Tokenized Warranty Based System For E-Commerce Platform Using Non-Fungible Tokens

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***Abstract*— The growth of online shopping presents challenges in warranty management due to tampering risks, limited transferability, and complex validation processes. This research proposes a blockchain-based solution using Non-Fungible Tokens (NFTs) to embed product expiry dates, employing a secure burning mechanism post-expiration. Integrated with IPFS for efficient data retrieval, the system introduces gamification elements to incentivize customer engagement, enhancing satisfaction with the warranty process.**

***Index Terms*— Online Shopping, Warranty Management, Blockchain Technology, Non-Fungible Tokens (NFTs), Secure Burning Mechanism, IPFS (InterPlanetary File System), Gamification**

I. Introduction

The rapid expansion of online shopping platforms has ushered in a new era of convenience and accessibility for consumers worldwide. However, with this convenience comes the challenge of effectively managing warranties for the myriad of products available online. Traditional warranty management systems often struggle to contend with issues such as tampering risks, limited transferability, and convoluted validation processes, leading to inefficiencies and frustration for both consumers and manufacturers alike. The current methods for detecting plant diseases typically rely on human expertise, involving manual observation and physical analysis. While this approach has been foundational in agriculture, it has inherent drawbacks that are increasingly difficult to ignore. It is time-consuming, labor-intensive, and costly, posing limitations on its scalability and efficiency. With the ever-growing global population and the subsequent need for increased food production, the inadequacies of these traditional methods become more pronounced. Thus, a pressing need has arisen for alternative, more efficient solutions.

To address these challenges, this research proposes a pioneering solution leveraging blockchain technology, specifically Non-Fungible Tokens (NFTs), to revolutionize warranty management in the digital age. By embedding product expiry dates within NFTs and implementing a secure burning mechanism post-expiration, the proposed system aims to ensure the authenticity and security of warranty claims while streamlining the validation process. Additionally, by integrating the InterPlanetary File System (IPFS) for storing NFT images and facilitating quick access to product details, the system seeks to enhance the efficiency and transparency of warranty management. Moreover, by incorporating gamification elements, such as rewards and incentives, the system aims to foster greater customer engagement and satisfaction, ultimately transforming the warranty process into a more seamless and enjoyable experience for all stakeholders involved.

II. Related Work

A. Modernizing E-commerce Warranties using Non-Fungible Tokens on the Blockchain

By: Aaliya Ali, Saransh Agrawal, Tanvi Pisalkar and Snehlata Dongre

The paper introduces a groundbreaking approach to streamline warranty management through the utilization of blockchain technology and Non-Fungible Tokens (NFTs). By integrating NFTs into the warranty issuance process, the system automates the generation of warranties, simplifying the overall process while ensuring decentralization, verification ease, and transparency. This innovative system offers a plethora of benefits, including protection against physical damage, providing concrete proof of ownership, guaranteeing authenticity, and enabling comprehensive tracking of the product's history. Through this cutting-edge solution, manufacturers and consumers alike can experience heightened efficiency, enhanced security, and greater trust in the warranty ecosystem.

B. Identification of Fake Products using Blockchain Technology

By: Nongmeikapam Thoiba Singh, Saurav, Vibhu Sharma, Abhishek Raizada, Shreya Sharma and Nishant Pathak

This research presents an innovative decentralized blockchain concept, highlighting the empowerment of

customers to independently verify product authenticity without solely depending on retail stores. The proposed system, devoid of counterfeit items, enables manufacturers to produce genuine products without the necessity of direct involvement from retail outlets. This streamlined approach not only eliminates the prevalence of fake goods but also alleviates the burden on manufacturers in ensuring product quality, consequently reducing associated costs.

C. System for Identifying Fake Product using Blockchain Technology

By: Roshan Jadhav, Altaf Shaikh, M. A. Jawale, A.B. Pawar and P. William

This study introduces a decentralized blockchain concept, emphasizing the ability of customers to authenticate products independently, diminishing reliance solely on retail outlets. The proposed system, void of counterfeit items, grants manufacturers the freedom to produce authentic goods without direct engagement with stores, thereby diminishing the expenses associated with ensuring product quality.

