remove it from their favorites list.	2	System removes the NFT to the user's favorite lists.
Alternative Flow			
1-A	User chooses to remove an NFT that is not present in the list.	1-A	The system produces a message that the NFT is not in the favorites list.

3.4.5 Buy NFT

Table 8: UC: 05 – Buy NFT

Name	Buy NFT		
Actors	Buyer		
Summary	User wants to buy an NFT from the marketplace		
Pre-Conditions	Buyer is validated and has enough balance.		
Post-Conditions	Buyer gets the digital ownership of the NFT.		
Special Requirements	None		
Basic Flow			
Actor Action		**System Response**	
1	Buyers choose an NFT to buy	2	System displays the price and other details about the NFT
3	Buyer makes the confirmation that they want to buy the NFT and pay for it.	4	System gives the digital ownership of the NFT to the buyer.
Alternative Flow			
3-A	Buyer fails to pay for the NFT.	4-A	The system gives an error messages related to payment failure.

3.4.6 Browse NFT Listing

Table 9: UC: 06 – Browse NFT Listings

Name	Browse NFT Listings		
Actors	User (Buyer/Seller)		
Summary	Sellers, Buyers, Platform Administrators want to browse NFT listing		
Pre-Conditions	User is validated and on the marketplace homepage.		
Post-Conditions	User has looked all the available NFT listings.		
Special Requirements	None		
Basic Flow			
Actor Action		**System Response**	
1	User access the NFT marketplace	2	System displays the available NFTs
3	User searches through the NFTs and browse the categories	4	System provides relevant information to the browsed NFTs
Alternative Flow			
	NA		NA

3.4.7 Manage NFT Collection

Table 10: UC: 07 – Manage NFT Collection

Name	Manage NFT Listings		
Actors	User (Buyer/Seller)		
Summary	Sellers, Buyers, Platform Administrators want to view their collection of NFT listings		
Pre-Conditions	User is validated and on the marketplace homepage.		
Post-Conditions	User has access to their NFTs collection		
Special Requirements	None		
Basic Flow			
Actor Action		**System Response**	
1	User access the NFT marketplace	2	System displays the available NFTs
3	User open their specific collection of NFTs	4	System displays the NFTs available in the user's collection.
Alternative Flow			
	NA		NA

3.4.8 Update NFT Details

Table 11: UC: 8 – Update NFT Details

Name	Browse NFT Listings		
Actors	Artist		
Summary	Artists need to improve or update their NFT information		
Pre-Conditions	Artist is logged in and owns the NFT.		
Post-Conditions	NFT details are updated.		
Special Requirements	None		
Basic Flow			
Actor Action		**System Response**	
1	User (artist) access the NFT marketplace	2	System displays their created NFTs
3	User open a specific NFT to update its details.	4	System updates the information available about the NFT
Alternative Flow			
3-A	User enters invalid information	4-A	System rejects the updated information

3.4.9 Contact Us

Table 12: UC: 9 – Contact Us

Name	Contact Us		
Actors	User		
Summary	User wants to contact the support team.		
Pre-Conditions	User is on the "Contact Us" page.		
Post-Conditions	User's message is submitted to the support team.		
Special Requirements	None		
Basic Flow			
Actor Action		**System Response**	
1	User access the Contact Us page.	2	System displays the contact form.
3	User fills in the contact form with their name, email, and message.	4	System accepts the form details.
Alternative Flow			
3-A	User enters invalid information	4-A	System rejects the form and give an error

3.4.10 Connect Meta Wallet

Table 13: UC: 10 – Connect Meta Wallet

Name	Connect Meta Wallet		
Actors	User		
Summary	User wants to connect their meta wallet to the marketplace.		
Pre-Conditions	User is logged in and wants to link their Meta Wallet.		
Post-Conditions	User's Meta Wallet is successfully linked.		
Special Requirements	None		
Basic Flow			
Actor Action		**System Response**	
1	User log in and choose to connect a crypto wallet.	2	System provides wallet option.
3	User chooses Meta Wallet and provide authentication information,	4	System connects the wallet with user's NFT marketplace.
Alternative Flow			
1-A	User enters invalid information	2-A	System produces an error and ask the user to add correct login details.
3-A	User provides incorrect details.	4-A	System fails to connect with the wallet.

