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# Revolutionizing E-Commerce Warranty Management with NON-FUNGIBLE TOKENS (NFTs)

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***Abstract*** Shopping online involves many risks in determining whether an item is genuine or counterfeit. Customers can have more peace of mind when purchasing items online if they can get a digital warranty with a physical product. NFTs are unique digital assets that can be easily verified on the blockchain. By using NFT for warranty representation, e-commerce companies can create a tamper-proof record of warranty coverage, streamline the claims process and reduce fraud. In addition, NFT can allow eCommerce organizations to implement new business models and discover new revenue streams, such as the ability to offer extended warranties or individual warranty packages to customers The proposed work discusses the potential benefits and difficulties of implementing an NFT-based eCommerce warranty system -Provides examples of use-cases They are extremely difficult to fake, and can be easily tracked and verified using Blockchain Explorer. To provide the aforementioned feature, we developed a demo-ecommerce website that offers a digital guarantee in the form of deteriorating NFTs in addition to the actual physical product.

***Index Terms*** *Blockchain, Counterfeit Prevention, Deteriorating NFT's, Digital Warranties, Decentralize, Extended warranties, E-commerce Warranty System, Fraud prevention, NFT's, Non-fungible token, Personalized Warranty packages, Streamlining Claims Process, Tokens, Tamper-Proof Record, Tokenization, Warranty System.*

## I. Introduction

E-commerce has grown in popularity in recent years, as online shopping has become a convenient and popular way for consumers to purchase various products. However, one of the challenges for e-commerce companies is how to assure customers about the quality and reliability of the products they sell. Warranty policies are a common way for eCommerce companies to provide this assurance, giving customers protection against defects and deficiencies in purchased products Traditional warranties are usually physical proof of purchase, such as a receipt or warranty card. To verify invoices we rely on manual verification methods but these systems can be vulnerable to fraud and abuse, as physical documents can be difficult to verify and provide opportunities for dishonest customers to make fraudulent claims. The requirement can include many customer service inquiries. Data breaches and fraudulent

transactions are a major concern for e-commerce merchants. In the past 24 months, 47 percent of businesses were affected by fraud, for a total loss of $42 billion. Data breaches typically include ransomware, malware, phishing, and denial-of-service attacks. Identifying guarantee fraud requires a enormous records of assurance claims. Warranty agreements contain clauses that accompany the sale of most merchandise. The producer undertakes to repair or replace the illness under the phrases of the guarantee. Warranties can also be limited to specific styles of defects and won't cover losses associated with misuse. When a company accepts a assurance claim, the producer will pay and send a new product to the service center. Additionally, the producer reimburses the provider facility's personnel for guarantee maintenance. Thus, a fraudulent guarantee claim compensates a carrier facility for repairs that never occurred or were not completed to deal with any other issue. They also offer a spare component that may be hooked up or sold to the customer or manufacturing unit they serve. Warranty fraud happens whilst people or corporations use guarantee pointers for his or her gain. This form of fraud is complicated and can occur with any employer that can provide warranties. Warranty fraud is regularly related to cheating clients misleading agencies through false claims. This false information can be used to obtain a refund or in lieu of a certified working product. However, customers are only one individual who can commit warranty fraud. The company may commit fraud by violating the terms of the written or implied warranty to protect against costs, as well as selling extended warranties that do not actually provide additional protection This will increase your revenue , without providing any services. This is possible when the extended warranty sold offers the same coverage as the base warranty. Anyone can commit this type of fraud, but customers, sellers and distributors are the most likely to commit fraud. If warranty fraud is a concern, in addition to implementing a system that can verify the accuracy of customer warranty claims, it is important to consider implementing policies to ensure your employees and associates comply warranty provisions.

To prevent such fraudulent activity, the proposed system is a warranty system that uses NFT's instead of traditional physical warranty or digital warranty NFTs as a tool to create a secure eCommerce warranty system effectively. By using NFT for warranty representation, e-commerce companies can create consistent records of warranty coverage, simplify claims, and reduce the risk of fraud on the paper side. The advantages and limitations of implementing e-commerce based on NFT warranty policy is discussed and examples of current and potential applications are further mentioned ahead.