D. A Blockchain-Based Fake Product Identification System

By: Yasmeen Dabbagh, Reem Khoja, Leena AlZahrani, Ghada AlShowaier and Nidal Nasser

This paper advocates for a solution harnessing blockchain technology to instill confidence and confront the rampant issue of counterfeit goods. By integrating authentic product serial numbers into a secure blockchain ledger, manufacturers provide consumers with the means to validate product authenticity with confidence before completing their purchase. This approach not only ensures the integrity of data but also fosters a transparent and reliable environment where consumers can make informed decisions, ultimately bolstering trust between buyers and sellers in the marketplace.

E. Fake Product Identification with the Help Of Block Chain Technology

By: S Kalpana Devi, K Samy Durai, Karthik M Shri Balaji and J Ravi Kumar

This research introduces a novel approach leveraging decentralized blockchain technology to address the pervasive issue of counterfeit products within the online retail sector. Its goal is to empower consumers by enabling independent verification of product authenticity while diminishing dependence on intermediaries. The proposed system establishes a decentralized blockchain network dedicated to combating counterfeiting, thereby enabling manufacturers to distribute products directly without relying on traditional retail channels. This streamlined process not only enhances consumer trust but also results in significant cost reductions in quality assurance measures.

F. Product Authentication System using Blockchain

By: Rishit Nagar, Nitish Chaturvedi, Mr Prabakaran J

Utilizing blockchain's decentralized nature, the proposed method effectively mitigates third-party intervention and the proliferation of counterfeit goods. With the alarming rise in counterfeit products, particularly in the online domain, blockchain technology emerges as a formidable solution to enhance security measures. Product details, encrypted within QR codes, are securely stored as blocks on the blockchain network. Through the company's affiliated website, users can confidently authenticate products, thus fortifying the defense against counterfeit threats with a resilient and reliable solution.

G. One Time QR-Code for Fake Product Identification

By: Rezak Aziz, Soumya Banerjee, Samia Bouzefrane and Thinh Le Vinh

The paper introduces a novel approach to tackle counterfeit goods within the supply chain through a QR code-based system. This innovative solution involves linking products to a Firebase object, allowing customers to employ a mobile application for scanning QR codes and verifying the authenticity of products. By leveraging this method, the system aims to bolster security measures and enhance reliability, thereby offering a robust defense against counterfeit products infiltrating the supply chain.

H. NFT-Based Traceability and Ownership Management of Medical Devices

By: Senay A. Gebreab, Haya R. Hasan, Khaled Salah and Raja Jayaram

The paper proposes a cutting-edge solution empowered by blockchain technology and Non-Fungible Tokens (NFTs) to address traceability concerns within healthcare supply chains. By leveraging NFTs, the system ensures secure and transparent tracking of digital twins representing medical devices, effectively mitigating risks associated with data integrity and counterfeiting. With decentralized storage mechanisms, the solution guarantees lifecycle tracking of medical devices, thereby enhancing reliability. The proposal encompasses comprehensive details such as system architecture, implementation strategies, testing outcomes, and a meticulous cost-security analysis, presenting a holistic approach towards revolutionizing traceability in healthcare supply chains.

I. An Ethereum based Fake Product Identification System using Smart Contract

By: Balasubramani S, Soumen Pramanick , Rohit Singh, Dhananjay Kumar

The paper advocates for the utilization of blockchain technology to combat the proliferation of counterfeit products, safeguarding brand integrity. Through the implementation of a blockchain-based system, unique serial numbers are assigned to products and securely stored within the blockchain network. This allows users to autonomously verify product authenticity by cross-referencing codes with the blockchain ledger, thereby receiving instant confirmation or alerts regarding potential counterfeit items. Such a system not only strengthens brand protection efforts but also empowers consumers with the ability to make informed purchasing decisions.By leveraging blockchain technology, the proposed system establishes a transparent and immutable record of product ownership and history, enhancing trust and accountability throughout the supply chain.

