THE USE OF BLOCKCHAIN IN THE MANAGEMENT OF COVID-19 VACCINE DATA

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Cover Page Footnote

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ABSTRACT -The ongoing COVID-19 pandemic has disrupted nearly every sector of the world economy. The recently discovered vaccine has promised a return to normalcy. Since traditional database storage systems can be tampered with quickly, the incorporation of blockchain would preclude the limitations of conventional database systems. This paper thus discusses the use of blockchain technology in managing the COVID-19 vaccine data to ensure credibility, safety, security, and transparency.

*Keywords -*Blockchain technology, COVID-19 vaccine data, and vaccine supply chain.

I. INTRODUCTION

In October 2020, two corporations announced the discovery of COVID-19 vaccines with efficacy rates of over 90 percent. It was impressive that the two companies took a relatively short time to develop an effective vaccine, an achievement that was a first for vaccine development because it often takes years of research to develop a vaccine upon disease outbreak. Still, there is a bigger challenge of distributing the vaccine to every person around the world. The storage and distribution of the COVID-19 vaccine will thus need the deployment of blockchain technology, which offers an immutable and decentralized database to help in storing supplies.

The two corporations that have developed the COVID-19 vaccine are Moderna and Pfizer. However, there is a key dissimilarity between the two vaccines in terms of storage. Moderna's vaccine needs to be stored at -20 Celsius degrees even though it can be stored in a regular refrigerator at 2 to 8 Celsius for about 1 month. On the other hand, Pfizer's vaccine needs a much colder room at -70 Celsius degrees and can only survive up to 5 days in a regular refrigerator. Usually, it is important to keep vaccines stored under cool conditions to preserve their efficacy. The newly invented blockchain technology seems to hold the answers regarding the management of the COVID-19 vaccine data, specifically the storage,the rapid rollout of the vaccine, and the deployment of an immunization campaign.

II. Statement of the Problem

The on-going COVID-19 pandemic has led to a rapid spread of the coronavirus leading to a rising death toll and an increase in transmission rates. The whole world is still trying to grasp the immensity of the problem, given that the pandemic is still ongoing. The COVID-19 vaccines present good news and a promise of a return to normalcy. Still, the success of the vaccine's rollout and distribution will be contingent on the accessibility of an effectiveand open distribution chain that the relevant stakeholders can audit. The traditional database storage systems have the limitations of a centralized control system where data can be tampered with when shared with other people. Other key issues with the traditional database management systems include a lack of participants' accountability, poor accuracy in tracking items, difficulty locating and fighting counterfeits, and stock management problems.

III. Purpose of the Study

This study will explore the possibilities of using blockchain technology to ensure the transparency of tracing COVID-19 vaccine data from registration, storage, delivery, and potential aftereffects. Blockchain's biggest advantage over the traditional database management system is the immutability of vaccine data and information integrity. As every vaccine is monitored, every link along the chain would help in keeping track of the whole process ,and the health department will monitor the entire chain to ensure proper functioning.

Research Question

(i) How can blockchain technology be applied in the management of COVID-19 vaccine data?

Research Objectives

   (i)   To discuss what blockchain tech is and the potential for implementation in healthcare

  (ii)   To discuss the opportunities for using blockchain technology to store and distribute COVID-19 vaccine data

 (iii)   To discuss the advantages of blockchain technology in managing COVID-19 vaccine data over a traditional database management system.

IV. LITERATURE REVIEW

According to [13], Blockchain is described as a mechanism for logging data that makes it harder to alter, hack, or cheat the structure. A blockchain system is a digital ledger of transactions replicated and shared across the whole grid of computer networks on the chain.

Every block in the chain bears numerous trades, and in each instance that a new connection is made in the Blockchain, a memory of the transaction is included in every member's ledger. Blockchain thus worked as a decentralized database administered by several participants and referred to as Distributed Ledger Technology (DLT) [13]. The hash system is such that if one block in the chain were altered, it would be clear that it had been interfered with. [13]claims that a blockchain is a form of DLT whereby transactions are logged using an absolute cryptographic autograph referred to as a hash.