## II. Literature Survey

With the rise in popularity of online shopping, product authenticity and warranty coverage problems are a major issue. This literature review examines the potential benefits and challenges of an ecommerce warranty system based on 'decaying' concept using blockchain technology and non-fungible tokens (NFTs) to implement digital decaying warranties for customers. Blockchain technology customer databases and CRMs provide very high levels of security for systems that create a reliable and authentic identity that can be confirmed by many other trusted parties. To combat fraudulent transactions, the proposed system provides users with a digital warranty using blockchain technology and NFT. The concept of blockchain technology was originally introduced in the Bitcoin Paper [1] . It laid the foundation for a decentralized, secure and transparent electronic money system. Ethereum, as described in Ethereum's paper [9], expanded the possibilities of blockchain by introducing smart contracts, which are autonomous contracts with contract terms directly encoded in NFTs, which has gained considerable attention in the art industry in terms of buying and selling digital art. [13] Discusses the implications of the NFT for artists, collectors, and the art market as a whole. The authors examine the unique characteristics of NFTs, such as verifiable ownership and provenance, which provide artists with additional income and digital rarities for collectors. [11] Provides an overview of NFTs and analyze their applications, opportunities and challenges. The paper discusses how NFTs can reshape the digital/virtual asset market and identifies areas such as gaming, virtual real estate and collectibles where NFTs have gained traction. The authors also highlight the challenges related to safety, scalability, and environmental concerns that need to be addressed for widespread adoption. [18] explore the potential of decentralized commerce and blockchain technology for integration into e-commerce, the paper describes how NFT can enable unique composition, verifiable authenticity, and decentralized marketplaces . The authors emphasize the importance of reliability, security and user experience in implementing an NFT-based e-commerce system. [23] It provides a description of blockchain technology, its design, brainstorming methods, and future trends. They emphasize the importance of efficiency and scalability in blockchain systems. Furthermore, [16] explores the mechanical properties of NFTs, investigating their design, properties, and safety and security

considerations. Potential applications and research challenges to be addressed are discussed. They examine the legal concerns surrounding the use of smart contracts, including NFT, and discuss how smart contracts challenge traditional contract law and raise questions about government sovereignty and technology committed to the cooperation of the nations. [24] Further explores the legal ramifications of blockchain and regulatory law and examines the potential impact on contractual relationships, intellectual property rights, and also explore the use of blockchain for IoT security and privacy, emphasizes the importance of public-key cryptography and smart contract-based mechanisms Highlights the potential benefits of smart homes [24] Systematically review blockchain technology, discussing research progress, opportunities and challenges and explores the privacy and security concerns associated with blockchain systems [20] Explores the token economy and how blockchain, smart contracts are changing finance and more. The author discusses the business models enabled by blockchain technology and the potential implications for organizations. The impact of blockchain on e-commerce is examined by [15] , with an overview of key research topics. Technical, legal, regulatory, quality, and customer data have been identified as key areas. This literature review provides a comprehensive overview of research and insights into the decline of NFT-based e-commerce warranty systems. The study showed that the integration of NFT into an e-commerce warranty system can increase reliability, transparency and authenticity. However, there are still technical, regulatory and legal challenges to overcome for widespread adoption. Further research is needed to explore alternative solutions and assess the long-term impact of an NFT-based e-commerce warranty system.

## III. Proposed Methodology

The objective of proposed method is to replace the Physical/Digital warranty or ownership card by a block chain based decaying warranty via NFTs which will ensure Transparency, Authenticity, and more security. The method facilitates conversion of physical product warranty cards into decaying NFTs using ERC721, allows brands and retailers to introduce an NFT which accompanies each of their products , enables customers to use the digital NFT to verify the authenticity and ownership of their product, and transfer ownership upon resale, if valid and required, allows brand/retailer to integrate the digital NFT to its warranty program, allowing owners to track repairs and replacements to the original item.

figure 1 describes the architecture diagram of the proposed system.