3.4.11 View Popular NFTs

Table 14: UC: 11 – View Popular NFTs

Name	View Popular NFTs		
Actors	User		
Summary	User is interested in viewing the trending NFTs on the marketplace.		
Pre-Conditions	The user is logged into the NFT marketplace.		
Post-Conditions	The user is able to see the list of popular NFTs.		
Special Requirements	None		
Basic Flow			
Actor Action		**System Response**	
1	User log in and open the popular NFTs section.	2	System displays the list of trending NFTs
3	User chooses a specific NFT to view its details	4	System displays the details of the specific NFTs.
Alternative Flow			
	NA		NA

3.4.12 Place a Bet on NFT

Table 15: UC: 12 – Place a Bet on NFT

Name	Place a Bet on NFT		
Actors	Buyer		
Summary	Buyer is interested in placing a bid on an NFT.		
Pre-Conditions	The buyer must be registered on the NFT marketplace.		
Post-Conditions	The bid is successfully placed on the NFT.		
Special Requirements	None		
Basic Flow			
Actor Action		**System Response**	
1	User chooses a specific NFT listing and choose to place a bet.	2	System provides the option to place a bet.
3	User enters the bid amount.	4	System updates the database with the bid.
Alternative Flow			
3-A	User enters an invalid bid amount	4-A	System rejects the bid and ask user to enter a valid bid amount.

3.4.13 Buy an NFT with MetaMask

Table 16: UC: 13 – Buy an NFT with MetaMask

Name	Buy an NFT with MetaMask		
Actors	Buyer		
Summary	The buyer wants to buy an NFT by paying through the MetaMask.		
Pre-Conditions	The buyer has a MetaMask wallet set up and connected to the marketplace		
Post-Conditions	The amount is deducted from the MetaMask wallet and the buyer gets the digital ownership of the NFT.		
Special Requirements	None		
Basic Flow			
Actor Action		**System Response**	
1	User chooses a specific NFT to buy.	2	System shows the NFT buying details and provide an option to buy it.
3	User confirms the purchase.	4	System deducts the amount from the user's MetaMask wallet and provide access to the NFT
Alternative Flow			
3-A	User does not confirm the purchase	4-A	System ends the purchase.
	NA	4-B	System finds the amount in the MetaMask to be less than the NFT's price and gives a message that user has insufficient funds.

3.5 Database Design

Pinata 3.0 (IPFS) is the decentralized database used in the full-stack NFT marketplace.

3.6 Data Flow Diagram

The following figure represents the level 1 DFD of NFT marketplace to understand the connection between different entities of the system.

