Blockchain-Based E-Commerce Warranty Systemusing NFTs

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***Abstract*—**The use of Non-Fungible Tokens (NFTs) in online markets can help solve several challenges related to buying and selling products online, especially luxury or high-end items. Thesechallenges often revolve around concerns about authenticity. Digital warranties provided through NFTs can offer customers greater confidence while making purchases by providing infor- mation about the item's history, warranty, and other details. When a customer transacts using our application, the NFTs associated with the purchased item are sent to their account. Asset tokenization, where NFTs represent trading assets, can help combat the proliferation of fake goods. By implementing digital warranties, brands can better protect against counterfeit products. Consumers may be more inclined to choose authentic products if digital warranties become a standard practice in the industry, signaling that products without an NFT-backed guarantee are likely not genuine. Some merchants may request assurances from franchises of brands, allowing retailers to source certified imports from other countries even without the explicit consent of the brand. Brands can also collaborate to adopt digital warranty solutions and address counterfeiting issues inthe industry. However, widespread adoption of this solution within the broader blockchain community is still lacking, and challenges persist despite the significant potential of NFTs, whichare experiencing rapid growth in the marketplace.

***Index Terms*—**NFT, Blockchain, Tokens, Warranty

I. Introduction

Purchasing luxury items online can be risky due to concerns about authenticity. Digital warranties give customers peace of mind by including the item's serial number and sending it to their smartphone. These warranties also offer details about the item's purchase history and warranty terms. When customers use our application to make a transaction, Non-Fungible Tokens (NFTs) are sent to their account. Asset tokenization, achieved through NFT creation, can effectively combat counterfeit goods.

NFTs serve as a mechanism to track and confirm owner- ship of unique assets, whether digital or physical. They can represent many objects like art, contracts, music scores, books, or real estate. Since NFTs operate on a blockchain, they are secure from tampering or seizure by malicious parties.

Blockchain technology is the underlying protocol that records and stores data across multiple computers, called nodes. Each block in a blockchain consists of encrypted digital transactions, and each block is linked to the next using cryptographic signatures. The blockchain replicates the most recent transactions across all blocks, ensuring a transparent and immutable record of data.

A. Blockchain

Blockchain, a decentralized digital ledger, ensures im- mutable transaction records through cryptographic signatures. Consensus mechanisms like proof of work and proof of stake authenticate transactions, enhancing security. Beyondfinance, blockchain finds utility in asset management, supply chain tracking, and digital identity verification due to its transparency, decentralization, and security features (Chhaliyal et al., 2023).

B. NFTs

An NFT, or Non-Fungible Token, uniquely validates owner- ship or authenticity of specific digital or physical items. Unlike cryptocurrencies like Bitcoin or Ethereum, NFTs are distinct and non-interchangeable, each possessing unique properties. Commonly used for digital artwork, collectibles, and virtual real estate, NFTs are securely stored on a blockchain, guaran- teeing transparent ownership and transaction records.

C. Tokenization

Tokenization involves converting asset entitlements into dig- ital tokens on a blockchain. These tokens represent ownership or access rights to the underlying asset, enabling fractional ownership and facilitating investment and trading in other- wise illiquid assets. Tokenizable assets range from real estate and artwork to stocks, bonds, commodities, and intellectual property. By utilizing blockchain, tokenization ensures trans- parency, security, and efficiency in asset management and ownership transfer.

D. Warrenty

A warranty is a commitment from a seller or manufacturer to a buyer, ensuring that a product meets defined quality, performance, or condition standards. Warranties typically cover material or workmanship defects and vary in duration and coverage based on product type and seller/manufacturer terms. They provide consumers with assurance that they can seek repair, replacement, or compensation if the product does not meet specified standards during the warranty period.

E. E-Commerce

E-commerce has evolved with blockchain integration, ensuring secure transactions and trust through non-fungible tokens (NFTs). NFTs serve as digital warranties, guaranteeing authenticity and quality for purchases by recording product history, warranty info, and ownership securely on the blockchain. This enhances consumer confidence, fights counterfeit goods, and streamlines processes, driving blockchain adoption in e-commerce.