J. NFTs for Open-Source and Commercial Software Licensing and Royalties

By: Mohammad Madine,Khaled Salah,Raja Jayaraman,Jamal Zemerly

This paper introduces a decentralized system that utilizes blockchain and NFTs to manage software licensing and royalties. The system aims to safeguard software ownership, facilitate direct payments, and ensure fair distribution of royalties. By leveraging blockchain technology and NFTs, the proposed system offers enhanced security and transparency in software transactions. It enables software creators to assert ownership rights, receive direct payments from users, and ensure that royalties are distributed equitably among all stakeholders. This innovative approach simplifies the licensing process, minimizes disputes, and promotes a more efficient and fair ecosystem for software developers and users alike.

III. Proposed Methodology

A. Overview

The proposed system introduces a novel approach to warranty management, leveraging blockchain technology and Non-Fungible Tokens (NFTs) to enhance transparency and security in online shopping. This innovative solution eliminates the need for traditional databases and simplifies ownership verification and warranty transfers for buyers and sellers. Through the integration of blockchain and NFTs, the system sets a new standard for trust and reliability in online shopping, promising a seamless and secure experience for all stakeholders involved.

B. Modules

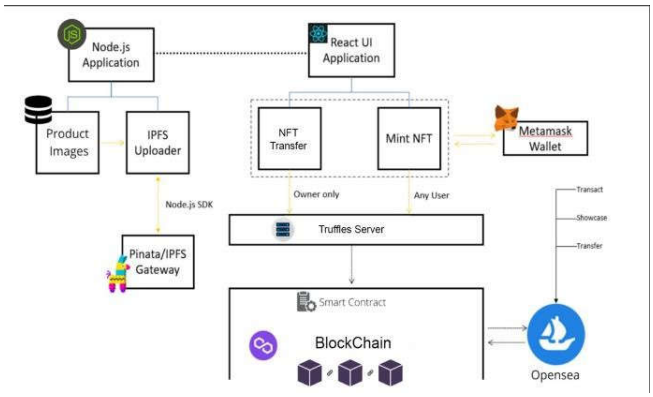

Fig. 1. Architecture Diagram

Fig 1 shows the flow of the process that takes place after an order for an eligible item has been placed. The product images is uploaded to Inter Planetary File System (IPFS).

IPFS, i.e. Inter Planetary File System is a distributed system for storing and accessing files, websites, applications, and data on the blockchain network. For storing and accessing data and files on IPFS, a gateway is needed. In this case, Pinata Cloud was used. The metadata is generated and stored in a Javascript Object Notation (JSON) file which is uploaded along with the image on the Pinata cloud using the NodeJS Pinata Software Development Kit (SDK). The image along with the metadata is now present on the Pinata cloud. The next step here is to generate and mint the warranty NFT. On the blockchain network, an ERC721 smart contract is deployed that is transferable, ownable, and allows minting NFTs with unique token IDs. The smart contract needs the wallet address (from which the NFT should be minted), the receiver wallet address (to which the NFT will get transferred after getting minted, which in our case is the customer's wallet Address), a token ID (a uniqueID for each NFT in the collection), and an IPFS gateway Uniform Resource Locator (URL) for metadata which includes the generated image's gateway URL. After passing these parameters programmatically, the NFT gets minted. For minting the NFT, the mint-NFT API call is triggered and ABI (Application Binary Interface defines the methods and variables that are available in a smart contract which are used to interact with the smart contract) of the smart contract is passed to the function to interact with the specific smart contract we want. Upon successful minting of the NFT, the user can check their wallet to verify they've received the warranty NFT. One way of doing this is checking it on OpenSea(an NFT Marketplace) i.e on the Polygon Mumbai Testnet currently. Another way to verify holding is through the MyWarranty section present on the Ecommerce website. It uses Alchemy-SDK which requires the private key and the type of network on which the smart contract is deployed and from which the NFT is minted. The fetch API will return a list of all valid NFT warranties owned by the user. ERC721 is a standard for representing ownership of non-fungible tokens, that is, where each token is unique. This provides the user with a method to prove the ownership of the product.

Technology stack and Tools involved in the proposed system – NodeJS, MongoDB(for storing user and order details), Pinata Cloud and Pinata SDK(For uploading images and metadata to IPFS), Polygon(Mumbai testnet for low fee NFT minting), Metamask (Crypto Wallet used to hold and swap crypto assests), Opensea (NFT marketplace), ERC721 Token Standard(Smart Contract for NFT), Alchemy API(for fetching a particular user's NFTs).

