Blockchain-Based Product Identification and Verification System For E-commerce

By
Sidharth K, 231040
Anandu S Nair, 231011

Abstract

The advancement of E-commerce and the consequent frequent dealing between strangers have created a high need for ways to authenticate products' genuineness and assurance for the buyer. In this project, the following challenges are identified as an opportunity to create a blockchain solution for this business model.

The concept we use in our system is to come up with global unique product identification where each product is given a unique ID which is saved in a blockchain. It thus combines these identifiers with other pertinent data about the products, which are placed in the blockchain to essentially provide a shielded product identification system. Consumers can obtain these identifiers from the E-commerce platform; this provides the customers with the assurement of originality of the product.

Once a product has been successfully delivered, there is a transfer of ownership in the blockchain, noting that a product has been sold. This status change is initiated by the E-commerce platform, while keeping the customer database sealed and still delivering the correct ownership status of the products. Advantages of the designed system include combating counterfeiting, establishing and increasing the transparency of the supply chain, and improving customer confidence. When applied in E-commerce, our intention is to lock in blockchain technology to produce a safer and much more credible platform for conducting business electronically.

2. Introduction

The technological advancement of E-commercial has changed the way people reach out for the products they want, many even with the comforts of their own living room. But this is a disadvantage of having fakes all in the name of convenience because these are the consequential effects that are dangerous to the consumers as well as affect the image of genuine traders. Since counterfeiters are continually improving on their methods of product imitation, traditional approaches to product verification may not hold water.

E-commerce in general has been on the rise and so has the incidence of Counterfeiting within this particular industry. Pseudo products, counterfeit, fake documents and other forms of fraud and forgery are common in E- commerce platforms since there are few physical checks and inspections. There are different ways that the fake traders employ to defraud the consumers, including the creation of fake sites that resemble an official brand site, with an aim of selling tampered, substandard, and counterfeit products to more consumers online, opening several sites on the same E-commercial platform to avoid quick identification of his/her illicit activities .

The main challenges outlined here suggest that blockchain technology is a feasible solution given that it is both secure and transparent. It is important to note that by using blockchain, it is possible to design such a system of records that can keep track of products' origin and prevent counterfeit goods from entering the market. This system will limit the cases of fake goods, which makes the consumer place their trust in E-commerce channels.

2. Literature review

2.1 Counterfeiting in E-commerce

Counterfeiting in E-commerce leads to a number of problems, including: Brands being associated with fake goods and therefore suffering a blow to their overall reputation and financial loss due to loss of sales revenue from fake products that customers have bought instead of the original genuine products. To address this

single most problem, several approaches have been made; for instance, the availability of anti-counterfeiting tools from E-commerce firms, the inclusion of anti-counterfeiting in IP plans, and the use of machine learning techniques in deep learning to identify counterfeits on the E-commerce platforms.

EU SME affected by counterfeiting through the sale of counterfeits on E-commerce platforms in India can undertake particular measures such as conducting market research in a bid to discover where counterfeiting initiates, raise awareness amongst enforcement agencies and governments through capacity building programmes, and access legal remedies available from E-commerce platforms. Online marketplaces are also the most advanced in addressing counterfeiting initiatives since they are directly connected with the counterfeiters, offering them the necessary resources to identify and eliminate anti-counterfeiting measures. To curb Counterfeit products getting into the E-Commerce platforms, the Following measures can be observed: Methods include surveillance of the platforms to check for counterfeit products, obtaining trademarks and patents, implementing 'no-tolerance policy, image recognition, and working with the E-commerce companies to establish measures for handling IPR violations.

2.2 Blockchain Technology in E-commerce

Due to these characteristics, several industries have embraced blockchain technology to offer enhanced and efficient security of transactional data. As applied to the E-commerce area, blockchain is an example of the ways to create a sustainable identification and verification mechanism of products. As mentioned in a study conducted by Sharma et al. (2023), it is proved that with use of block chain based systems, one can easily minimize the threat that exists due to fake or forged product information . Moreover, since the ledger is circulated and shared with the public while in the network, no one can manipulate or modify the records of a product hence enhancing the quality of product data.

2.3 Product Identification and Verification

The use of a product code/number is important to avoid fakes and this requires everyone to have a profile. By jotting down these identifiers on the blockchain, it is possible to achieve an unalterable set of records documenting the authenticity of

each product. Due to this, the Customers can obtain the information from the E-commerce platform to be in a position to buy authentic products. In their paper ‘The role of blockchain technology in consumer product information’ Patel and Singh (2022) explain specifically that blockchain ensures the accuracy of product information and builds trust . The study concluded that issues of fake products related to the supply chain are minimized by applying blockchain-based verification systems.