According to [15], Every chain in the Blockchain comprises several blocks, and each block consists of three components that include data in the league, a 32-bit entire numeral that is referred to as a nonce, and the hash. The nonce is arbitrarily made when a partnership is created, making a block title hash.

As per[17, 18] Miners must use special software to resolve the intricate computations of locating a nonce that produces a good soup. Up to 4 billion nonce-hash groupings must be mined before one is found.

According to [3], decentralization is one of the most vital notions in blockchain technology. No single computer or company can own an entire blockchain. Instead, it is a dispersed ledger through the nodes linked to the chain that owns the chain. The nodes can be any form of electric device that upholds the copies of the Blockchain and ensures that the network functions well.
Every node keeps its duplicate of the Blockchain, and the grid has to computationally support the recently mined block for the entire Blockchain to be reorganized, reliable, and authorized [3].

[16]claims that blockchain technology can be implemented in the medical sector since it is not limited to just virtual currencies. The conventional and general means of vaccine traceability and management are predicated on the figure cataloging technique, which inherently has three significant issues:

1.   Numbers can be forged easily, causing a concealed danger of fake logs.
2.   The numerical system is usually so big to uphold on a countrywide scale.
3.   Vaccine data is generally prone to tampering or deletion.

In the vaccine blockchain scheme design, every vaccine is allocated an RFID tag used to input the vaccine data suitably and without much human intervention or workload. RFID is a safe and established technology extensively implemented in the public transportation scheme
For the third inherent issue of tinkered records, Blockchain would eschew having a centralized server. It is thus hard for malicious hackers to interfere with or delete such records[16].
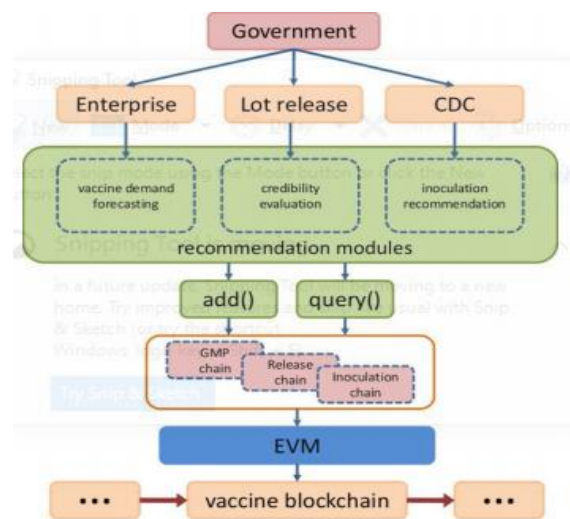
Figure 1. The Outline of the Vaccine Blockchain System

V. METHODOLOGY

Introduction

The qualitative study sought to align the blockchain framework to manage COVID-19 vaccine data. The literature review section discussed how Blockchain works as a decentralized database administered by several participants as a Distributed Ledger Technology (DLT). The methodology involved mapping information to discuss how Blockchain can be applied in the vaccine supply chain system.

Steps Involved in the Methodology

- The initial step in the methodology thus entailed identifying apposite keywords that would be inserted or pasted in online databases and libraries to locate the best sources for the study.
- After selecting fitting keywords, the second step involved pasting the keywords into the online libraries to select the best sources to be used.
- The researcher would then modify the set of keywords to select the best ones to be used while removing the unrelated ones.
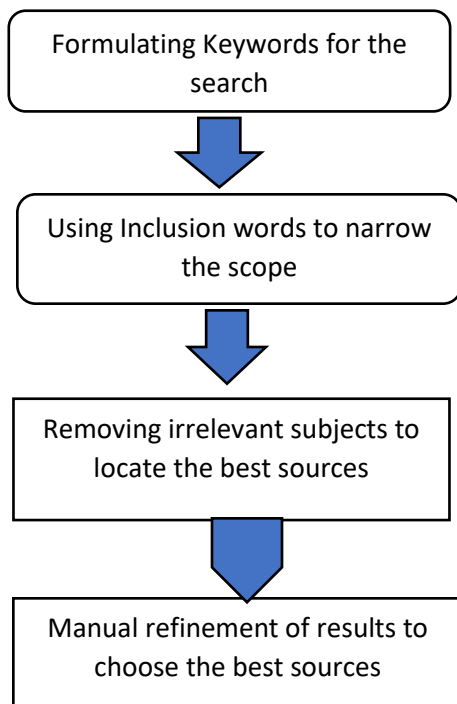- The third step in the methodology