C. Methodology

The proposed system is an e-commerce platform that integrates the sale of physical products with non-fungible tokens (NFTs) and warranty management. The workflow commences with the seller initiating the process by uploading product details and creating an associated NFT, which carries a warranty for the physical product(see Fig 2). This NFT is then linked to the product, effectively establishing a digital representation and ownership record. Once the product is listed on the marketplace, it becomes visible to potential customers. Upon selecting a desired product, the customer can proceed with the purchase.

At this stage, a gamification element is introduced in the form of a spinning wheel game. The outcome of this game determines the number of days by which the product's warranty expiry date is extended, incentivizing customer engagement. Following the purchase, the NFT ownership is transferred to the customer, granting them verifiable digital ownership of the product. The customer receives an email containing the purchase details and relevant metadata. Additionally, a dedicated "My Orders" page is available, allowing customers to view their order history, warranty information, repair logs, and explore resale options.

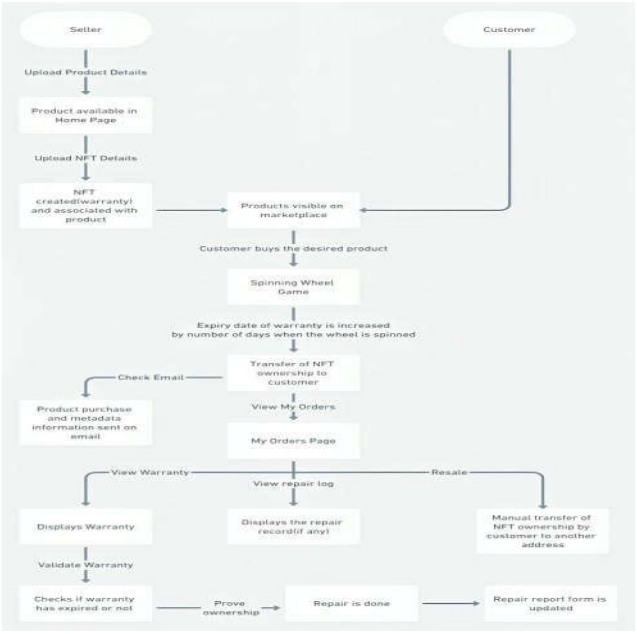

Fig. 2. Proposed Model

The warranty management aspect of the system is facilitated through various features. Customers can view and validate the warranty status, ensuring transparency regarding its expiration. If ownership verification is required, the customer can initiate the "Prove ownership" process, which leverages the immutable nature of the NFT ownership records. In the event of a product repair, the customer can initiate the repair process, and the system will update the repair report form accordingly. The repair log is accessible through the "View repair log" option, providing a comprehensive record of any maintenance or repairs performed on the product. Furthermore, the system enables customers to resell their products by manually transferring the NFT ownership to another address, facilitating seamless ownership transfer and potential resale opportunities.

IV. WORKING

The working of our prototype can be understood as per the following steps:

A. Product Listing and NFT Creation:

Sellers kickstart the process by furnishing comprehensive details about the physical product. An associated non-fungible token (NFT) is generated, housing the product's warranty information. This NFT is intertwined with the physical product, establishing a digital counterpart and ownership trail. Subsequently, the product is showcased on the e-commerce platform, enhancing visibility for potential buyers zero.

B. Customer Purchase and Warranty Extension:

Customers navigate through the marketplace and select their desired product. Upon purchase, a captivating gamification feature, such as a spinning wheel game, is presented. The outcome of this game dictates the extension duration of the product's warranty expiration date. This fosters customer engagement and adds an interactive dimension to the purchasing journey.

C. NFT Ownership Transfer and Order Management:

Post-purchase, ownership of the NFT is transferred to the customer, providing verifiable digital ownership of the product. The customer receives a detailed email containing purchase specifics and pertinent metadata. A dedicated "My Orders" section empowers customers to peruse their order history, warranty details, repair logs (if applicable), and explore potential resale avenues.