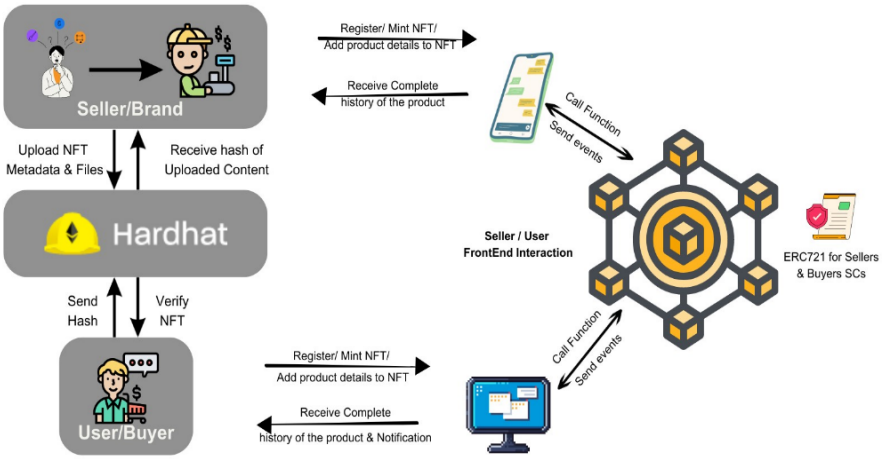


*Figure 1: High-level System Architecture diagram*

**Product registration:** When a product is manufactured, it is registered on the e-commerce warranty system. The registration process includes creating a digital identity for the product and storing information such as the product's make, model, serial number, and other relevant details. A web-based user interface is developed for manufacturers to register their products to the system by using product registration form, product details input, and product image upload.

**NFT Minting:** Once registered, the NFT representing the product certificate is generated and attached to the product's digital identification. The NFT contains information such as the name of the registration date, the warranty expiration date, and the unique serial number used to verify the authenticity of the product. NFTs are minted and stored and transferred in a tamper-proof and decentralize manner on the Ethereum blockchain network.

**Product sale and Warranty Verification:** When an item is sold, the NFT representing the title is transferred to the new owner. The new owner can use NFT to verify the authenticity of the item and track its ownership throughout its life. Customers to verify their purchase by scanning the QR code on the product or searching for NFT on Blockchain Explorer.

**Warranty claims:** The consumer's warranty claim is transferred to the manufacturer through the e-commerce warranty system. The manufacturer may use product NFT to validate the product and process warranty claims accordingly. A web-based user interface has been developed for manufacturers to handle warranty claims and manage their products in the system. The proposed system is implemented on a blockchain network, which provides tamper-proof storage of the product's digital identity and NFTs as shown in figure 2. This ensures that the product's authenticity and ownership can be verified and tracked throughout its lifetime. In order to evaluate the proposed system, a prototype of the system is implemented and tested with a sample set of products. The metrics used for evaluation are authentication accuracy, the percentage of products that are correctly identified as authentic or counterfeit.

**Efficiency:** It is defined as the time required to authenticate the product using the proposed system and compare it to the time required for current e-commerce warranty systems.

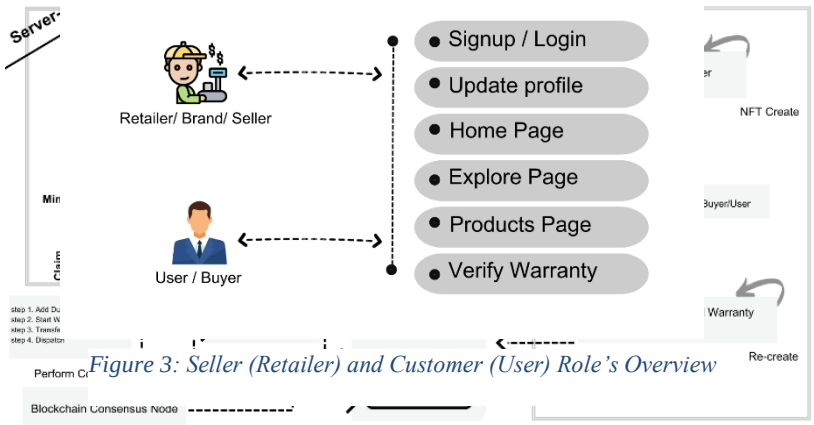


*Figure 3: Seller (Retailer) and Customer (User) Role's Overview*

*Figure 2: Client–Server Model (User-Seller interaction)*

The Seller can mint the Warranty NFT and generate warranty for the customers. This happens by calling a function