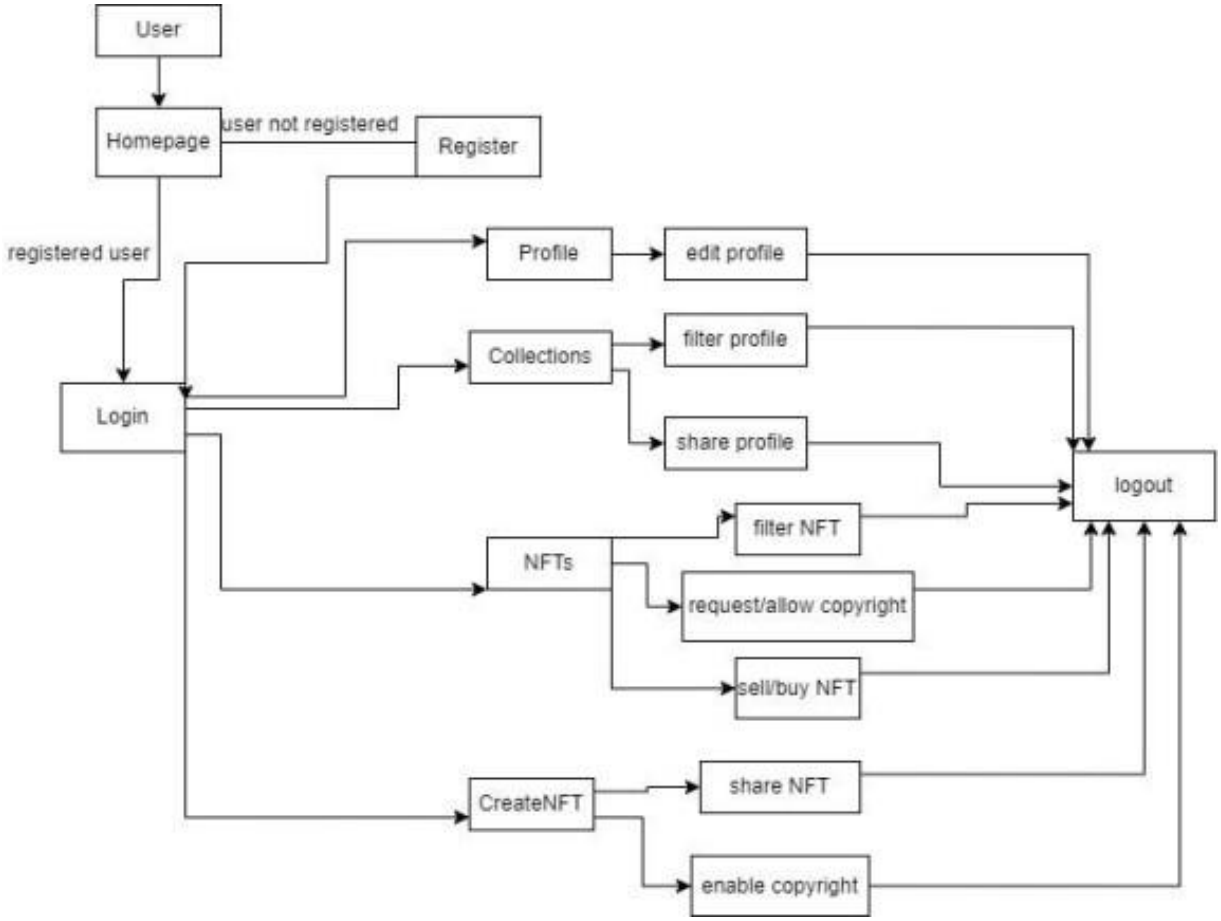

Figure 3: DFD of NFT Marketplace

Chapter 4:

Implementation and

Test Cases

This chapter dives into the implementation and detailed test cases used to ensure the NFT marketplace is working properly and efficiently.

4.1 Implementation

4.1.1 Endeavour

To develop a full-stack NFT marketplace using modern tools and technologies to ensure users can buy, sell, and bid on NFTs.

4.1.2 Team Members and Work Breakdown

Table 17: Work Breakdown

Name	ID	Tasks
Usman Ayub	27952	• Smart Contract Building • Front End Development
Muhammad Afzaal Hameed	23733	• Front-End Development • Documentation
Mussab Saeed	27660	• Blockchain Deployment • Smart Contracts Building

4.1.3 Tools and Technologies

Following are the key tools and technologies used in the development of the full-stack NFT marketplace:

4.1.3.1 Next.js

Next.js is a web development framework built on the React features. It is used to develop a clean, responsive, and intuitive interface of the NFT marketplace. Simple CSS, HTML, and JavaScript are also used with Next.js for frontend development.

4.1.3.2 Solidity

Solidity programming language is used for backend development as smart contracts are the core of the NFT marketplace.

4.1.3.3 Hardhat

Hardhat is a development environment. It is used to create and test smart contracts deployed on the Ethereum blockchain network.

4.1.3.4 Ethereum Blockchain Network

The logic for smart contracts written in Solidity programming language is deployed on the Ethereum blockchain network.

4.1.3.5 Pinata

Pinata is a web 3.0 software that uses the Interplanetary File System (IPFS) to store and distribute data. It is used as the primary decentralized database of the NFT marketplace to ensure users have a quick and reliable access to data.

4.1.3.6 MetaMask

MetaMask is a crypto wallet integrated with the NFT marketplace for authorization and transactions.

4.2 Test Cases Design and Description

Following are the different test cases used to ensure maximum performance of the NFT marketplace:

4.2.1 User Authentication (MetaMask)

Table 18: User Registration

User Registration			
Test Case ID:	TC - 01	**Test Date:**	20/10/24
Test case Version:	1	**Use Case Reference(s):**	UC - 01
Revision History:	NA		
Objective	To ensure user can register on the platform.		
Product/Ver/Module:	1.0		
Environment:	Chrome, Windows		
Assumptions:	NA		
Pre-Requisite:	User has a stable internet connection		

Step No.	**Execution description**	**Procedure result**
1	• Username: "testuser" (alphanumeric, 5-20 characters) • Email: "test@example.com" (valid email format) • Password: "Password123!" (8-20 characters, includes uppercase, lowercase, digit, special character)	Valid

	• Confirm Password: "Password123!" (matches Password) • Wallet Address: "0x1234567890abcdef1234567890abcdef12345678" (valid Ethereum address format)	
2	• Does not contain '@' (userexample.com).Include characters • Includes characters (user@exampl*e.com).Not End with '.' • Includes special characters (user@ex!ample.com). • Does not end with '.' (user@examplecom).	Invalid
Comments: Passed		

