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A BLOCKCHAIN-BASED APPROACH FOR DRUG TRACEABILITY IN HEALTHCARE SUPPLY CHAIN

PUNAM KHESE Trinity College Of Engineering And Research, India
SUJEET MORE Trinity College Of Engineering And Research, India
AMRUTA SARUDKAR Trinity College Of Engineering And Research, India

Abstract—
Healthcare supply chains are complex structures spanning across multiple organizational and geographical boundaries, providing critical backbone to services vital for everyday life. The inherent complexity of such systems can introduce impurities including inaccurate information, lack of transparency and limited data provenance. Counterfeit drugs is one consequence of such limitations within existing supply chains which not only has serious adverse impact on human health but also causes severe economic loss to the healthcare industry. Consequently, existing studies have emphasized the need for a robust, endto-end track and trace system for pharmaceutical supply chains. Therein, an end-to-end product tracking system across the pharmaceutical supply chain is paramount to ensuring product safety and eliminating counterfeits. Most existing track and trace systems are centralized leading to data privacy, transparency and authenticity issues in healthcare supply chains. In this paper, we present an Ethereumblockchain-based approach leveraging smart contracts and decentralized off-chain storage for efficient product traceability in the healthcare supply chain. The smart contract guarantees data provenance, eliminates the need for intermediaries and provides a secure, immutable history of transactions to all stakeholders. We present the system architecture and detailed algorithms that govern the working principles of our proposed solution. We perform testing and validation, and present cost and security analysis of the system to evaluate its effectiveness to enhance traceability within pharmaceutical supply chains.

Index Terms—
Blockchain, Drug Counterfeiting, Traceability, Healthcare, Supply Chain, Trust, Security

I. INTRODUCTION

The current nature and scope of food supply chain management are considered a complex network where different entities such as materials, vendors, distributors, producers, retailers, multiple processing units, and others are involved. Increased complexity not only impacts the inefficiencies in the process and creates more challenges like counterfeit food products with nonprovisioned drug traces but also impacts the food industry adversely. Although the Food Safety and Standards Authority of India (FSSAI) has passed several laws and amended them regularly to ensure food safety, its implication seems to lessen at an individual step in the process ultimately diminishing its effects. This allows the scope of malicious food tampering and practices leading to unsafe food products in the market. The counterfeit drugs in food items adversely impact public health [1]. The major contribution of the research is to conduct a comparative analysis of Blockchain in improving drug monitoring in foodstuffs. The critical determinants of the study include using Blockchain for best interconnectivity, providing critical help for stakeholders in tracking goods, and protecting against challenges and issues. The implementation of Blockchain technology has opened up a new model of application creation which is based on the implementation of the critical data structure, the basic approach is that the data structure is related to a linked list of blocks which are mainly shared through the nodes and each node possesses an original copy of the blocks [2]. The emergence of different applications such as the Internet of things, machine learning, and deep learning supports enhancing document management and enables proper tracking and traceability of the data in an effective manner. Additional complexity not only affects operational inefficiencies and generates new issues, such as fraudulent food items

containing commonly used diagnostic drug residues, but also has a negative influence on the food sector. That although the Food Safety and Standards Authority of India (FSSAI) has created various regulations and revised them on a regular basis to maintain food safety, their impact appears to erode at each stage of the process, eventually reducing their impacts. These aspects can be leveraged in the food industry to track the illicit drugs in the F&B supply chain effectively. The food retailers can use the Blockchain technology to leverage the validation of the structure and support in gathering related information for each transaction, which are commonly mentioned through hashes and support in the transfer of data through a peer-to-peer network, which will make it difficult in hacking data and records

II. RELATED WORK

Hyperledger Fabric is a platform that delivers universal distributed solutions with a layered architecture that ensures data security, endurance, versatility, and scalability [6]. It is a business-oriented DLT based on Blockchain that employs contracts to establish rapport among many entities. Hyperledger Fabric does away with mining but keeps all of the benefits of a traditional Blockchain cryptocurrency (such as Bitcoin or Ethereum), such as unaltered block sequence determinism and double avoidance cost [7]. With hundreds or even thousands of requests per second, Hyperledger Fabric has proved to give great business performance [8]. When standard programming languages (Java, Go, and NodeJS) are used to create smart contracts, the technology's approval rate is lower than when proprietary programming languages are utilised (e.g., solidity in Ethereum). Blockchain technology aids in the creation of an authorised secure network for detecting and tracking supply chain information events, as well as providing timestamp files for each transaction [9]. This technique will facilitate access to the food supply chain, promote collaboration among untrustworthy parties, and develop an endless and unchanging decentralised drug monitoring system. To build compatible solutions for numerous controllers, sharing of data is required [10].

The successful execution of the Bitcoin application data format has given rise to a new concept for software development based on Blockchain technology. A Blockchain data structure can be compared to a linked list that is shared across the network, with each node having a copy of every block (linked to the longest chain) generated by its generator [11]. In domains such as the IoT, e-governance, and e-document handling, many authentic solutions have lately been developed. Due to its self-encrypting structure between deals (through exchanging) and the public access to a global digital ledger, these solutions reap the benefits of Blockchain technology [12]. Since it would be costly to revise from inception to final log action, establishing a Blockchain coupled with cryptographic construction makes it exceedingly impossible to break records

III. OBJECTIVES

This paper is aimed to ensure the safety and authenticity of drugs by providing a tamper-proof record of their movement through the supply chain. to prevent counterfeit drugs from entering the market and to identify and recall contaminated drugs more quickly.to reduce fraud and corruption, and to improve trust between stakeholders.

IV. METHODOLOGY

The methodology of the study is involved in using quantitative research design as it supports the authors to investigate the research area in an effective manner; the researcher is more focused on understanding the critical determinants of using Blockchain which supports drug traceability [14]. The research applied quantitative analysis for the research because it helps in successfully identifying the critical determinants influencing drug monitoring in food. A survey method is used to collect data, and previous evaluations are also employed to obtain a better knowledge of the subject. The primary data source is generated through the survey method. The researcher uses closed-ended questions which intend to understand the responses from the sample population on the application of Blockchain

technology towards drug traceability. The authors also use secondary data sources for collecting the past reviews related to the topic

V. DISCUSSION

In today's world, the healthcare industry relies on extensive supply chains that cross organizational and geographic boundaries. Impurities such as erroneous information, a lack of transparency, and restricted data provenance can be introduced by the intrinsic complexity of such systems. Counterfeit medications are one of the consequences of such constraints in existing supply chains, which not only has a negative impact on human health but also costs the healthcare business a lot of money. A dependable end-toend track and trace system for pharmaceutical supply chains has thus been emphasized in prior study.

VI. CONCLUSION

We looked into the problem of drug traceability in pharmaceutical supply chains and found that it is especially important in the fight against the sale of fake medications. Using blockchain technology, we have created and tested a system for tracking and tracing pharmaceuticals in a distributed fashion. Because of the cryptographic foundations of blockchain technology, we suggest a method that makes use of smart contracts on Ethereumblockchain to automatically record occurrences and make those records available to all stakeholders

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