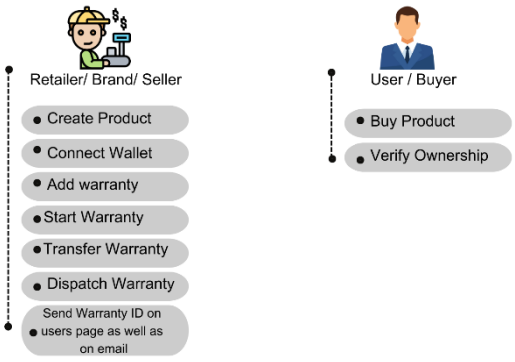


*Figure 4: Seller (Retailer) and Customer (User) Functions*

from the deployed contract which takes care of minting.

On minting WarrantyNFT, an email is sent to the customer with all the details about the product and its warranty using an EmailJS and the customer even gets to see his/her loyalty points and all the NFTs through his login. This happens by fetching live data from the blockchain and rendering in proper format from Frontend. This also proves that the customer owns all the NFTs which are displayed on his/her side because the backend only returns them if their owner is this customer. Also, the expired NFTs are filtered out. This way the user can no longer access the warranty which has expired. Expanding the NFT card shows some additional details like previous owners and claims. This is also done by fetching each of them individually and rendering from frontend. If the transfers remaining of the NFT is not 0 then the customer can transfer his product's WarrantyNFT by clicking the

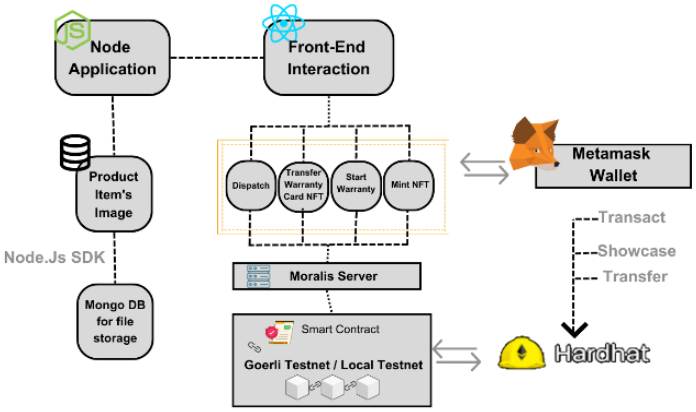


*Figure 5: High-level System Architecture 2*

Transfer button in the expanded view of NFT. This updates the data on blockchain, transfers the ownership of that NFT and sends an email to the receiver. After reloading, the customer will no longer be able to see that NFT.

The customer can claim the warranty by clicking the 'Claim' button in the expanded view of the NFT. After a successful claim, the claim timeline will be updated with the new claim data. This also happens by calling a dedicated function which handles the claim process and returns required data. When a customer buys a product and is issued a WarrantyNFT, he/she is awarded some points (Purchase Points) which is set by the seller at the time of deployment. If at the time of issuing warranty, the customer has points more than or equal to the Threshold Points, then he/she can use points and get an extra 100 days (Extra Warranty) of warranty period. After doing so, some points (Redeem Points) are deducted from the customer's total points. Note that in current implementation