4.2.2 Search NFT

Table 19: Search NFT

Search			
Test Case ID:	TC - 03	**Test Date:**	20/10/24
Test case Version:	1	**Use Case Reference(s):**	UC - 02
Revision History:	NA		
Objective	To ensure user can login on the platform.		
Product/Ver/Module:	1.0		
Environment:	Chrome, Windows		
Assumptions:	NA		
Pre-Requisite:	User has a stable internet connection and existing account to search NFT.		
Step No.	**Execution description**	**Procedure result**	
1	Query: "cool" (1-100 characters, matches existing NFTs)	Valid	
2	Query: "co#%#!ol" (1-100 characters, matches existing NFTs)	Invalid	
Comments: Passed			

4.2.3 Favorite NFT

Table 20: Favorite NFT

Favorite NFT			
Test Case ID:	TC - 04	**Test Date:**	20/10/24
Test case Version:	1	**Use Case Reference(s):**	UC – 03, UC - 04

Revision History:	NA	
Objective	To ensure user can add an NFT to their favorite.	
Product/Ver/Module:	1.0	
Environment:	Chrome, Windows	
Assumptions:	NA	
Pre-Requisite:	User has a stable internet connection and existing account to search NFT.	
Step No.	**Execution description**	**Procedure result**
1	Add an existing NFT ID	Valid
2	Add a non-existing or invalid NFT ID	Invalid
Comments: Passed		

4.2.4 Buy NFT

Table 21: Buy NFT

Buy NFT			
Test Case ID:	TC - 04	**Test Date:**	20/10/24
Test case Version:	1	**Use Case Reference(s):**	UC – 16
Revision History:	NA		
Objective	To ensure user can buy an NFT.		
Product/Ver/Module:	1.0		
Environment:	Chrome, Windows		
Assumptions:	NA		
Pre-Requisite:	User has a stable internet connection and existing account to buy an NF.		
Step No.	**Execution description**	**Procedure result**	
1	User ID: 1 (valid existing user ID) NFT ID: 1 (valid existing NFT ID) Payment Method: "MetaMask" (valid payment method) Amount: 1.5 (valid amount, within user's balance)	Valid	
2	Invalid payment method or lack of MetaMask integration.	Invalid	
Comments: Passed			

The above test cases have overall contributed towards the successful development and implementation of the full-stack NFT marketplace to ensure all users can buy, sell, and create NFTs on this safe and user-friendly platform.

Chapter 5:

Experimental Results & Analysis

5.1 Introduction

In this chapter, a summary of the results achieved with the full-stack NFT marketplace is explained, along with the key features and successful implementation of the core functionalities. Moreover, a critical review is included to identify the strengths of the project and identify key areas for improvement.

5.2 Project Achievements

The purpose of the full-stack NFT marketplace project was to create a comprehensive platform that users can rely on to sell and buy NFTs. The goal has been achieved with the help of tools and technologies like Next.js, Pinata, Solidity, and Hardhat. The platform acts as an all-in-one marketplace where users can browse the NFTs and easily buy or sell them by integrating their MetaMask crypto wallet.

Moreover, the project's goal of making the NFT marketplace accessible and user-friendly is achieved through a user-friendly interface. Significant improvements have been made on the existing NFT marketplaces and platforms by focusing on faster transactions, lower fees, and easier navigation.

5.3 Critical Analysis

Maximum effort has been done to overcome the limitations of the existing NFT marketplaces and build a reliable full-stack NFT marketplace. Yet, there are a few areas of the project that has some limitations and loopholes:

5.3.1 Security

The complexity of the blockchain technology and Ethereum blockchain network increases security threats to the entire platform. As a result, the NFTs and financial transactions are vulnerable to security threats, such as hacking.

5.3.2 Scalability

The growing requirements in terms of number of uses, NFTs types, and blockchain networks can bring scalability issues in the marketplace.

5.3.3 Accessibility

Since NFT is a growing market, not many users are well-aware of the marketplace usage. Hence, it can be difficult for some users to access and use the NFT marketplace despite its user-friendly interface.

5.3.4 Regulations

The growing nature of the crypto industry also means there are evolving rules and regulations related to NFTs. Hence, keeping the NFT marketplace in compliant with new legal standards is a challenge.

5.4 Conclusion

Despite the numerous challenges, a lot has been achieved on this project of developing a full-stack NFT marketplace. Overall, it is a reliable and user-friendly platform through which users can buy and sell NFTs with lower transaction costs and quicker speed.

