Practical Anti-Counterfeit Medicine Management System Based On Block Chain Technology

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Abstract- *Counterfeit drugs have greatly decreased thanks to block chain technology's transparency, immutability, and security in the medicinal supply chain. However, the majority of suggestions for Block chain-based medical management are impractical. Furthermore, there is the issue of medication cloning. This hasn't been explicitly resolved yet. In this research, we present a unique Block chain-based product ownership management mechanism for anti-counterfeit pharmaceutical systems that will help to prevent drug cloning and improve practical applicability. Based on criteria such as practical application, anti-clone, low cost, customer-oriented, and scalability, the analysis and assessment results of our suggested system surpass those of similar solutions. Furthermore, preliminary testing on a modest scale demonstrates that our suggested technology performs as expected in a real-world setting.*

Some of the terms used in this paper are Block chain, Ethereum, Smart Contracts, Ownership Management, and Anti-Counterfeit Medicine.

I. INTRODUCTION

According to a report by the World Health Organization, Medicine counterfeiting is a worldwide issue. Pharmaceutical crimes are on the rise, thanks to the large sums of money made from counterfeit drugs significantly growing. According to the World Health Organization, the revenue from counterfeit drugs might be as high as $1 billion. The global pharmaceutical market is expected to surpass $200 billion. Furthermore, the percentage of counterfeit drugs in the In developed countries, the pharmaceutical market accounts for 10% of the total.30% in developed countries and 30% in developing countries [1].Because of its presence, the public's health is jeopardised as a result of the huge quantity of counterfeit drugs. The patient has a direct impact[2]

To address the aforementioed issue, we propose an Ethereum-based anti-counterfeit medication system (ACMS)."Block chain" and "IPFS" networks are two different types of networks[3]. Our paper contributions are presented in the following manner:

- First, we present a Block chain-based solution for non-retail and retail goods ownership management. Medication that is resistant to drug cloning
- After that, we create an Ethereum smart contract. ACMS should use the Ethereum Block chain if it is practical.as well as IPFS networks. Our proposed proposal's content has a smart contract for Ethereum.[4-10]&[12]
- Finally, our proposed system has been effectively implemented in a small-scale experiment. Finally, we examine and analyse the system we've proposed. with supporting evidence to demonstrate superiority.

Background:

A. Block chain innovation

Satoshi Nakamoto was the first to invent and design the block chain. In 2008, Nakamoto [14] "A distributed digital ledger" is what Block chain is. Block chain has attracted a lot of interest from the tech community because of its benefits such as transparency, security, immutability, and availability.

B. Ethereum Platform

The Ethereum block chain network is used by our proposed ACMS. We'll go over some fundamental terminology in this section.

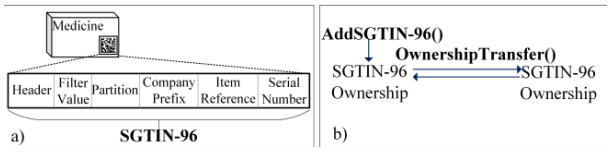


Figure 1. Example of an SGTIN-96

Our paper includes an example of an SGTIN-96 (serialised global trade item number) for a retail medicine unit, as well as an Ethereum smart contract function-based retail medicine unit ownership management mechanism[15]. The Ethereum platform is described in detail here.

Keep track of Ethereum: Externally Owned Accounts (EOA) and contract accounts are the two forms of Ethereum accounts. EOA is used throughout this paper. An EOA is essentially an Ethereum public key that is managed by an Ethereum private key (EPK). Wallet programmes are used to maintain EOA and EPK.

Smart Contract (SC) is a Turing-complete programming language-based computer programme. Each SC is converted to bytecode and stored on the Ethereum Block chain network, each with its own address.

In SC, a **function** is a type of part content. The function has the ability to communicate with other SCs, make decisions, store data, and send ether to others. We use functions to store data in this study.

In addition, we use a modifier function to attach the requirement that the designated function can only be executed by the specified EOA.

The cost of **gas** used to perform the operation in SC is an internal cost.

Remix-IDE: Remix is a browser-based compiler and IDE that allows researchers to develop and debug the Ethereum SC using the Solidity programming language[16]. We visit https://remix.ethereum.org to use Remix-IDE.