II. Problem Statement

Traditional e-commerce warranty systems face numerous inherent limitations that hinder their effectiveness and undermine trust between buyers and sellers. These challenges encompass:

1. Centralization and Intermediaries: Big companies or middlemen handling warranty claims lead to slow and costly processes, risking system crashes.
2. Lack of Transparency: Complex warranty terms make it hard for customers to understand and trust the system, affecting e-commerce site credibility.
3. Fraudulent Activities: Weak checks on claims and documents enable fraudulent practices, harming both businesses and genuine customers.
4. Inefficiencies and Cost Overheads: Paper-based processes result in errors and high expenses, frustrating customers with delays and complications.
5. Complexity and Fragmentation: Varied warranty rules across e-commerce sites confuse customers and businesses, hindering efficient warranty utilization.
6. Limited Options for Consumers: Predefined warranty packages restrict consumer choice and customization, reducing satisfaction and flexibility.
7. Customer Support Challenges: Cumbersome and slow customer support exacerbates frustration and dissatisfaction with warranty processes.
8. Risk of Data Privacy Breaches: Centralized storage of warranty data increases the risk of privacy breaches, undermining trust and raising security concerns.

III. Literature review

Modernizing E-commerce warranties using Non-Fungible Tokens on the Blockchain" by Ali et al. (2023) pointed out the drawbacks of physical and digital warranties. by making use of NFTs on the blockchain. This paper also suggested the progression alongside the benefits that the suggested system has over the conventional method.

TABLE I
Literature review table

Title	Methodology	Observation/Remark
Paper:-IARJSET International Advanced Research Journal in Science, Engineering and Technology Author:- Gaurav Chhapliyal, AnkushGupta, Nikhil Mathur Year:- 02, Feb-2023	NFTs are traded across various platforms and are expanding into diverse sectors. They're utilized in education for certification, in fashion for item identification, and in sports for innovative income streams like basketball card sales.	Disadvantages:- NFTs face challenges such as the absence of standardized security for smart contracts, ambiguity surrounding intellectual property rights, the potential for fraud through artist impersonation, compromised user privacy and security, and notable environmental impact due to high energy usage.
Paper:-A Behaviouristic Semantic Approach to Blockchain-based E-Commerce Author: G.Bella.D.Cantone. M. Nicolosia and D.F.santamaria Year:- 17, July 2023	Our platform is an aggregator for e-commerce, retailers, and customers to manage warranties via blockchain. It simplifies the process for all users, requiring minimal blockchain knowledge. With just a valid Metamask wallet and Ethereum balance, anyone can utilize our services.	Conclusion:- By integrating blockchain, we've revolutionized our e-commerce, enhancing security, transparency, and efficiency. We're committed to leveraging blockchain for innovation, enriching customer experiences, and leading in e-commerce..
Paper:-Blockchain-Based E-Commerce: A Review on Applications and Challenges Author:- Hamed Taherdoost and Mitra Mandanchaian Year:- 17, April-2023	In e-commerce, blockchain technology offers numerous benefits, aiding firms in overcoming challenges. Applications leveraging blockchain enhance synergy efficiency, streamline processes, and reduce operating costs. These advantages are particularly evident in supply chain management and the banking sector.	Advantages:- Blockchain in e-commerce extendsto various sectors like sustainability, logistics, and finance. However, further research is needed to address additional challenges and develop effective evaluation models for its impact.
Paper:-A Blockchain-based, Semantically Enriched Software Framework for Trustworthy Decentralized Applications Author:- T.G.Papaioannou, Petar Kochovski Year:-12, July- 2023	This paper outlines the ONTOCHAIN blockchain software framework, covering its existing functionality and providing references. We also showcased some features. Future plans include deploying various Dapps on ONTOCHAIN, like semantic digital logbooks for companies and buildings.	Advantages: Key areas benefiting from blockchain include data credibility in online content, decentralized social networks, energy data management, traffic control, logistics/supply chain integrity, remotework and presence,fair data markets, and healthcare data sharing.