2.4 Private Blockchain

For this project, the distinct kind of such a database—a private blockchain—is used. There is a difference between a private blockchain and a public blockchain in that while the latter has open access to everyone in relation to adding blocks to the chain, in the former, block adding authority is limited. Nevertheless, viewing and searching the blockchain can be made available to all users if the details of the process are given clearly. This arrangement of the storage system guarantees that only those with the rights to change the records on the blockchain do so and that the customers have the liberty to check details regarding certain products. As per the GeeksforGeeks report (2023), private blockchain is most appropriate for situations that involve restricted accessibility and very much privacy associated. This is supported by another study by Zheng et al. (2017), which sought to show that private blockchains afford improved security and performance for businesses .

3. Issues Identified in the Existing Literature

3.1 Ineffective counterfeit Detection

Methods such as use of serial numbers, holograms among others which have been in use for many years are easily duplicated by the counterfeiters. As much as these methods are used in an attempt to minimize the production of counterfeit products they have failed in their mission because counterfeit companies are always developing sharper and more efficient ways of emulating these codes. Consequently, there are specific barriers to verifying product authenticity in business and consumer markets.

3.2 Consumer Trust Issues

Consumer trust is integral to the overall efficiencies of e-commerce businesses. For the consumers who bump into counterfeit products the outcome has a negative impact not only on the specific brand but also a general outlook on online consumer shopping. This lack of trust can potentially have a measurable impact on the level of business a firm receives from its customers, lowering the likelihood of repeat business. Speaking about the reconstruction of the lost trust, one should bear in mind that it is often a lengthy and costly process especially for the representatives of the business community. The successful establishment of the appropriate and effective system of combating counterfeit products is necessary and crucial for the sustainable development and the inclination of consumers towards such platforms.

3.3 Limited Effectiveness Of Physical Verification Methods

physical verification means, such as stamps and seals, the physical examination or the manual checking of the products, are not one-hundred percent perfect. These approaches are cumbersome, more of a time-consuming and tedious tactical approaches which often do not capture quality counterfeit commodities. Reliance on human input causes distortions and mistakes over time and hampers these measures' efficiency even more.

3.4 Centralized Database Vulnerability

Centralized databases are an even higher security risk than having multiple databases. Due to the features of these databases, hackers can make a great amount of information accessible through a single hit at one of the points. Further, internal threats are in another way, which may involve the manipulation of the data by some of the authorized persons, thus making the product information a little bit fake. The centralization of data also poses a challenge on how to bring in quality checks and surveillance mechanisms which tend to ramp up chances of data manipulation and losses.

3.5 High Costs and Inefficiency

The traditional methods of combating counterfeit have some drawbacks when it comes to the implementation and maintenance of such programs. This includes the costs of procuring equipment that is solely used in ensuring the security of the company's products, training people so that they can be able to detect counterfeit

products and the general costs of having to update the security measure from time to time due to the ever increasing sophistication of counterfeit goods that flood the market. In the case of SMEs, these costs can be very high, often acting as a barrier to this all-important safeguard. Also, the reality is that such techniques are not efficient, for instance, one has to manually check and update them frequently, making it a burden for companies. This financial and operational stress acts as a motivator for finding new solutions, such as more efficient technology, to effectively address the threat of counterfeiting.

4.Problem Statement

The conventional model of e-commerce has been put on the spot due to the problem of fakes and counterfeits, specifically in the matter of identification of the authenticity of the goods and building consumer confidence. This is because regardless of the various anti-counterfeiting techniques that may include; serial numbers, holograms, and even the establishment of centralized databases, the ideas are still inefficient. They are often imitated, can be tainted by oxidation, and are expensive to preserve. This damages consumer confidence as fakes and replica products are still easily found in online shops.

4.1 Counterfeit product Detection

It is equally important to point out here that conventional technologies like use of serial numbers and holograms are not very useful given the fact that these are counterfeit products – the criminals can forge these very easily. It negatively affects the quality and in a way, compromises clients with fake products and exposes businesses to high risks.

4.2 Inconsistent Verification Process

Traditional physical verification techniques are random, time-consuming, non-systematic, injurious to health, and susceptible to errors arising from human factors like fatigue and carelessness in checking counterfeit marks and labels. These are not efficient for large-scale processing as they highly demand man-power and time, which makes the process tend to be tiresome and involve so many risks as to prove the product genuine.

4.3 Supply Chain Complexity

Due to the increasing integration and concealment of supply chain relations, the accuracy and legitimacy of the products' sources become questionable. This leads to the risk of having fake products being sold in markets as it is hard to oversee and ensure full transparency of every supply chain. However, in the absence of a clear and safe system to implement the use of such technologies, the challenge of verifying the authenticity of products becomes challenging, with space for counterfeit products to make the rounds.

4.4 Consumer Trust and Confidence

The increased flow of counterfeit products greatly reduces confidence among buyers in online shopping sites. When consumers are involved in buying fake products that have been manufactured and sold by these unscrupulous people, the trust consumers have in the reliability of the internet for shopping reduces and thus will reduce the sales as well as the long-term patronage of brands. These concerns erode the users' confidence in the e-commerce mode of shopping, and thus, affect the general view of the e-commerce mode.