TESTRPC is a Node.js-based Ethereum client that may be used to prototype new ideas before deploying them on the Ethereum network. A TestRPC is a node in a local Ethereum network that behaves like a genuine node.

IPFS (Internet Protocol File System)

IPFS (Interplanetary File System) is a peer-to-peer network and protocol. The IPFS is a decentralised storage network that uses a hashing technique to identify each file[17]. We exclusively store data in JSON format in our system. IPFS returns a unique hash for each piece of data it stores. After that, we use the SC function to save storage costs on the Ethereum block chain network by storing this unique related hash.

D. Healthcare Global Trade Item Number

The GTIN (Worldwide Trade Identification Number) is a code that is used to identify medicinal products as they move through the global medication supply chain. The GS1 General Specifications define the GTIN structure. In this paper, we use the GS1-128 format as the identifying code for medical items. The GS1-128 format contains master data (GTIN) and transactional information (lot number, expiration date, serial number) in the GS1 System of standards.

E. Standard Ownership Management System Based on Ethereum

We proposed the first block chain-based product ownership approach for the supply chain system[12]. EOA specifically refers to the owner of the product's GTIN code. Only the owner of GTIN can transfer ownership to another EOA using the modifier function in the Ethereum SC. Cloning of authentic GTIN is completely avoided by using the product ownership mechanism. This approach, on the other hand, is limited to a particular product. As illustrated in Fig. 1 , each retail pharmaceutical has the SGTIN-96 when this system is used for the drug supply chain. The stakeholders execute functions in SC to move ownership of SGTIN-96 across the drug supply chain, as shown in Fig. 1 . To generate the initialised ownership, the medicine maker uses the AddSGTIN-96() method. The Ownership Transfer () function is then used by stakeholders in the medication supply chain to transfer ownership of drugs. However, transferring ownership of individual products is time-consuming and inconvenient.

II. LITERATURE REVIEW

1. A Smart Contract for Coffee Transport and Storage with Data Validation

Author: Cristian Valencia-Payan

Year:2022

Link: https://ieeexplore.ieee.org/document/9749279

Problem Identified and Objective

Recently there has been an increase in the use of Blockchain technology for multiple purposes; one of them has been food traceability. This technology has increased quality control, safety, and reliability. So, the producers are looking for better ways to trace the products at any supply chain stage to ensure their quality. A smart contract is a transaction protocol that execute automatically when a predefined set of conditions are met.

Paper Objective

In this paper, the author proposed a smart contract to monitor the status of the coffee beans in the transport and storage stages with data validation. Using the Hyperledger Fabric Blockchain tool, then deploy a test network of two actors, also known as organizations.

Methodology

The smart contract will bridge the real world and the Blockchain network, collecting data and updating the traceable variables logs. The author deployed a test Blockchain network using the Hyperledger Fabric to evaluate our proposed smart contract. The test network consists of two organizations with two and three transactional endpoints known as Peers; the peers will be in charge of sending the transaction to the network on the dedicated channel; an organization can be a multinational corporation, a national company or a single individual. In Hyperledger Fabric the channels are the way of communication for peers; a peer can join multiple channels at the same time, each transaction made by a peer must have a target channel and smart contract.

Findings

However, the proposed smart Contract is still in an early development stage. More variables and knowledge will be needed to make it more robust and practical to use on another stage of the coffee supply chain. More work is required to make sure it is feasible and has practical significance, and future iterations will include validations rules not considered at this point. In-situ validations are needed to find problems not presented in controlled environments.

2. EVO-NFC: Extra Virgin Olive Oil Traceability Using NFC Suitable for Small-Medium Farms
Author: Massimo Conti
Year:2022
Link: https://ieeexplore.ieee.org/document/9714345

Problem Identified and Objective

Food traceability is a fundamental requirement for the agriculture of the future. A food traceability system should ensure food safety and quality control, allow authentication, fraud prevention and control by the authority, improve consumers' safety and confidence. The agri-food supply chain is complex and difficult to handle due to the presence of various stakeholders and control authorities. Consequently, the complexity and the cost of traceability systems make it inapplicable for small and medium enterprises (SMEs).

Paper Objective

This work defines of a food traceability system using existing low-cost digital technologies with the possibility to be integrated into a database for public authority controls. Smartphone applications allow consumer involvement and a bidirectional interaction between the company and the consumer. This work proposes the use of smartphone with NFC technology in every phase of the food chain bringing the information to the final consumer.