Formulating Keywords for the search

Using Inclusion words to narrow the scope

Removing irrelevant subjects to locate the best sources

Manual refinement of results to choose the best sources

Chart 1. The Stages of the Methodology

The keywords that were to be used in the study include 'blockchain technology, 'how blockchain technology works,' 'application of blockchain technology in healthcare, and 'application of blockchain technology in managing COVID-19 vaccine data'. The keywords were pasted in online databases and libraries like Google Scholar, SAGE Journals, and EBSCO Host. Since the researcher required peer-reviewed materials to be used in the study, the sites were important for selecting the best peer-reviewed materials. The researcher narrowed the scope of the study by using conjunctions such as 'AND' and 'OR' as inclusion words. The researcher

shifted between the various online databases and then selected the best sources on the pertinence of the knowledge and information in discussing blockchain application in COVID-19 vaccine management.

Conclusion

After the input of the keywords in the search buttons of the online databases and libraries, the average search results were 50,917 sources. Upon inserting the inclusion words, the average yield of the search results was 2,013 sources. The removal of irrelevant sources yielded 195 sources, while the search results' manual refinement yielded 17 sources. In the end, the researcher was able to utilize the 17 sources to show how blockchain technology can be implemented in managing COVID-19 vaccine data.

RESULTS AND DISCUSSION

Blockchain is considered the best infrastructure platform for supplying COVID-19 vaccine data because it satisfies two significant prerequisites for creating the digital trust (Antal, Cioara, Antal&Anghel, 2021). First, it is not owned by any person. It offers a general and consistent protocol that every participant along the supply chain can easily link and share the pertinent data. Second, Blockchain is immutable, and thus current data cannot be erased, only added, which brings a higher level of answerability for all participants appending new information. [10].

The outcome is a real-time platform that offers an entire track of every item, including extra data as needed (Azim, Islam &Spranger, 2020).

COVID-19 Current Supply Chain

The current supply chain of the COVID-19 vaccine is such that manufacturers produce the vaccine and then track the delivery of their shipment [14]. The implementation of blockchain technology would present an advantage in the immutability of the storage conditions of vaccine data and resources [7]. Monitoring every vaccine over the blockchain technology will be such that every link along the Blockchain can keep track of the whole process, and health departments can monitor the chain in its entirety to intervene where necessary to guarantee proper functioning [2].

All medical institutions that deal with the COVID-19 vaccine can manage their stocks better by reducing the demand and supply constraints and getting verifications on vaccine authenticity or proper storage conditions.

Components of the Blockchain-powered COVID-19Vaccine Supply Chain

GMP Chain

Returning to figure 1, the blockchain supply chain components include GMP chain, the Release chain, and the Inoculation chain. To begin with, vaccines are considered a special kind of enterprise[9]. While vaccines companies work to ensure optimum efficiency, reduction of operation costs, and improvement of operational efficiency, they are also subjected to more social responsibility compared to regular companies, where manufacturing and operational processes are subjected to stricter supervisions by the FDA (Food and Drug Administration) (Bansal, [6].