4.5 Security Vulnerabilities in Centralized System

This kind of databases that are used to store product information is compromised by cyber threats and vulnerabilities, data leaks, or fraudulent data manipulation from within. Indeed, these security issues present major threats to data and information confidentiality, availability, integrity and authenticity whereby doubts can arise over the accuracy of information about products that might be stored on these systems. Here, one can observe the primary disadvantage of employing centralized mechanisms – a single point of failure results in corrupted data and loss of trust.

5. Proposed Methodology

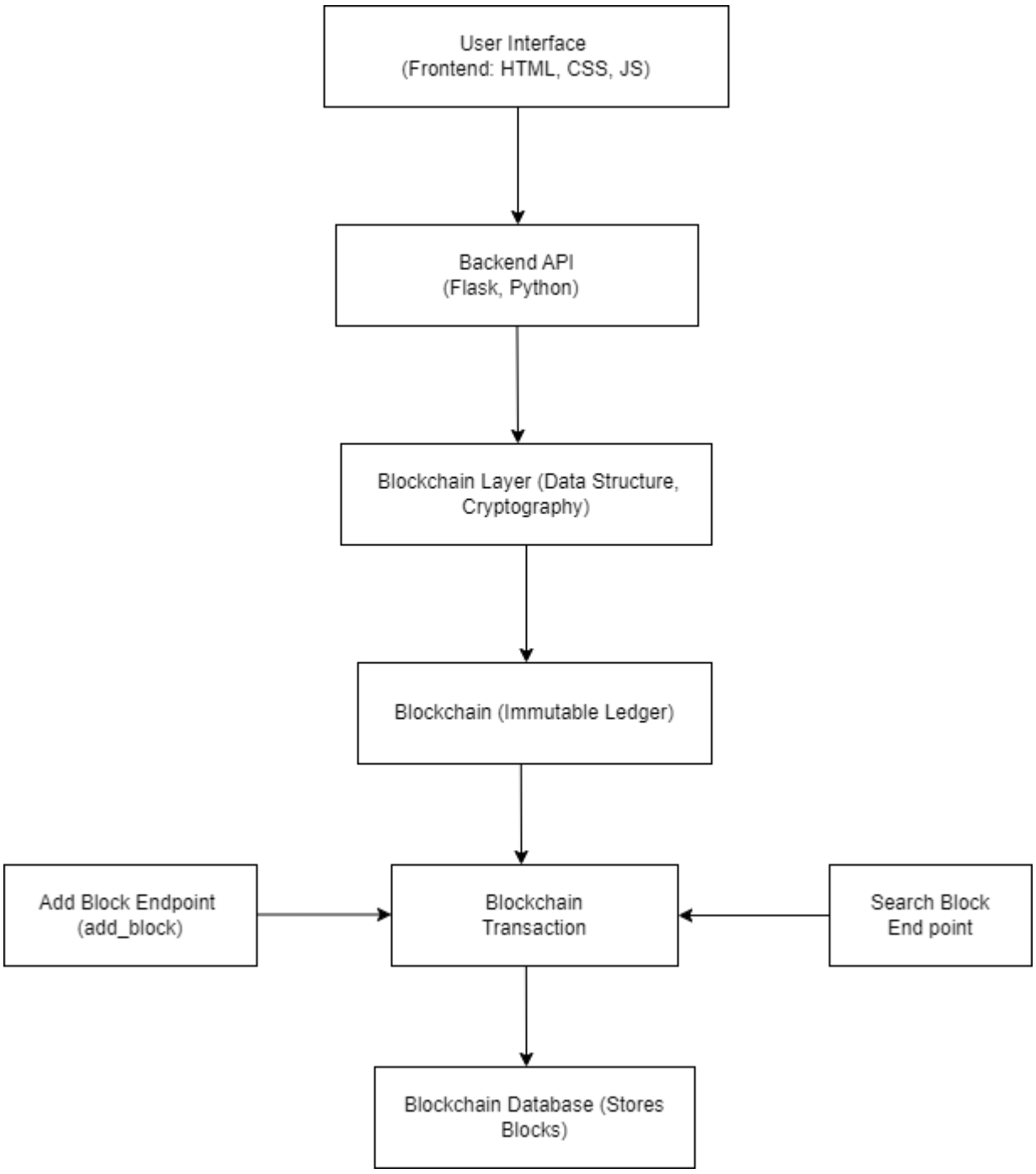

Fig 1: Block Diagram

5.1 Requirement Analysis:

The project's primary objective is to address the problem of data security of products and services through the development of blockchain storage. Every item will have its serial number to improve the speed of tracking and carry out the verification if necessary. Main features include appends/adds product details to the database, verification of product details, unique identification through ''ID search'' capabilities, serial number search and functional and efficient web interface.