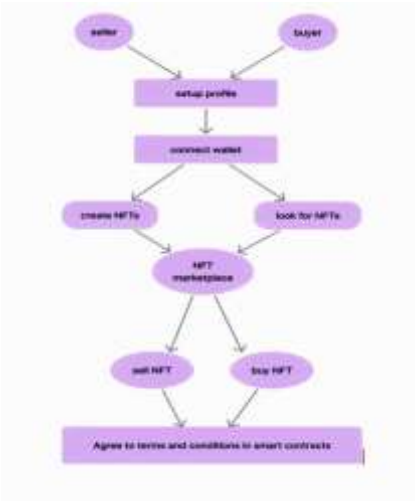

Fig. 1. Methodology Overview

IV. Methodology

Warranty management is a critical aspect of product life-cycle management. Traditional warranty systems often suffer from opacity, inefficiency, and susceptibility to fraudulent claims. Non-Fungible Tokens (NFTs), Leveraging blockchain technology, it provides a decentralized and transparent methodology for managing warranties. In this methodology, we outline the steps required to integrate NFTs into warranty systems effectively.

To begin, during the customer purchase phase, relevantdata such as product type, purchase date, customer details,and transaction identifiers are collected using point-of-sale(POS) systems or e-commerce platforms. Following this, an NFT representing the product's warranty is generated ona blockchain platform like Ethereum, embedding warrantyterms and conditions within the NFT metadata. This NFT is then linked to the specific purchase transaction using APIsor smart contracts to ensure secure and verifiable linkage.Details about the purchased product, including serial numbers, specifications, and model details, are recorded alongside the NFT and purchase data.

Upon completion of the sale, ownership of the NFT is transferred to the buyer through secure transfer mechanisms, with validation of the recipient's identity to prevent unauthorized access. Subsequently, warranty coverage is activated based on NFT ownership, with validation against the purchase record and definition of warranty terms within the NFT.

In the event of a warranty claim, information such as timestamps of claim submissions, detailed descriptions of the issue, and relevant evidence like photos or videos are recorded. Smart contracts are utilized for claim verification, automatically assessing claims against predefined rules to ensure transparency and immutability through blockchain. Following successful verification, records are updated to reflect the claim status, with an audit trail maintained for accountability.

Data analysis focuses on patterns related to warranty activation and claims, including activation frequency, time taken for activation after purchase, frequency of claims, and average resolution time. Additionally, the effectiveness of smart contract-based claim verification is evaluated to assess its impact on reducing human error and streamlining the process.

Expected outcomes of implementing NFT-based warranty systems include enhanced transparency, improved visibility into warranty processes for both customers and manufacturers and reduced asymmetry of information. Furthermore, fraud reduction is anticipated through blockchain's immutability, which prevents fraudulent claims and increases trust in the warranty system.

In conclusion, incorporating NFTs into warranty systems represents a paradigm shift in warranty management. By following this methodology, organizations can create a robust, transparent, and efficient warranty management framework. Further research and real-world implementations will refine this approach and contribute to the evolution of warranty practices.

V. Proposed System

The objective is to replace traditional physical warranties with blockchain-based warranties using Non-Fungible Tokens (NFTs). This involves several key aims:

1. Track Repairs and Replacements: Implement a system where users can track the repair and replacement history of products through the associated NFT warranty. The NFT warranty would decay after a certain period of use, reflecting the wear and tear of the product and indicating eligibility for warranty benefits.

2. Fraud Detection: Utilize NFT verification mechanisms to prevent fraud before purchasing products. By verifying the authenticity of the NFT associated with the product, potential buyers can ensure they are acquiring genuine items with valid warranties.

3. Provide Purchase History and Item Information: Enable access to detailed purchasing history and item information through the NFT warranty. This information would offer transparency to buyers, allowing them to make informed decisions based on the product's background and previous ownership.

4. Claim Warranty Services: Facilitate a straightforward process for users to claim warranty services on their products. As soon as a product goes out of warranty, the associated NFT warranty would decay, signaling the end of warranty coverage.

5. Transfer Warranty Upon Resale: Streamline the transfer of warranty and related documents with a simple click when a product is resold. This ensures that the new owner inherits the remaining warranty coverage seamlessly, reducing the complexity and administrative burden for both sellers and buyers.