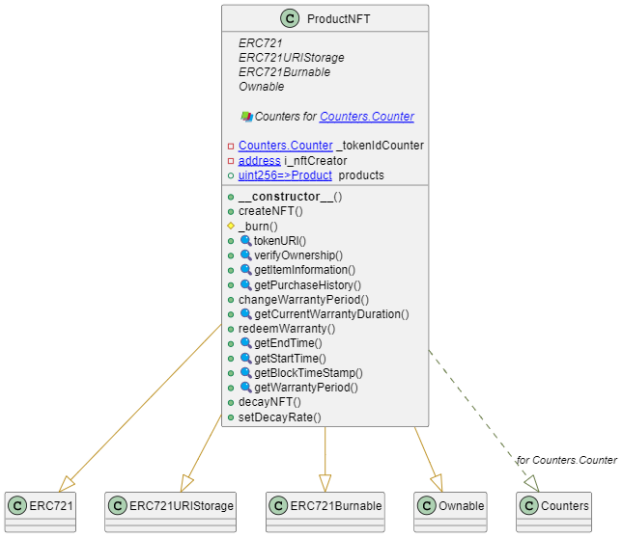


*Figure 6: UML Diagram of smart contract i.e. WarrantyNFT*

Purchase Points, Threshold Points, Extra Warranty and Redeem Points are set by the seller at the time of contract deployment.

Smart contract warrentyNFT which is for NFT and ERC721 is deployed on Ethereum's Goerli Testnet using Hardhat and Alchemy providers. Frontend is built on React and styled with CSS.

**IV. System Requirements**

The system implementation technologies are listed below
**Hardhat:** Hardhat is a development environment on the Ethereum network used for creating and testing smart contracts. It offers tools such as a local blockchain network, a testing framework, and a deployment pipeline to make development and testing of smart contracts easier.

To test and develop the contract, Hardhat might be used to compile and deploy it to a nearby blockchain network. Additionally, Hardhat offers a console interface for engaging with and evaluating the deployed contract's features.

Additionally, Hardhat is simple to integrate with current development workflows thanks to built-in support for well-liked developer tools like Truffle and Web3.js. Overall, the development process may be streamlined and the time and effort needed to create and test smart contracts can be decreased with the aid of Hardhat.

**MetaMask:** Users can communicate with Ethereum-based decentralised applications (dApps) and smart contracts via the well-known browser extension wallet known as MetaMask. MetaMask can be used to connect to the Ethereum network and communicate with the smart contract that has been set up on the network inside the context of the specified Solidity code.

Users may simply carry out operations and transactions thanks to MetaMask's user-friendly interface for engaging with smart contracts. Additionally, it handles transaction signing using the user's private key, giving users a safe means to communicate with smart contracts.

**Goerli Testnet:** It is a public Ethereum testing network that allows users and developers to test their smart contracts and Ethereum apps in a secure environment without using Ethereum itself. It is one of the many Ethereum testing networks accessible to Ropsten, Kovan, and Rinkeby. The Goerli test network was launched in 2019 thanks to the initiatives of many members of the Ethereum community. It uses a Proof-of-Authority (PoA) consensus mechanism, which allows fast and efficient block confirmation time. Applications, smart contracts and dApps built on Ethereum are typically tested and implemented using Goerli. Before being deployed on the main network, developers use it to test new functionality and network enhancements for the Ethereum network. It enables testing and evaluation of various frameworks, libraries and tools used in Ethereum development.

**JavaScript:** The programming language JavaScript is mainly used to create interactive web content. Both the client side (in a web browser) and the server side (with the help of tools like Node.js) can use JavaScript. It is often used to provide dynamic behavior of websites, such as modifying the page content based on user activities, verifying document entry, receiving data from servers and generating speech commonly used JavaScript for building online applications including single page and persistent web applications. An extensive range of libraries and frameworks enables developers to create amazing apps with lots of power. All things considered, JavaScript is a simple and essential language for modern web development.

**React and CSS:** React is a JavaScript framework for building user interfaces. It can be used to create web applications that communicate with smart contracts on the Ethereum network. Building modular and reusable components with React is straightforward and can be used to create a user interface that interacts with a smart contract. A web application created with React can have its user interface styled using CSS. This makes it possible to customise the user interface's design and theming. React can be used to develop the user interface of a dApp that communicates with a smart contract, and CSS can be used to style it.

Using Web3.js, a JavaScript tool for interfacing with the Ethereum network, the React application can call the smart contract methods. As a result, the user interface and the functionality of smart contracts can be seamlessly integrated.