Methodology

The novelty of the proposed solution is the use of the same NFC technology for food traceability from production directly to the consumer. Furthermore, unlike conventional QRcode, the app installed in the consumer smartphone allows a bidirectional interaction between the company and the consumer. This allows market analysis and gives to the company feedback on consumer habits, taste and preferences, fundamental for market purposes. Block chain has not applied in the transcription of the data in the proposed solution, but it could be applied.

Findings

A great work has been carried out carried out on the acquisition the knowledge and best practice of the extra virgin olive oil from small farms, that are the main target of this research. The knowledge allowed the definitions of the specification of the traceability system.

3. Secure Identification, Traceability and Real-Time Tracking of Agricultural Food Supply During Transportation Using Internet of Things
Author: Muhammad NasirMumtazBhutta
Year:2021
Link: https://ieeexplore.ieee.org/document/9417183

Problem Identified and Objective

Food supply chain process comprises crops collection, processing of food, shipping & delivery to the whole seller in the market. Harvested foods decompose from the moment they are harvested due to attacks from enzymes, oxidation, and microorganisms. These include bacteria, mold, yeast, moisture, temperature, and chemical reaction. The spoilage of fresh food has increased over time due to the multistage slow food supply chain process. The identification, traceability, and real-time tracking of goods in supply chains have always been a challenge. The advent of the Internet of Things and cloud computing has brought a new approach to the food supply chain process for better cooperation among supply chain partners. The supply chain management (SCM) benefit greatly through automation based on key technologies of IoT, Radio Frequency Identification (RFID), and Wireless Sensor Networks (WSN). These technologies collect the data relevant to the food supply chain system, such as identifying tag-possessed objects or individuals and sensing capabilities of the surrounding environment. However, the collected data can

be tempered or modified by attackers to provide false information about environmental conditions. They can destroy or damage the product due to false identification of dynamic environmental conditions. Furthermore, the current automation systems in industry-based retail logistics and SCM do not provide efficient solutions for monitoring the quality of perishable products with integrated solutions. This research aims to develop a secure monitoring and reporting system based on IoT to update the quality of the perishables along with the SCM with a focus on transportation without any human intervention.

Methodology

Supply chain management owns substantial worth in all business aspects. The conventional SCM methods are inefficient, sluggish, and do not keep pace with the modern revolutionary business sneeds. This study proposes a reliable, auditable, and trackable SCM framework that ensures transaction integrity, immutability, and transparency in the entire course of shipments of perishable products. The system provides a coherent digital representation of valuable assets to all stakeholders, from raw material suppliers to end-users or consumers. In the proposed Blockchain-based SCM, each of the stakeholders joins as Blockchain node to make Blockchain transactions as well as participate in keeping Blockchain up to date. On joining the Blockchain, each node is given a public/private key pair to process secure cryptographic operations according to Blockchain architecture.

Findings

The proposed system bestowed secure monitoring and reporting based on IoT and Blockchain frameworks to override the empowered the stakeholders to update the quality of the perishables preserving the privacy and security aspects without any human intervention. conventional supply chain management mechanisms that are economically and computationally expensive.

III. PROPOSED SYSTEM

Block chain supply chain management solution with a built-in mechanism for counterfeit goods identification and brand protection. Automate and consolidate interactions between suppliers, manufacturers, distributors, logistics hubs, retailers, and consumers within the supply chain. Provide efficient tools for product lifecycle management & components' authenticity verification.

In the proposed Block chain-based Anti-Counterfeiting, each of the stake- holders (e.g., suppliers, producers, factories, logistics items retailers and consumers, etc.) joins as Block chain node to make Block chain transactions as well as participate in keeping Block chain up to date. On joining the Block chain, each node is given a public/private keypair to process secure cryptographic operations according to Block chain architecture. The particular transaction is first created or generated by the system passed to all stakeholders who view and authenticate it. For authentication purposes, the transaction initiator signs the transaction with its private key which is further validated by each other processing node (stakeholder) with the public key of the initiator. Once the transaction is established on the network, the transaction block is added as a new block to the existing blocks in the Block chain by using a suitable consensus mechanism. In the proposed architecture, it is recommended to use Proof of Supply Chain Share (PoSCS) as a consensus mechanism which is based on Proof of Stake (PoS). The other popular consensus mechanism like Proof of Work (PoW) and PoS may not be suitable for Product SCM due to the high demand for computational resources and wealth in the distributed network. Each block in this chain keeps the hash address of the next neighbor. The last block in this data structure does not point to any other block. In creating and authenticating a new block, the previous block of the existing chain points to the newly created block.