For vaccine companies, they must adapt to the GMP standards' design to record all processes involved in

| Production Record	Packing Record
Name of product and the batch number Date and time of production Signatures of the head of manufacturing and then the reviewers Batch numbers of raw and supplementary materials with weight included Parameters of the manufacturing equipment A record of control results and the signatures of the operators A record of any abnormalities witnessed and signatures of operators A quality assurance period	The product name, packing forms, and batch numbers Production dates and validity periods Dates of packing operations Signatures of personnel involved in packing vaccines, including the operator Batch number of packaging materials used Review records in accordance with process regulations Details of packing operations inclusive of amount of equipment on the assembly line Printed packaging materials with batch number and a validity period Abnormal records followed by investigation reports, and signatures of those who are involved.
Inspection Record	**Inoculation Record**
The name of the product, dosage form, specifications, and batch number Quality standards and inspection procedure Type and specification of equipment used in inspection Batch number of test solution and standard product Data of the animals used during inspection Data on inspection process and results Date of inspection Signatures of the officials and inspectors involved in the inspection process Signature of the reviewer Date of review	Identification of the vaccine recipient Gender of the vaccine recipient The age of the vaccine recipient Name of product and batch number The address of inoculation The date and time of inoculation The dosage that is given to the patients The doctor involved in the vaccination process

The blockchain technology system would thus streamline vaccine distribution to save lives and minimize vaccine hesitancy, an issue WHO (World Health Organization) named one of the top threats to public health [1].

the production of the vaccine[9].GMP is a quality assurance system that ensures that food and drug products are manufactured consistently and safely. GMP is intended to mitigate the risks in production that cannot be eradicated through tests on the final product. GMP standards need companies to capture

every vaccine's production data from packing to inoculation[4].

Table 1. The Production, Packing, Inspection, and Inoculation Records

The Release Chain
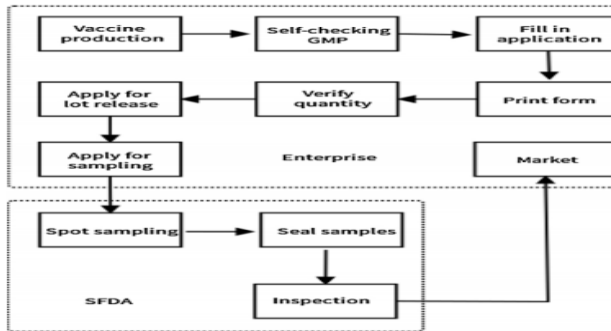
Figure 3: The Vaccine Lot Release Process

Manufacturing a vaccine is a multi-step process that should satisfy the GMP quality ideals. After the internal review, the company can proceed to apply for a GMP certificate from the FDA. The next step is submitting the application form for the lot release, after which the company applies for vaccine sampling. When a recipient is inoculated, they should submit an inoculation application to the CDC and receive the CDC's injection [4].

Challenges to Adopting Blockchain Technology in COVID-19 Vaccine Supply Chain

The COVID-19 pandemic has affected and reshaped people's social lives and businesses. Digitizing vaccination certificates through Blockchain to re-open businesses would mitigate the spread of the coronavirus. The features of blockchain technology like traceability, decentralization, and transparency would enhance trust levels among the involved parties. However, there are still challenges that would affect the implementation process. The slow adoption of blockchain technology has been due to reduced incentives for companies to overhaul their legacy business practices that have worked well over the years [5, 12].

CONCLUSION

Blockchain technology has become a buzzword given the ubiquity of Bitcoin crypto currency. Blockchain technology works as a digital ledger of transactions replicated and shared across the entire network of computer networks on the blockchain. The ongoing COVID-19 pandemic has led to a rapid spread of the coronavirus leading to a rising death toll and an increase in transmission rates. The recently discovered COVID-19 vaccines present good news and a promise of a quick return to normalcy. However, the success of the COVID-19 vaccine's rollout and distribution will be contingent on the accessibility of an effective and open distribution chain that the relevant stakeholders can audit.

The implementation of blockchain technology in the COVID-19 supply chain would be designed to offer a cooperative, accountable, and collaborative environment for all the entities involved in the logistics of PPEs and vaccines. Blockchain is a relatively new technology, meaning that most people are skeptical about it. The adoption rate can be enhanced by guaranteeing operational transparency and assuring compliance with regulations like GDPR to ensure users' privacy. Blockchain technology would be beneficial to the COVID-19 vaccine supply chain due to theend-to-end traceability feature that offers real-time visibility of vaccine distribution, reduced risk of fraud and disruptions, and safety and efficacy assurance that builds trust.

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