Covid-19 Vaccination: A Strategic Approach Using Block chain Technology

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Abstract. The covid-19 virus made its first appearance in late 2019. The virus originally arose in Wuhan and spread around the world as a result of people traveling. The SARS-CoV-2 virus has two traits that pushed the entire globe into a worldwide lockdown: exponential spread and high fatality rates. Health and economic crises, as well as social divisions, have placed the world in a precarious position. Unprecedented pressure on the health-care system highlighted several flaws not only in this business but also in many other industries, posing a new set of dif- faculties for researchers and scientists. An important step to attend in short time period to end the pandemic is vaccination. The vaccines had been clinically evaluated and authorized, bringing us to the immunization stage. In this situation, safety, security, transparency, and traceability are critical. In this paper, we propose a Block chain-based system to manage vaccine registration, storage, and distribution as a contribution to ensuring an effective immunization campaign.
Keywords: Block chain Technology, Covid 19, Immunization, Virus, Vaccination.

1. Introduction

The COVID-19 epidemic had an immediate impact on the planet and our lives [1]. Unfortunately, millions of people have already died as a result of this infection. Since its discovery in Wuhan, China, in December 2019 [2], it has spread fast by community transmission, resulting in roughly 65 million confirmed cases and over 1.5 million fatalities by December 2020. Even though enormous attempts were made to combat the pandemic, the virus spread was barely halted. Restric- tions are still in place in several nations to avoid choking hospitals and treatment facilities. Vaccination is one way to put a stop to the pandemic. Vaccines are a vital tool for preserving life and protecting individuals from diseases such as covid-19. It causes the immune system to produce antibodies in order to avoid coming into touch with the virus. It is vital to get vaccinated not just to protect one, but also to help prevent the spread of viruses [3]. The quick roll-out of a vaccine and the deployment of a global vaccination campaign are crucial. In this setting for pandemic control. Pharmaceutical firms have focused their efforts from the start of the epidemic on finding a vaccine in record speed in order to stop COVID-19 containment. While several COVID-19 vaccines are in the last stages of testing, mass vaccination preparation and planning becomes critical. Nonetheless, a number of factors are expected to impact the COVID-19 vaccination program's effectiveness. In the event of a pandemic, a vaccination may be the most effective counter- measure. Individuals are often given priority for vaccination depending on their risk profile and rate of transmission. A solid plan is critical for the success of an immunization process (once the illness has spread to more specific groups of individuals), always taking into account the most efficient use of vaccine re- sources [4]. Block chain, in our opinion, may give the technological means to solve them. The first is the availability of an end-to-end supply chain and logistics sys- tem that is functioning and transparent. Block chain is a set of distributed ledgers made famous by the crypto currency. Data is spread across the network in Block chain, making data tampering harder.

COVID-19 vaccine distribution can be more efficient and transparent with regard to block chain, which ensures traceability and a thorough audit of storage and delivery circumstances. Data accountability and provenance monitoring in vaccination delivery might be totally automated with block chain-based solutions. As a result, it will be possible to integrate various information of silos owned and maintained by various sorts of stakeholders along the distribution chain. The COVID-19 vaccination supply chain may be traceable by self-enforcing smart contracts. A tamper-proof record of a breach in ensuring the delivery conditions will be kept on the block chain. Due to the distributed ledger block distribution and replication characteristics, all network peers will be made aware. Finally, the block chain may serve as verification of the distribution chain, making counter- feiting the vaccine extremely difficult. Medical units and vaccination recipients would be able to track it back to the corporations that have registered the vac- cine batches in circulation at any time. The second factor is the accuracy and transparency with which persons are registered and managed on the vaccination waiting list. The information on this list is not only sensitive, but it also neces- sitates accuracy, immutability, and the avoidance of impersonation. Block chain technology may be used to deliver these qualities. Block chain has the potential to transform how the waiting list is administered by allowing parties who are not known to each other to securely transact the vaccine as a digital commodity without the need for a central trusted intermediary. The need for third-party businesses to organize and administer the waiting list will be eliminated with such a decentralized approach. All network peers can restrict access to their private information thanks to the immutability of transactions and the authorization offered by smart contracts. A smart

contract's activities may be broadcast over the network and recorded on the block chain, making them publicly trans- parent. Transactional privacy, as well as personal data privacy, may be ensured by incorporating revolutionary solutions, which are cryptographic approaches. that may enforce privacy for confirming private data without disclosing it in its form. Finally, by developing an open and public reporting system for probable adverse effects, the third objective is to develop faith in the vaccine's effectiveness. In this regard, a block chain platform would offer benefits over current state- of-the-art systems. The vaccination lot will be associated with a transaction, which will be replicated across the network. All other peers will be informed, and the report will be confirmed by the peers' agreement on the vaccination lot. Furthermore, because all reported adverse effects are maintained in an im- mutable log, they are safeguarded against manipulation. The remainder of the paper is organized as follows. Section 2 reviews related to current literature work. Section 3 introduces the architecture of block chain technology in detail. Then, Section 4 presents the details of block chain approach for vaccination Finally, we concluded this paper in Section 5.