6. Reduce Intermediaries: By implementing blockchain-based NFT warranties, the number of intermediaries involved in warranty processes can be reduced. This streamlines the warranty management process, leading to greater efficiency and cost savings for businesses and consumers.

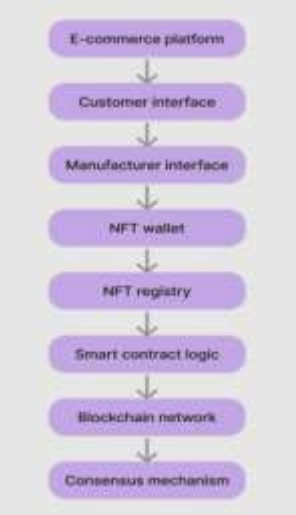

Fig. 2. Proposed System Architecture

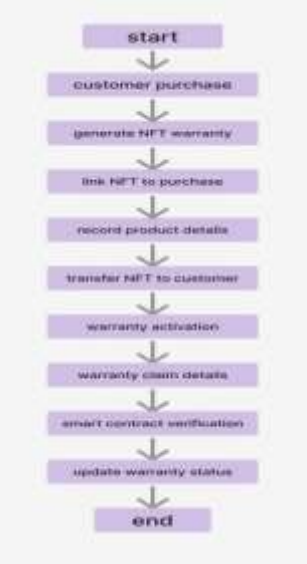

Fig. 3. Workflow Visualization

VI. WORKFLOW

Upon a customer's acquisition of a product from a seller, that product has a unique product ID and NFT token that the seller can use to sell the product to the customer and resellit. For the customer to claim the product's warranty, the seller provides NFT tokens for the product. Using a smart contract on the Ethereum Blockchain to grant a product warranty. A warranty for products delineates its duration and terms, ensuring assurances on quality and performance. In the realm of blockchain, reframe:

1. Start: - The workflow begins with the initiation of the purchase process by the customer.

2. Customer Purchase: - The customer purchases a product from the manufacturer or seller.

3. Generate NFT Warranty: - Upon purchase, the manufacturer generates a Non-Fungible Token (NFT) that represents the product's warranty.

4. Link NFT to Purchase: - The NFT is then linked to the specific purchase transaction, establishing a verifiable connection between the product and its warranty.

5. Record Product Details: - Details about the purchased product, such as serial numbers, specifications, and model details, are recorded and associated with the NFT and purchase data.

6. Transfer NFT to Customer: - The manufacturer transfers ownership of the NFT to the customer, confirming the activation of the product's warranty.

7. Warranty Activation: - Upon receiving the NFT, the customer activates the warranty coverage associated with the product.

8. Warranty Claim Details: - If the customer encounters any issues with the product within the warranty period, they can submit warranty claim details, including timestamps of claim submissions, issue descriptions, and relevant evidence.

9. Smart Contract Verification: - The warranty claim details are verified using smart contracts, which automatically assess the validity of the claim against predefined rules and conditions.

10. Update Warranty Status: - After successful verification, the warranty status is updated, reflecting the outcome of the claim process (e.g., approved, rejected). Additionally, an audit trail of all changes is maintained for transparency and accountability.

11. End: - The workflow concludes with the completion of the warranty claim process, ensuring customer satisfaction and adherence to warranty terms.

This workflow ensures a structured and transparent process for managing warranties using NFTs, from purchase and activation to claim verification and status updates. By leveraging blockchain technology and smart contracts, the system enhances efficiency, security, and trust in the warranty management process.

VII. RESULT AND ANALYSIS

Upon customer acquisition, each product is assigned a unique product ID and NFT token by the manufacturer or seller. This NFT token serves as the product's warranty, allowing customers to claim warranty coverage. Leveraging a smart contract on the Ethereum Blockchain, the process beginswith the purchase, followed by NFT generation and link- ing to the purchase transaction. Product details are recorded and associated with the NFT, which is then transferred tothe customer, activating the warranty. Customers can submit claims, verified via smart contracts, with outcomes updating the warranty status accordingly. This streamlined approach ensures transparency and efficiency in managing warranties, enhancing customer satisfaction and trust in the process.