**Node.Js:** Developers may run JavaScript code outside of a web browser thanks to Node.js, a JavaScript runtime environment. It offers a number of functionalities that are helpful for creating server-side applications, such as the capacity to manage network requests, work with files and directories, and communicate with databases.

Node.js can be used to create backend services that communicate with smart contracts that have been put on the blockchain in the context of Solidity code. To build a web application that can communicate with the Ethereum network, transmit payments to smart contracts, and access data from the blockchain, developers can use Node.js frameworks like Web3.js.

Additionally, command-line tools for deploying, testing, and interacting with smart contracts can be created using Node.js. Developers can create JavaScript scripts that install and test Solidity contracts on the blockchain using the Truffle framework, for instance. Node.js is an effective platform for developing decentralised applications and communicating with smart contracts. It may be used with other web development tools like React, CSS, and Web3.js to produce a full web-based solution.

**Solidity:** Solidity is an object-oriented language with JavaScript-like similarities that is meant to be easy to use, effective, and safe. Self-executing software programmes known as "smart contracts" automatically uphold the terms of an agreement, enabling trustless transactions and doing away with the need for middlemen. The Ethereum Virtual Machine (EVM) hosts the bytecode-compiled Solidity code, which may then be executed by network nodes.

**Moralis:** Developers may rapidly and easily build and expand decentralised applications with Moralis' backend infrastructure. It offers a collection of strong APIs that deconstruct and simplify the complexities of blockchain programming. Because Moralis handles the backend, developers can concentrate on creating the user interface for their application. It enables developers to easily create cross-chain apps because it supports a variety of blockchains, including Ethereum, Binance Smart Chain, Polygon, and more. For all of your needs in developing blockchain applications, Moralis also offers a variety of services like user authentication, storage, and real-time notifications.

## V. Result

In this section, we present the outcomes of the implemented prototype, highlighting the key functionalities and limitations of the blockchain-based Decaying Warranty system using NFTs.

### Implemented Features

#### 1. Product Registration and NFT Minting

The system successfully enables product registration, creating a digital identity for each product, and minting NFTs to represent the warranty associated with the product. As illustrated in Figure 1, the product registration process involves the input of essential product details, leading to the creation of a unique digital identity. This information is securely stored and associated with the NFT minted on the Ethereum blockchain using ERC721 standard.

#### 2. Product Sale and Warranty Verification

Figure 2 depicts the Client-Server Model, showing the smooth transfer of the NFT representing the product's warranty to the new owner upon the product's sale. The customer is able to verify the authenticity of their purchased products by the unique number received by E-Mail when purchasing the product, as outlined in the system's architecture. This process ensures the secure transfer of ownership and warranty details for the product, enhancing transparency and accountability.