We propose a decentralized block chain with know your product code for our system. In our system there will be four stakeholders including Manufacturer, Distributor, Retailer, Consumer. To participate in the system, every stakeholder needs to generate a key pair of EOA (Externally owned Account) and KYPC. The key pair of EOA and KYPC is responsible for deploying or executing the function of the smart contracts.

Know Your Product Code Block chain-Enabled Product Anti-Counterfeiting-Each and every product will have a pair of global Id and unique Id in the manufacturing unit to identify the product in the Manufacturing Unit generated using KYPC Generator anti-counterfeiting identification code, and other information of the product are added to the block chain.

Block Genuine verify is powered by an advanced block chain protocol that ensures secure storage of data on the product's manufacturer and origin. It allows tracking and monitoring products from production lines to distribution centres to the point of sale and the consumers.

IV. EXPERIMENTAL RESULTS AND DISCUSSION

This real-time system can be implemented to check the received product is a counterfeit product or original

product. The manufacturer uses the SHA-256 algorithm to generate a QR code in blockchain technology. The generated QR code is scanned by the user to check given product is fake or real.

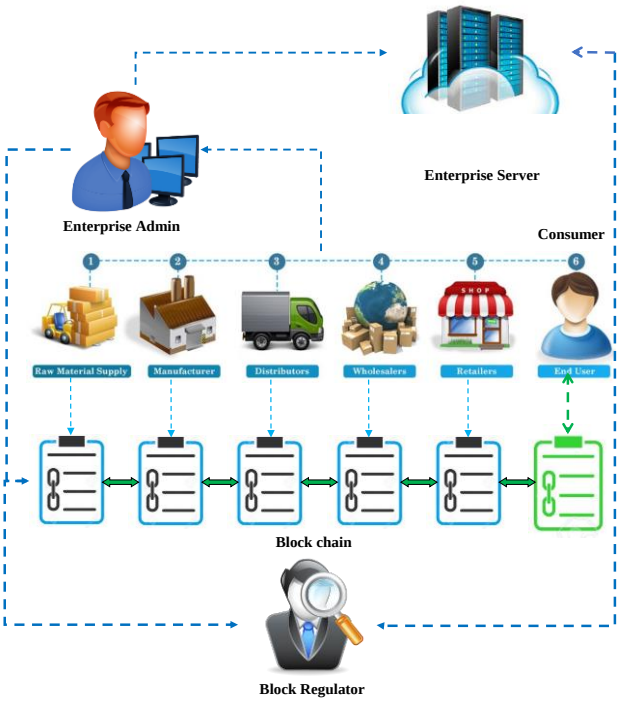
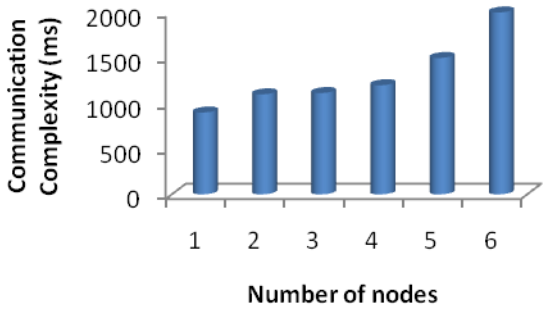


Figure 1.System model diagram



V. CONCLUSION

We have introduced a revolutionary anti-counterfeit pharmaceutical system in this study that resists drug cloning and improves practical applicability. Our system is built on the Ethereum Block chain and IPFS networks to enable tamper-proof, secure, and dependable tracking of real pharmaceuticals. Furthermore, we have upgraded the Ethereum smart contract-based Block chain-product ownership approach. We've also included comparisons based on the analysis and evaluation results to demonstrate the advantages of our proposed method. We will optimise medication smart contracts in the future to reduce the cost of gas used.

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