2. Related Work

In the state of the art, ICT solutions for aiding vaccination campaigns are generally recommended for optimum vaccine distribution planning [5]. In [6], a drive- through vaccination simulation tool based on event processing and agent-based modeling is provided for design and feasibility assessment of such facilities to reduce waiting times, staff required immunization intervals, and other factors. In the event of an influenza outbreak, vaccine distribution for a diverse population has been tackled using mathematical modeling with an equity constraint to ensure justice and maximize the quantity of vaccine doses [7]. For optimizing distribution network architecture, many heuristics and specific optimization algorithms have been suggested [8]. Recent advances in modern technologies such as the Internet of Things (IoT), machine learning, and block chain have paved the way for the development of more intelligent and inventive systems that may be used to a variety of sectors, such as healthcare [9]. The authors [10] propose IoT devices to track the carrier's position, temperature, and humidity in order to optimize and increase vaccination coverage in distant areas while maintaining transparency in the process. In [11] the author, describe block chain-based decentralized methods for resolving healthcare sector concerns such as data protection and confidentiality. Recent research have highlighted the potential of block chain in battling the COVID-19 pandemic, with the majority of them focusing on decentralized contract and symptom monitoring, as well as ensuring security and immutability [12]. The author [13] discusses relevant application cases for block chain technology in COVID-19 pandemic contact tracking, patient data exchange, and supply chain management. Other research has showed that block chain may be utilized to construct trustworthy prediction algorithms that can aid in the containment of pandemic threats on national territory or to track citizens' movements in quarantine circumstances utilizing IoT infrastructures [14]. To combat the COVID-19 pandemic, incentive-based systems have been developed that employ block chain to avoid data manipulation and incentives for rewarding patients who stay in quarantine.

Industry supply chains have been offered as a method for organization and administration using block chain. IoT and block chain frameworks may offer a feasible solution for pharmaceutical supply chains where temperature monitor- ing and counterfeit medicines prevention are critical [15]. In [16], a machine learning recommendation engine is integrated with a block chain medicine sup- ply chain management system. Hyper ledger fabrics are employed in the supply chain management system to continually monitor and track the medication de- livery process, while N-gram and Light GBM models are utilized to propose the best medications to clients. In [17], the Gcoin block chain is recommended for drug data flow in order to provide transparent drug transaction data in which all units participating in the drug supply chain may participate at the same time in order to avoid medication counterfeiting. There are few techniques in the literature that address the creation of block chain-based vaccination delivery platforms. The authors [18] propose a block chain-based management system for monitoring vaccination supply chains using smart contracts that also handle vaccine expiry and fraud detection. Machine learning models are used to make recommendations on which vaccinations and vaccination procedures to utilize. In [19] proposes a block chain approach for the COVID-19 vaccination delivery network. The concept recommends tracking each phase from development to application, taking into account emerging and commercial chains and relying on block chain to authenticate and track modifications. Similarly, in [20], smart containers with IoT sensors are suggested and utilized to govern shipping, payments, and receiver legitimacy, among other things. VeChain [21] is working on a block chain-based infrastructure for vaccine manufacturing and tracing in China, which will use IoT devices to gather vaccine manufacturing data and store it on an enterprise block chain for immutability. Finally, because COVID-19 will require two vaccine doses, block chain can assist monitor vaccines and ensure they haven't been tampered with, as well as maintain track of patients' vaccine records and offer evidence of immunization.

3. Block chain And Smart Contracts

Block chain technology was first introduced in 2008 by Satoshi Nakamoto and gained popularity as a Bit coin crypt currency technology [22]. Its distributed ledger technology attracted many participants to exchange digital coins via de- centralized network without third party intervention. The block chain technology provides salient features such as decentralizations, accountability, security, trans- patency, traceability and immutability [22]. Due to its nature, various industries shown interest towards the block chain technology and successfully implemented in business, finance and healthcare. In healthcare the main concern is to protect the privacy of patient information which in turn is the key component of block chain technology. The blocks are defined as list of records/ledgers that permanently store data