Chapter 6:

Conclusion and Future Directions

6.1 Conclusion

The entire process of developing the full-stack NFT marketplace is thoroughly described in this comprehensive report. The overall development process puts special focus on identifying the limitations of the existing platforms and overcoming these limitations using modern tools and technologies like Next.js, Solidity, and Hardhat.

Moreover, the basic features of an NFT marketplaces like buying and selling NFTs are significantly extended by providing the ability to create NFTs to the users. Other than the development of a safe and user-friendly NFT marketplace, this project establishes a strong framework for developing an advanced and more innovative NFT marketplace in the future.

6.2 Future Work

There is still a significant room for improvement and innovation in NFT marketplace platforms

- Applying machine learning algorithms to bring advanced search features in the marketplace for effective NFT discovery based on user preferences and criteria.
- Create a recommendation system to encourage users buy NFTs as per their interests.
- To reduce the environmental impact of NFT transactions and blockchain technology, consider including sustainable consensus methods into your marketplace, such as proof-of-stake [17].
- Integration of the NFT marketplace with the metaverse can be a true game-changer. It can display the NFTs to more people in real-time and hence promote, transactions.
- Keep up with the changing legal and regulatory environment related to crypto and NFTs to ensure maximum compliance.

Overall, implementation of these recommendations in the future NFT marketplaces can result in development of a highly advanced marketplace where users can create, sell, and buy NFTs in a more interactive manner.

References

[1] M. &. B. S. M. H. Solouki, “An in-depth insight at digital ownership through dynamic NFTs,” *Procedia Computer Science,* vol. 214, pp. 875-882, 2022.

[2] Statista, “NFT - statistics & facts,” 21 June 2014. [Online]. Available: https://www.statista.com/topics/8513/nft/.

[3] T. A. S. S. S. J. D. a. B. A. Ahram, “Blockchain technology innovations,” in *IEEE technology & engineering management conference,* 2017.

[4] G. I. A. N. de GUZMAN, “ NFT marketplace design impact: comprehensive analysis of NFT market and ecosystem.,” 2022.

[5] A. K. J. P. L. &. D. A. Park, “The evolution of nonfungible tokens: Complexity and novelty of NFT use-cases.,” *IT Professional,* vol. 4, no. 1, pp. 9-14, 2022.

[6] M. &. F. M. Rasolroveicy, “Performance and cost evaluation of public blockchain: An nft marketplace case study.,” in *4th Conference on Blockchain Research & Applications for Innovative Networks and Services (BRAINS),* 2022.

[7] W. e. Z. H. I. J. &. B. N. Z. (. Rehman, “NFTs: Applications and challenges,” in *22nd International Arab Conference on Information Technology (ACIT) (pp. 1-7). IEEE.,* 2021.

[8] W. L. Ng, “A new era of the visual art market?: A platform analysis of the biggest nft market opensea on diversity and equality.,” 2022.

[9] K. G. O. G. P. G. Chirag Chaudhari, “NFT MARKET PLACE,” *International Research Journal of Modernization in Engineering Technology and Science* , vol. 5, no. 10, pp. 2495-2501, 2023.

[10] P. Kireyev, “NFT marketplace design and market intelligence.,” 2022.

[11] L. Ante, “Non-fungible token (NFT) markets on the Ethereum blockchain: Temporal development, cointegration and interrelations.,” *Economics of Innovation and New Technology,* vol. 32, no. 8, pp. 1216-1234., 2023.

[12] P. S. G. R. &. G. R. Batra, “NFT Marketplace,” 2023.

[13] OpenSea, “OpenSea, NFT Marketplace,” 2024. [Online]. Available: https://opensea.io/.

[14] S. &. R. Y. Bhujel, “A survey: Security, transparency, and scalability issues of nft’s and its marketplaces.,” *Sensors,* vol. 22, no. 22, p. 8833, 2022.

[15] J. J. R. L. A. L.-L. R. P. J. M. &. S. T. Blomberg, “An Exploration of Procedural Content Generation for Top-Down Level Design.,” 2018.

[16] T. M. Kister, “Improving the information development process: A refined iterative development model.,” *Technical Communication,* vol. 63, no. 1, pp. 186-211, 2016.

[17] A. &. Y. F. Lal, “Climate concerns and the future of nonfungible tokens: Leveraging environmental benefits of the Ethereum Merge.,” *Proceedings of the National Academy of Sciences,,* vol. 29, p. 120, 2023.

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