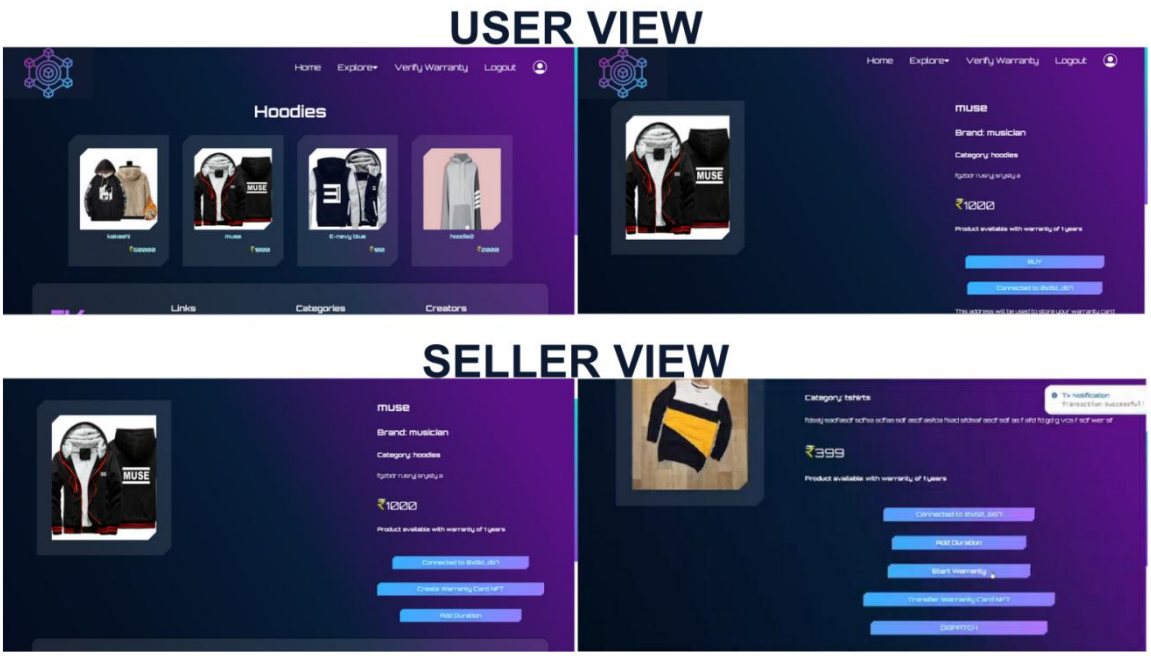


**Figure 7: The User and Seller Final View**

### 3. Warranty Claims and User Interface

As presented in Figure 3, the Seller (Retailer) and Customer (User) Roles Overview, the system facilitates the efficient processing of warranty claims, enabling customers to submit claims that manufacturers can authenticate using the associated NFTs. The intuitive web-based user interface supports seamless interaction between customers and manufacturers, ensuring a streamlined and user-friendly experience.

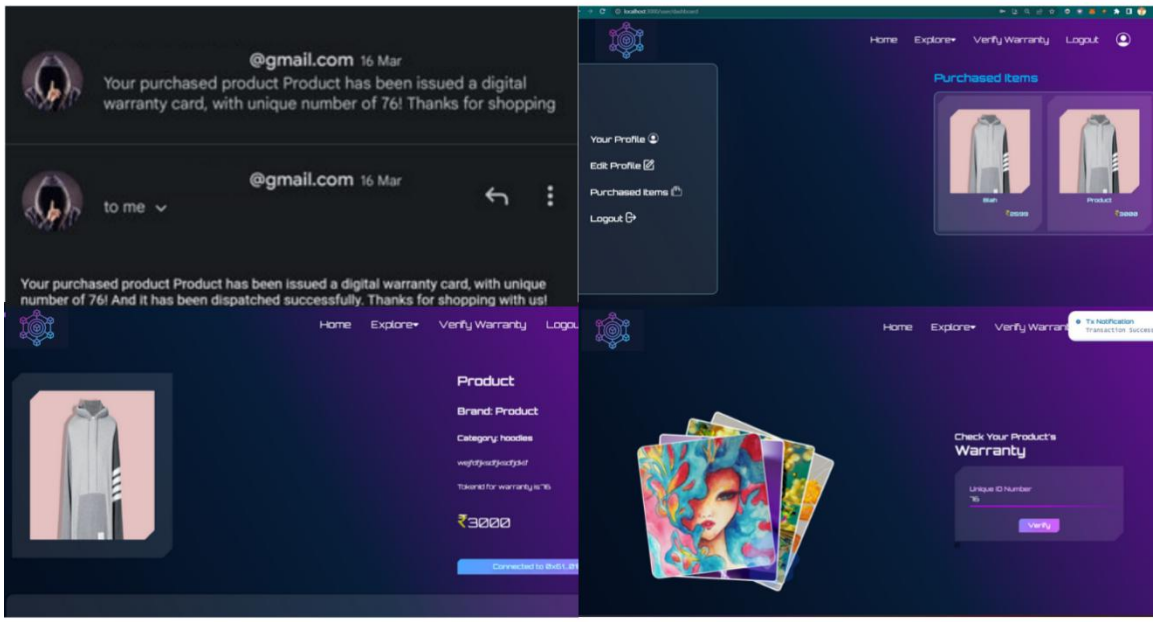


**Figure 8: The User and Seller Final View**

### Current Limitations

The implemented prototype demonstrates the following limitations:

**Single Seller Support**: The current version of the system only supports a single seller, restricting the platform's scalability and broader adoption, as depicted in Figure 9.