related to the Bit coin network. Each block contains a cryp to graphic hash of the previous block, a timestamp, and transaction data. The different structures of block chain technology fall under three categories namely public, private and Consortium. Public block chain are open source and can be access by anyone who is interested to participate. Few examples of such structures are Bit coin, Ethereum and Lit coin. The well known algorithm used is Proof of Work (PoW). In contrast, private block chain is controlled by specific organization or authorized users and participants need to request for permission to join the network, and all transactions are available upon access provided by the authorized participants only. While Consortium block chain consist of a few organizations with laid out procedures and controlled by the preliminary assigned users. An overview of a block chain structure is as shown in Fig. 1.
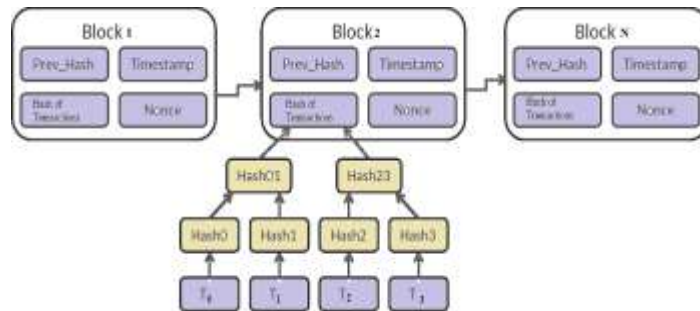

FIGURE 1. Block Chain Architecture

In public block chain, the transaction to be added are completely transparent to all participates with the help of consensus. In contrast, for private block chains, the authorized used will valid the transactions upon the request of participant to join the network, and all transactions, while Consortium block chains are adapt- able in that they allow users to select whether certain data can be made public or kept private [11]. The technology framework for constructing decentralized application is pro- vided by block chain. It consists of a linked list of blocks connected together by hash pointers, each block holding transactions for a digital asset [11]. As a result, block chain technology is built on hash-based data structures, which provide features such as collision avoidance, data binding, and data concealment. As a result, the transactions are recorded in tamper-evident data structures, resulting in a log of state changes that may be used to track data origin and traceability. State transitions can refer to a coin transaction, such as Bit coin, smart contract state updates, such as Ethereum, or a property, such as DigiShares, among other things. The log of transactions is immutably sealed by mining algorithms, which rely on the cooperation of all network members. Block chain is a strong technology for developing secure and dependable decentralized systems because of the immutability of the structures and the security provided by asymmetric cryptography. In any case, malevolent participants' assaults must be addressed. They are entering the network in order to sabotage the validity and integrity of the validation process or to generate forks in the chain's linear structure. Due to the difficulty of mining (e.g., Proof-of-Work algorithm) or other types of consensus algorithms [22], which need the consent of over 50% of network members, this is avoided in block chain. Proof Protocols are the most widely utilized consensus algorithms in block chain networks. Proof of Work (PoW) is the consensus mechanism employed by Bit coin and Ethereal, two of the most well-known public block chains. In the COVID 19 epidemic, QR codes were also the primary way of touch less engagement, particularly in hospitals. We propose a block chain system to handle the distribution and administration of COVID-19 vaccinations, based on the state of the art provided in Section II. In our instance, vaccination is the most important digital asset. On the block chain, transactions reflecting the interactions of various parties with the system, as well as the passage of vaccines along the supply chain from creation to administration, are recorded. Smart contracts establish vaccine distribution administration rules that are replicated in each network node and enable for transaction validation.

4. A Block chain Approach For Vaccination

The quick roll-out of a vaccine and the deployment of a global vaccination campaign are crucial in the context of the COVID-19 pandemic, but their success will be contingent on the availability of an operational and transparent distribution chain that can be audited by all stake holders. We examine how block chain technology may aid the COVID-19 immunization plan in a number of ways. We offer a system that use block chain technology to ensure the data integrity and immutability of vaccination beneficiary registrations, preventing identity theft and impersonation. Smart contracts are designed to monitor and track appropriate vaccine distribution circumstances against vaccine makers' safe handling requirements, allowing all network peers to be informed. A transparent and tamper-proof method for adverse effects self-reporting is given for vaccination delivery, taking into account the beneficiary and administered vaccine association. Here, we present our digital strategy to assisting a country's immunization procedure. We provide a framework with roles and their relationships that consider the entire process from vaccine manufacture to immunization. The purpose is to solve issues such as a lack of registration records and record uniformity, which can

help with the development of a strategic vaccination strategy as well as vaccine manufacturing and distribution coordination. We choose Block chain as a digital platform primarily because of its stability. As a result, it is possible to minimize data manipulation and minimize situations of faked records by eliminating the lack of records (because information about the vaccination is
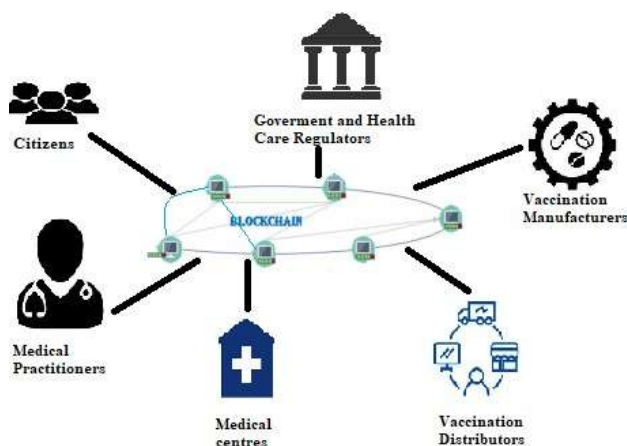