The homepage in Fig. 4 prominently features product registration and contact sections, designed with a user-friendly interface for effortless navigation. Clear call-to-action buttons

Fig. 4. Home page

Fig. 5. Company portal of the website

encourage users to delve deeper, streamlining product searches and facilitating swift purchases.

The company portal in Fig. 5 serves as a centralized hub offering vital information and resources for employees, facilitating seamless internal communication and access to registered products. It comprehensively houses data pertinent to each registered product, including details like material composition for clothing items or specifications for smartphones. Organized into individual cards, the portal provides in-depth product information within a user-friendly interface, enhancing accessibility and workflow efficiency.

The Add Product page in Fig. 6 offers a platform to input detailed information about each registered item, encompassing name, serial number, recipient's Metamask address for sale, validity duration, terms, and product type. Users navigate through categories, view high-quality images, and submit items to the company portal. This ensures the specified user

Fig. 6. Add product details on the company portal page

Fig. 7. Metamask setup for transferring ETH tokens

Fig. 8. Product details page

can view the product before its validity expires, facilitating a seamless shopping experience.

fig.7 depicts the successful transfer of ETH tokens from the company to the specified customer, facilitating the delivery of the product added to the company portal. In MetaMask, the address is also known as the Ethereum address or wallet address. It is a unique identifier composed of a string of alphanumeric characters (usually starting with "0x") that represents a user's digital wallet on the Ethereum blockchain. This address is used for sending, receiving, and storing Ethereum (ETH) and other ERC-20 tokens, as well as for interacting with smart contracts and decentralized applications (DApps).

The customer side, they receive a confirmation indicating the successful transfer of ETH tokens from the company. This signifies that the product they added through the company portal is now being sent to them.

In fig.8, the details of the product added by the company are displayed, including its name, specifications, and any additional information provided. This allows the customer to review and verify the details of the product before completing the transaction. Along with the product details, the date and time of purchase, as well as the validity period, are also displayed. This ensures transparency and enables the customer to track when the purchase was made and how long the product is valid for.

VIII. FUTURE SCOPE

1. Enhanced Webpage Integration with Intelligent Contracts:- Explore the integration of intelligent contracts directly within the webpage to streamline processes and enhance automation.

2. Categorization of NFTs: - Develop a robust categorization system to organize NFTs into different categories based on product types, warranty durations, or other relevant criteria. This would facilitate easier navigation and management of NFTs.

3. GUI for Manufacturer-Driven NFT Creation: - Implement a user-friendly graphical interface (GUI) that allows manufacturers to easily create NFTs without the need for coding knowledge. This would democratize the creation process and encourage broader adoption among manufacturers.

4. Engagement Features Integration: - Integrate engagement features like Scratch Cards and Loyalty programs to incentivize user participation and increase customer engagement with the warranty system. This could include gamified experiences and rewards for active participation.

5. Wallet-Free Individual Access: - Explore alternative authentication mechanisms that allow individuals to interact with NFTs without requiring blockchain wallet accounts. This could involve token-based authentication or integration with existing authentication systems.

6. Scalability Solutions for Small Items: - Investigate scalability solutions to overcome limitations in using NFTs for smaller items or low-value products. This could involve batch processing, aggregation of items, or optimization techniques to improve efficiency and scalability.

IX. CONCLUSION

According to theoretical analysis from existing literature, Blockchain Technology presents significant potential in addressing various challenges related to data integrity, transparency, security, fraud reduction, and trust establishment across numerous industries. Its transformative impact is anticipated across finance, accounting, e-government, business process management (BPM), insurance, entertainment, trading platforms, healthcare, the Internet of Things (IoT), law firms, and more. Despite its promise to drive economic efficiency and societal benefits, implementing blockchain technology in businesses across various sectors can be prohibitively expensive. Non-Fungible Tokens (NFTs), leveraging blockchain technology, particularly Ethereum, offer transparency, traceability,and security. Their unique characteristics enable novel usecases, such as exclusive ownership of digital assets, facilitating authentication, and tracking of asset ownership. However, the burgeoning popularity of NFTs brings challenges such as the lack of standardized security measures for smart contracts, uncertainties surrounding intellectual property rights, fraud risks linked to artist impersonation, transparency compromising user privacy, and environmental concerns due to high energy consumption.

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