D. Warranty Management and Repair Tracking

Customers effortlessly verify the warranty status of their purchased products. For ownership validation, customers can initiate the "Prove Ownership" process, leveraging the immutable nature of NFT ownership records. In the event of product repairs, customers can trigger the repair process, with the system duly updating the repair report form. The repair log, accessible through the "View Repair Log" option, provides a comprehensive record of all maintenance or repairs conducted on the product.

V. RESULTS

A blockchain-based eCommerce warranty system that uses special digital stickers called Non-Fungible Tokens (NFTs) to handle warranties. These NFTs act like virtual warranty cards that are generated in real-time for products. When someone buys a product with a warranty, they get a digital sticker (NFT) [see Fig 3], instead of a paper warranty card. This sticker is unique to them and can be easily managed on our website.

In our system, a blockchain smart contract serves as the backbone, allowing users to easily prove ownership of their purchases. This smart contract not only provides a secure way to demonstrate ownership but also acts as a repository of essential information such as purchasing history, warranty duration, and other item specifics. When a customer makes a purchase, a warranty card containing the item's token id, serial number is automatically generated.

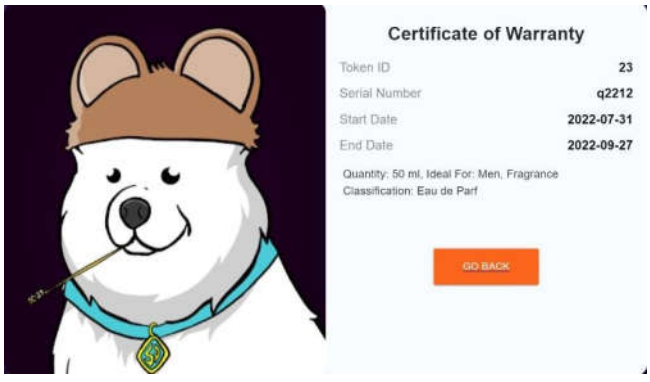

Fig. 3. Sample warranty image.

Moreover, we've incorporated a unique feature into our system where NFTs, representing warranties, gradually lose their validity over time. This decay mechanism ensures that after a certain period, NFTs become ineffective for redeeming warranty benefits offered by the brand or retailer. Additionally, to streamline operations for brands and retailers, we've

developed a user-friendly GUI-based tool that requires no knowledge of blockchain programming. Furthermore, we've enhanced customer engagement by adding gamification elements to our loyalty program, allowing users to earn rewards and bonuses through various activities and games.

Earlier, Digital warranties used to be transferable, but the process was a hassle with lots of paperwork. To transfer a physical warranty, you had to gather documents like proof of ownership and details of the old and new owners. Our solution makes this easier by simplifying the whole process. With just a few clicks, you can issue, transfer, and verify warranties. Plus, expired warranties are sent to a place where no one can access them.

The proposed solution comes with the following benefits:

1) *Protection against physical damage:* Unlike traditional warranties, warranty NFTs aren't on paper, making them immune to physical harm or tampering.
2) *Proof Of Ownerships:* With an NFT, a user can easily prove his/her ownership of a product.
3) *Authenticity:* Since blockchain data is unchangeable, NFTs remain authentic and tamper-proof.
4) *Product history tracking:* NFTs simplify product history tracking, to know how old a product is and if the warranty still holds valid.
5) *Easy ownership transfer:* When reselling, transferring ownership is as simple as moving the warranty NFT to the buyer's wallet address, eliminating the need for paperwork.

Therefore, our solution makes managing warranties easy. It keeps your items safe, proves you own them easily, and lets you transfer ownership without any hassle. It's a simple way to handle warranties, making life simpler for everyone involved.

VI. Conclusion

Using blockchain and NFTs for warranties is a better way compared to traditional methods like physical documents or cloud-based systems. This study introduces how NFTs on blockchain can track product warranties effectively. With this system, problems with managing warranties in the real world are solved. Customers can use digital NFTs to prove they own a product and verify its authenticity. They can also get both physical products and digital versions, which adds extra assurance. These NFTs make it easy to check, transfer ownership, and expire when the warranty ends.

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