FIGURE 2. A Block Diagram for Vaccination Management using Block Chain Technology

The figure 2 presents the block diagram for vaccination management using blockhead technology. Vaccination is well recognized to be a difficult process that varies by country. We present a generic and reliable methodology in this work. On order to man- age data modification in the Block chain, roles must be specified. To ensure data consistency, we limit the types of data that each role may register or retrieve. The entity that regulates and directs operations in a society is referred to as the Government. The Government plays the most important function, as it has access to almost all data. Any individual in a society is represented by the term "person." A vaccination can be given to a person. The firm that prepares and registers vaccine batches/lots for delivery is known as the vaccine manufacturer. IoT sensor devices that monitor vaccine distribution, storage, and handling in real time by vaccine distributors. Medical Centers are any government-approved vaccination centers for providing immunization. The medical centers will receive and prepare the vaccine for administration to the beneficiaries. the doctor who verifies the vaccination recipient, delivery, and storage conditions, as well as administering the vaccination. Beneficiaries register for vaccination, and all activities are recorded as immutable transactions in the distributed ledger, which are stored in blocks that are copied to all peer actors in the chain.

Block chain represents the network that Government, vaccination manufacturer, distributors, medical Center, practitioners and citizens where data is stored. Data is divided into two categories: public and private. Block chain technology is widely used because it is a decentralized public ledger system with built- in consensus processes [23]. An attack on this network would be prohibitively expensive and time-consuming, discouraging the attempt. At the same time, by utilizing decentralized records, it is possible to have trustworthy access to information [24]. The biometrics and rudimentary information of a person should be included in the national identification to be used in the system. For instance, in India, Aadhaar is a 12-digit unique-identity number assigned to all Indian individuals based on their biometric and demographic information. The data is collected by the Unique Identification Ascendancy of India (UIDAI), a statutory ascendancy within the Ministry of Electronics and Information Technology that was created in January 2009 by the Regime of India. Aadhar is being used by a number of firms in India to expedite the process. In most situations, research and interviews done during the initiative's early phases revealed that pharmaceuticals arriving straight from the manufacturer's facility are reliable, and that the danger of fake pharmaceuticals entering the supply chain occurs when the items are passed between the various stages and levels (i.e. wholesalers, distributors, or sub-distributors). Drugs can be stolen, falsified, and substituted at every stage along the way from the factory to the patient. As a result of such negligence, pharma companies lose money and, more significantly, patients' safety is jeopardized. Block chain technology was discovered to have the potential to increase transaction transparency, efficiency, and dependability in the highly regulated pharmaceutical business. Manufacturers and other supply chain participants can use block chain to gain real-time data access and increased visibility throughout the supply chain, from raw material/API suppliers' product codes to pharmacy stores dispensing prescription/OTC medicines to patients. End-to-end traceability of pharmaceutical drugs: Provide streamlined visibility of the movement of drugs or medicines at each stage/stakeholder in the value chain. This improved traceability facilitates the optimization of drug flow and an efficient inventory management system, leading to considerable improvement in planning of stocks. Transparency improves accountability: Drugs may be tracked throughout the supply chain at each point of ownership. It is also feasible to track down the players or parties engaged in the supply chain. If an issue occurs during the distribution of pharmaceuticals or treatments, block chain may be used to track down the last stakeholder through whom the product traveled.

5. Conclusion

We described a block chain-based system for tracing COVID-19 vaccination registration, storage, and delivery in this study. To prevent identity theft and impersonation, block chain is utilized to provide data immutability, transparency, and accuracy of beneficiary registration for vaccination. Decentralized smart con- tracts can be used to track and monitor vaccination delivery against producer- defined standards for safe manipulation. A block chain system for vaccination administration provides transparent and tamper-proof self-reporting of adverse effects, individual identity, and vaccination association. All of the important factors we outlined for a successful monitoring campaign would be effectively addressed by the proposed system improve the efficiency and transparency of COVID-19 vaccine distribution by ensuring traceability and a thorough inspection of storage and delivery conditions. It also ensures transparency and accuracy in the registration and maintenance of the vaccination waiting list.

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