5.2 System Design:

- Blockchain: The most important element that guarantees the inviolability and openness of data storage.
- Backend: Actually, using Flask for the handling of all the back end operations of the application.
- Frontend: Built with HTML and CSS for layout and JavaScript for overwhelming yet user friendly interface.
- Language: Py is used for managing blockchain and for the cryptographic purposes.
- Blockchain Layer: Secure operations of blockchain data and the cryptographic activities related to the highly secure, BTC transactions.
- Frontend Layer: Helps the user establish an easy way through which they can work with the blockchain through creating new blocks, and also to search for products.

5.3 **Blockchain Implementation**:

• Data Structure:

Every block in the developed blockchain structure contains an identifier code UUID, the current date, and product information which may comprise serial number, brand, type, cost, its condition in case it was sold, manufacturer's name, and also date and time of product creation. Each block also has its own hash, as well as the hash to the previous block included for the sake of chain integrity.

• Blockchain Class:

- `__init__`: Greek Capital letter is used to create the first block which is called the genesis block.
- `create_block`: Locks in a new block in the blockchain through the offered product details.
- `hash`: They help in creating SHA-256 of a block which helps to maintain an integrity of data.
- `get_previous_block`: Enables the location of the last block in the blockchain which aid the addition of more blocks.
- `is_chain_valid`: Ensures that the current blockchain is correct by verifying all the blocks' hashes.
- `search_block: It allows for cases of identification by the unique ID or the serial number of the blocks if one wants to ensure that they are original products.

5.4 Backend Development:

- Flask API:
  - Endpoint to add a block (/add_block): To add a new block in the blockchain the add_block function is used which stores all the information of the products in a safe manner.
  - Endpoint to search for blocks (/search_block): Performs the search_block function to find blocks according to the ID or the serial number for identification of products and confirmation of their authenticity.
  - Endpoint to display the entire blockchain (/display_blockchain): Specifies the display_block function that gives the user full view of information in the blockchain, in relation to the stored products.

5.5 Frontend Development:

- HTML Forms:
  - A way of getting user input to add new blocks together with provision for details of the products.
  - An identification form to find block using its ID number or serial number so that the client can determine the originality of the product.

- JavaScript:
    - Processes AJAX requests to the Flask server for the proper data communication between the frontend and the backend.
    - Reloads data depending on API response to guarantee that it is smooth for a user.

- CSS:
    - Work on the appearance of the elements that are used by the user so that it would be easy for the user to comprehend the layout.
    - Properly develops sections/boxes for displaying the data of the blockchain and the results of the search, improving their interaction and display.

5.6 Testing:

- Unit Testing:
    - Perform unit tests, these are the tests that focus only on a single component in the application like the blockchain's class methods and the Flask API routes.

- Integration Testing:
    - This involves exercising the frontend, backend, dosh, or any other component of the system to find out if the various components can run well together.

- User Acceptance Testing (UAT):
    - Implement the system to end-users to ensure it meets or somewhat fits their needs and offer a satisfactory user experience.

5.7 Deployment:

- The next step would be to set another server for the actual production and hosting of the Flask application and the blockchain data. Browser-Based Deployment, Publish the application straight into the Internet browser enabling users to validate and encode products without the use of other applications