**Gas Fees for Transfer and Claim**: Users are currently required to pay gas fees for transfer and claim features, resulting in additional costs for certain transactions, as discussed in the proposed system architecture.

**Manual Deployment of Warranty Conditions**: Sellers are obligated to manually deploy warranty conditions on Hardhat, necessitating technical knowledge and manual input, as indicated in the proposed methodology. The retailer must have some knowledge about Web3 and how to deploy Smart Contract through code. As of now, the user/customer cannot redeem the digital warranty/NFT from the website.

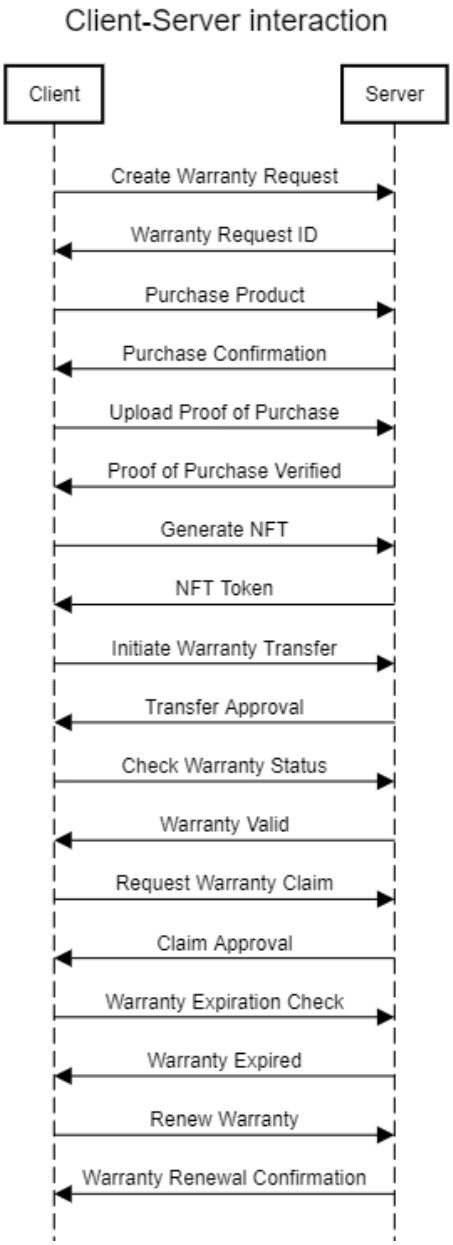


*Figure 9: Client-Server Interaction Model*

## VI. Future Enhancements

We are going to cut the small amount of gas fees which is required by the retailer while generating the warranty. Currently, the retailer has to connect its wallet and pay the gas fees, we are working on a way that will allow the creator of the platform to handle all these gas fees, connecting wallets and warranties.

We will be going to add other features like login from multiple devices, and add to the cart (Routes are already added in the code but we are unable to implement them due to time constraints). Integrating wallet with an email IDs thus reducing the friction for the mass usage of the technology by the general public.

We will be also going to add email verification and change the password to verify the account on signup. We are also willing to add payment integration in the future.

## VII. Conclusion

In this report, we propose a solution for a blockchain-based decaying system using NFTs as decaying. Our solution uses standard security features such as transparency, accountability, and non-repudiation with blocking. Our system design consists of decentralized and on-chain IPFS to strengthen trust in our NFT-based warranties. Our project is carefully designed to detect and eliminate warranty fraud and unauthorized users while automating the entire process. All variables have been carefully considered to prevent fraud. The on-chain provenance data ensures reliability and transparency. In addition, we offer a unique way to reward buyers and sellers with our unique loyalty program. We also perform security checks on our smart contracts to protect against vulnerabilities. As a challenge, there are some limitations that can be the focus of future research. Overall, blockchain is a powerful tool for tracking the integrity of NFT products. They provide a reliable way to verify the authenticity of an object by consuming its history.

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