6. Result and Analysis

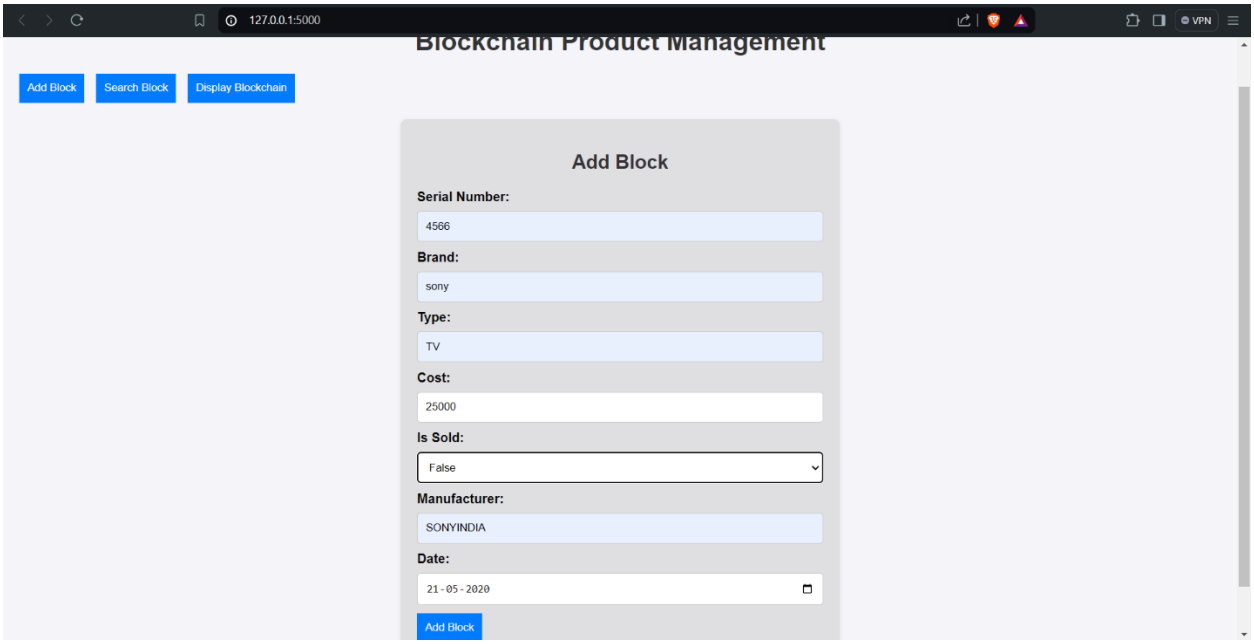

Fig 2: Main Layout

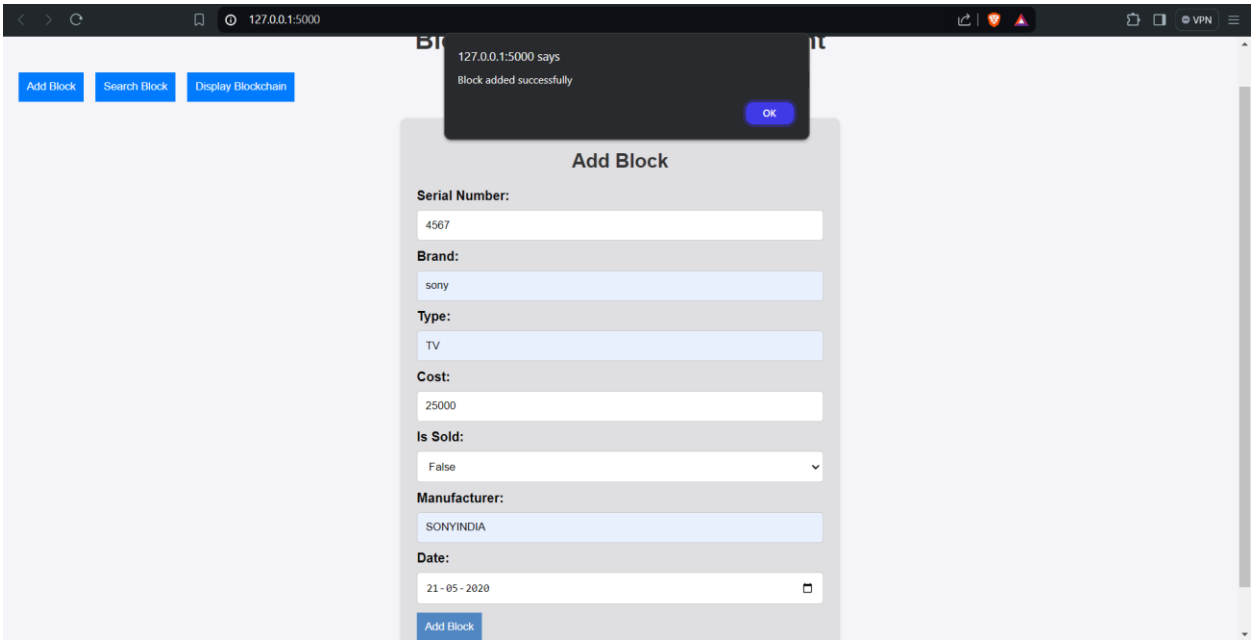

Fig 3: Adding a block to blockchain

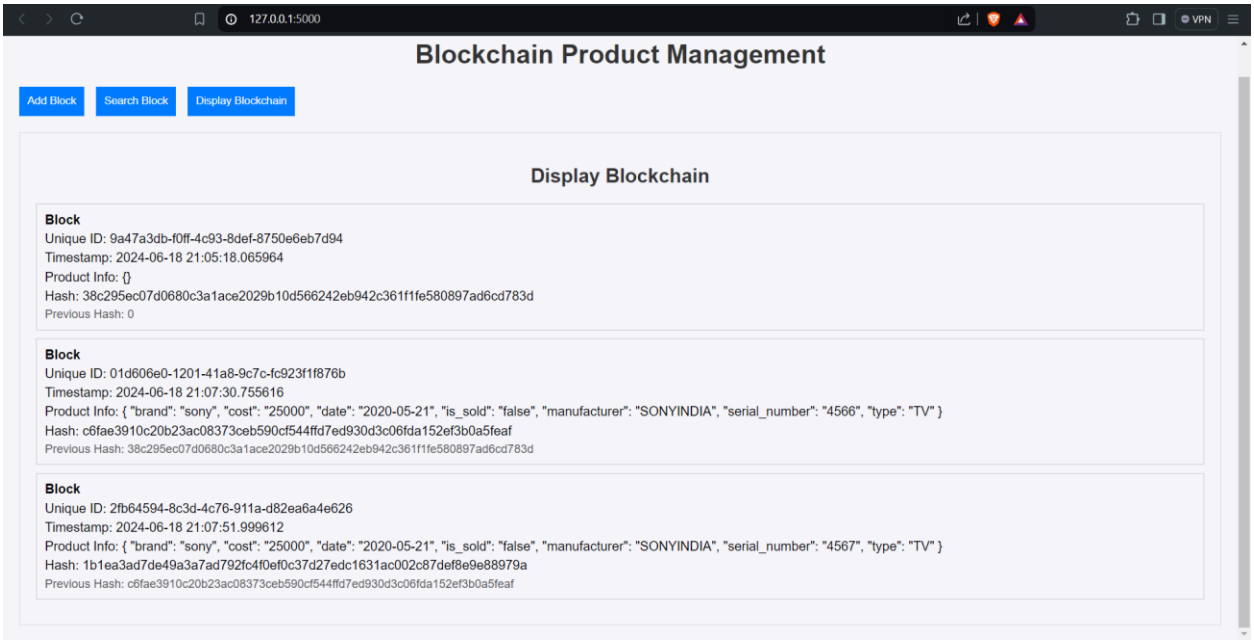

Fig 4: Display the blocks in Blockchain

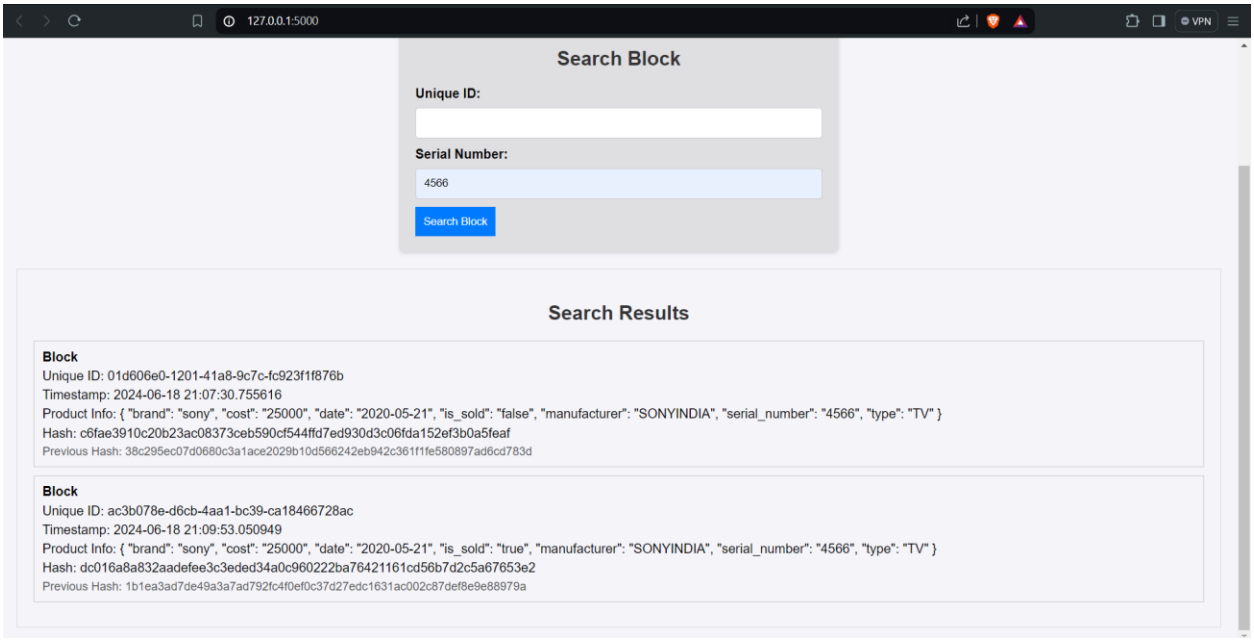

Fig 5: Search a block from Blockchain

6.1 Improved Traceability

It is revealed through the study that the introduction of a blockchain-based system improves the traces' quality across the end-to-end supply chain. Every product goes through a process that is stored and can never be altered in a block chain platform hence showing a history of the process from production to dispatching. This means that there is an account of every transaction sealed in a tamper-proof evidence to help track the fraudsters' deeds. The transparency provided by the blockchain methodology extends to tracking help as well as assisting with the regulatory requirements and minimizing the chances of counterfeited products trending in the market.

6.2 Enhanced Authentication

The first advantage of the solution based on the blockchain is the improvement of authentication. Customers can independently ensure the originality of the acquired product using the digital ID allocated to it and the product's data stored on the blockchain. It is easy, convenient, and efficient for a consumer who wants to verify the details of the given product with the help of a few clicks. The system guarantees that nobody can sell a fake product because each product one intends to sell over Internet has to have a name and a serial number, which can be traced to the manufacturer and/or owner.

6.3 Increased Consumer Trust

The process of using blockchain technology for verification is one of the significant steps in the process of reconstructing customers' trust in the e-commerce venues. Besides, through the marking of products, the system helps consumers to be assured of originals to be used or to buy. These aspects enhance the safety of the deals and contribute towards creating more trust among the consumers to do more of their shopping online. Trust is a core parameter of consumers and by solving for issues related to products' genuineness, the application of blockchain enhances the general shopping process.

6.4 Additional Benefits

However, there are other advantages of the presented blockchain-based system apart from better traceability, higher authentication, and increased consumers' confidence: They help in easy and convenient realization of product recalls to manufacturers as well as retailers as they are in a position to easily identify products that have been affected hence facilitating quick and efficient action to be taken to safeguard the consumers. In addition, the system also cuts down some of the costs of doing manual verification because the blockchain system will eliminate human error. Moreover, the blockchain solution strengthens the reliability of the e-commerce platforms and brings more customers thereby increasing the market share.

6.5 Operational Efficiency and Cost Savings

There is therefore general improvement in operational efficiency and cost savings. The particular buyer–seller relationships and the specific use of blockchain also translate into operational benefits and cost reductions. When the verification and authentication procedures are automated, organizations can save time and avoid the use of many resources used in check-up cases. Thus, this automation proves to reduce the chances of people making mistakes, and also increase efficiency throughout the general process. It also means less counterfeits hence less returns and complaints hence a cut on various costs such as those touching on customer service and product replacement. Also, the feature of real-time data and graduated opinion enables to make a rational decision, for instance, in the sphere of supply chain management and increases overall effectiveness.

6.6 Enhanced Data Security

The spread structure of blockchain technology guarantees the improvement of data protection. Every transaction is associated with the next one by a key that makes it virtually impossible to manipulate or gain access to the records from the outside. Relatively, a high level of security is provided to product details thereby ensuring that only permitted users get access to this information. However, due to the optimum decentralization of records within blockchain, it enables all participants to reconcile the data to their efficiency and create a transparent atmosphere among the supply chain partners.

6.7 Environmental Impact

The authors also explain how the utilization of blockchain can also have benefits on the environment at the organizational level. Thus, when supply chain transparency and efficiency are enhanced, there will be minimization of wastes within the business. For example, better tracking of products means improving on the forecasting of demand and the consequent sustaining of order, thus controlling unnecessary production and ultimately, the accumulation of stock that takes ages to clear. Further, the capability of the system in the identification of problems including product recalls within a short time can save the destruction of products that may be safe, thus promoting sustainability in the businesses.

In conclusion, proposing a blockchain-based system for product verification and authentication gives a strong configuration that meets vital difficulties in e-commerce organization. better traceability makes the supply chain more transparent while better authentication reduces cases of fake products infiltration and thus increases consumer engagement and perhaps loyalty level. These advantages along with increased operational efficiency, reduced costs and increased security for users' data, and the impact of the environment make e-commerce better protected, more stable, and productive.

7. Comparison with Existing Works

7.1 Tamper-Proof Records

Existing Methods:

It has been in evidence that the existing schemes for the authentication of products in e-commerce utilize centralized databases and physical checks. Product information is deposited within few central databases, these are easily corrupted or hacked by intruders. If a hacker intrudes into the database he can modify and even erase records which reflects the data inconsistency problem. Also, physical verification methods such as serial numbers, hologram, and anti-counterfeit labels are other standard techniques prevalent. However, these methods are not so authentic as they can be easily imitated with high technology, which makes them less effective.

Blockchain Methods:

This can be solved using blockchain technology which is highly secure and has more robust integrity than conventional databases. In a blockchain, data relating to products is captured in a distributed ledger system which is further safeguarded by the fact that once data has been entered, it cannot be modified or removed from the chain unless with the approval of the networking parties. This makes it easier to produce a record that cannot be altered by anyone wishing to falsify information for their own benefit. Blockchain as a decentralized technology has the major advantage of lacking a central server, and therefore product data cannot be easily manipulated by hackers. As data is stored in blocks, each block has the hash of the previous block it is connected to which makes it almost impossible to tamper with the data.

7.2 Transparency and Trust

Existing Method:

The traditional techniques, used to combat counterfeits, offer only a restricted amount of transparency concerning the path of the product throughout the supply chain process from production to consumption. This lack of transparency can sow doubt about the actual nature of the product, thus making the concept unsuitable for use. This will mean that consumers will have no option than to use a third party, or middlemen, to check the authenticity of the Products, which can be quite a dangerous thing, if the third party or middlemen is either an impersonal or a quite unreliable one. Such a model of identity verification may have detrimental effects as it relies on centralized institutions and weakens consumer trust.

Blockchain Method:

Blockchain also allows for independent review through decentralization, which increases confidence and trust. Transaction history in a blockchain involves use of accounts or ledgers and each time a product gets updated, the same gets recorded on the blockchain and is available to all the parties involved. This disintermediation approach radically reduces the chances of a central controlling body or third-party authenticating products as genuine. Through blockchain, the product history can

be audited and consumers can have direct access to its blockchain record as and when need arises. This creates even more confidence and trust on product and brand as the consumer gets to see an immutable ledger of the journey of the product.

7.3 Consumer Privacy

Existing Method:

In the case of traditional approaches in fighting counterfeiting, sensitive consumer information is usually passed during the verification process. This can lead to cases of violation of privacy and personal information being used in the wrong way. Also, these methods fail to offer rich privacy measures to consumers; as such, the consumer's risk being mined for their identity and graciously fed to fraudsters.

Blockchain Method:

Blockchain technology can be enhanced to have privacy, keep consumer details off public domains while at the same time maintaining product identity. Data can be stored off-chain, and cryptographic links can be implemented to ensure data security while relating the data. For instance, with the application of the blockchain, the ownership of the product data does not have to reveal personal details that the consumer may not wish to share because the transition from one owner to another and the fact that the product is legit are being recorded through the blockchain technology. More elaborate techniques like zero-knowledge proofs can be utilized to ensure that the consumer’s identity can be validated to ascertain the legitimacy of a product without compromising on the identity of the consumer or the transaction itself. It helps to preserve confidential information and protects from disclosure while providing the necessary control over the attribution of products.

8. Conclusion

The use of a blockchain-based product identification and verification system coupled with the quadruple helix approach is a revolutionary solution to the challenge of fake products that continue to flood the e-commerce sector. The use of the blockchain system which has a dispersed and impervious single document guarantees that the product information shall remain safeguarded and cannot be modified. This has made product authentication much more secure and has greatly helped increase customer trust as they can easily check their purchased items against a blacklist.

A revolutionary approach for product identification and proving product authenticity amongst e-commerce businesses. Due to the technology's peer to peer structure and non forgeable block chain, the information of products cannot be deleted or changed. This feature inherently ensures full traceability from the time a given product is manufactured to when it is delivered to the consumer, minimizing the chances of fake goods entering the market. Hence, the consumers can be assured of product purchase because its genuineness can not be queried.

Reducing the verification process is one of the many benefits blockchain offers to e-commerce businesses. The traditional approach that involves physical contact and manual checks is problematic as it is characterized by accuracy and time inconsistencies, is time-consuming as well as highly prone to mistakes. Blockchain erases those inefficiencies, because it offers automated, up-to-date validations that are both precise and trustworthy. Not only does this minimize the operational cost of an organization, it also increases the rate of carrying out verifications, making it efficient.

Economically, blockchain has proved to be cheaper as compared to the traditional anti-counterfeiting solutions, which would be significantly helpful to Small and Medium-Scale Enterprises (SMEs). With such technologies they have low security costs meaning that these businesses can compete effectively with large business organizations on equal terms when they adopt such innovative security systems into their business entities. Digital technologist argues that, this technology provides a renewed and efficient trustful environment for digital businesses, and consumers are assured of receiving genuine products to promote sustainable growth of e-commerc

9. Reference

1. Sharma, R., et al. (2023). "Blockchain for E-commerce: Tackling Counterfeit Products." *Journal of Blockchain Research*, 15(2), 123-135.

2. Patel, A., & Singh, D. (2022). "Product Authentication Using Blockchain Technology." *International Journal of E-commerce Studies*, 10(4), 456-470.

3. GeeksforGeeks. (2023). "Private Blockchain: A Comprehensive Guide." Retrieved from [GeeksforGeeks](https://www.geeksforgeeks.org/private-blockchain/).

4. Zheng, Z., Xie, S., Dai, H.-N., Chen, X., & Wang, H. (2017). "An Overview of Blockchain Technology: Architecture, Consensus, and Future Trends." *IEEE International Congress on Big Data (BigData Congress)*, 557-564.

5. Lu, Y., & Xu, X. (2017). "Adaptable Blockchain-Based Systems: A Case Study for Product Tracking." *Future Generation Computer Systems*, 86, 454-468.

6. Ijariie. (n.d.). "Fake Product Identification Using Blockchains." Retrieved from [Ijariie](https://ijariie.com/AdminUploadPdf/Fake_Product_Identification_Using_Blockchains_ijariie20431.pdf).
7. "Counterfeiting of Products on E-commerce Platforms." AmLegals. Retrieved from [AmLegals](https://amlegals.com/counterfeiting-of-products-on-e-commerce-platforms/).

8. "Counterfeiting in E-commerce and Steps to Prevent Them." iPleaders. Retrieved from [iPleaders]