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VACCINATION SYSTEM USING BLOCKCHAIN

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1. PROBLEM DESCRIPTION

Design and implement a vaccination system that keeps track of vaccine administration, post administration side-effects, and issuing of vaccine certificates.

2. INTRODUCTION

COVID-19 virus, part of the coronavirus ribonucleic acid virus family, has generated a worldwide pandemic. It is very easy to spread and has been the cause of a lot of pressure on the healthcare system as well as for the levels of society. Since its identification in Wuhan, China in December 2019, it has spread rapidly through community transmission, generating up to December 2020 to around 65 million confirmed cases and more than 1.5 million deaths. Even if significant efforts have been made for fighting the pandemic, the spreading rate of the virus has only slowed. In many countries, restriction measures are still in place to avoid suffocating the hospitals and treatment centres. In this context, the rapid rollout of a vaccine, and the implementation of a worldwide immunization campaign is critical for the control of the pandemic.

Hence, since the beginning of the pandemic pharmaceutical companies have concentrated their efforts on developing a vaccine in record time to achieve COVID-19 containment. Preparing and planning for mass immunization has become extremely important. Several aspects are likely to affect the success of the COVID-19 immunization program if they are not properly addressed.

[2]The implementation of a worldwide immunization campaign is critical, but its success will depend on the availability of an operational and transparent distribution chain that can be audited by all relevant stakeholders. Blockchain technology can be used for assuring the transparent tracing of COVID-19 vaccine registration, storage and delivery, and side effects self-reporting. Such system implementation in which blockchain technology is used for assuring data integrity and immutability in case of beneficiary registration for vaccination, eliminating identity thefts and impersonations.

New technologies have emerged to improve the functioning of the blockchains. This is the case of Ethereum, which has the execution of smart contracts in its architecture. These contracts are algorithms inserted in this network, and that can be sent by blockchain, have automated behaviours, do not require third parties, and provide greater security to all parties.

Smart contracts are defined to monitor and track the proper vaccine distribution conditions against the safe handling rules defined by vaccine producers enabling the awareness of all network peers. For vaccine administration, a transparent and

tamper-proof side effects self-reporting solution is provided considering person identification and administered vaccine association.

Transactional privacy, as well as the privacy of personal data, can be assured using novel solutions such as the incorporation of zero-knowledge proofs which are cryptographic techniques that can assure privacy for verifying private data without revealing it. Blockchain can increase the efficiency and transparency of COVID-19 vaccine distribution assuring the traceability and the rigorous audit of the storage and delivery conditions.

The blockchain-based solutions may provide a fully automated implementation of data accountability and provenance tracking in vaccine distribution, which will enable the integration of different information silos as well owned and managed by different types of stakeholders on the entire distribution chain. Self-enforcing smart contracts may assure the traceability of the COVID-19 vaccine supply chain, especially the cold part of the chain in which the vaccine needs to be kept at extremely low temperatures to remain viable.

Moreover, a breach in assuring the delivery conditions will be registered on the chain in a tamper-proof manner and all the peers of the network will be made aware due to the distributed ledger block distribution and replication features. Furthermore, the blockchain can act as proof of the delivery chain, making it impossible to counterfeit the vaccine, since at any point the medical units and the vaccine beneficiaries would be able to trace it back up to the companies that have registered the vaccine lots in circulation. The development of machine learning technologies provides additional ways to analyze the data in information management systems. Smart contract functions and can be used to address the problem of vaccine expiration and vaccine record fraud. Additionally, the use of machine learning models can provide valuable recommendations to immunization practitioners and recipients, allowing them to choose better immunization methods and vaccines.

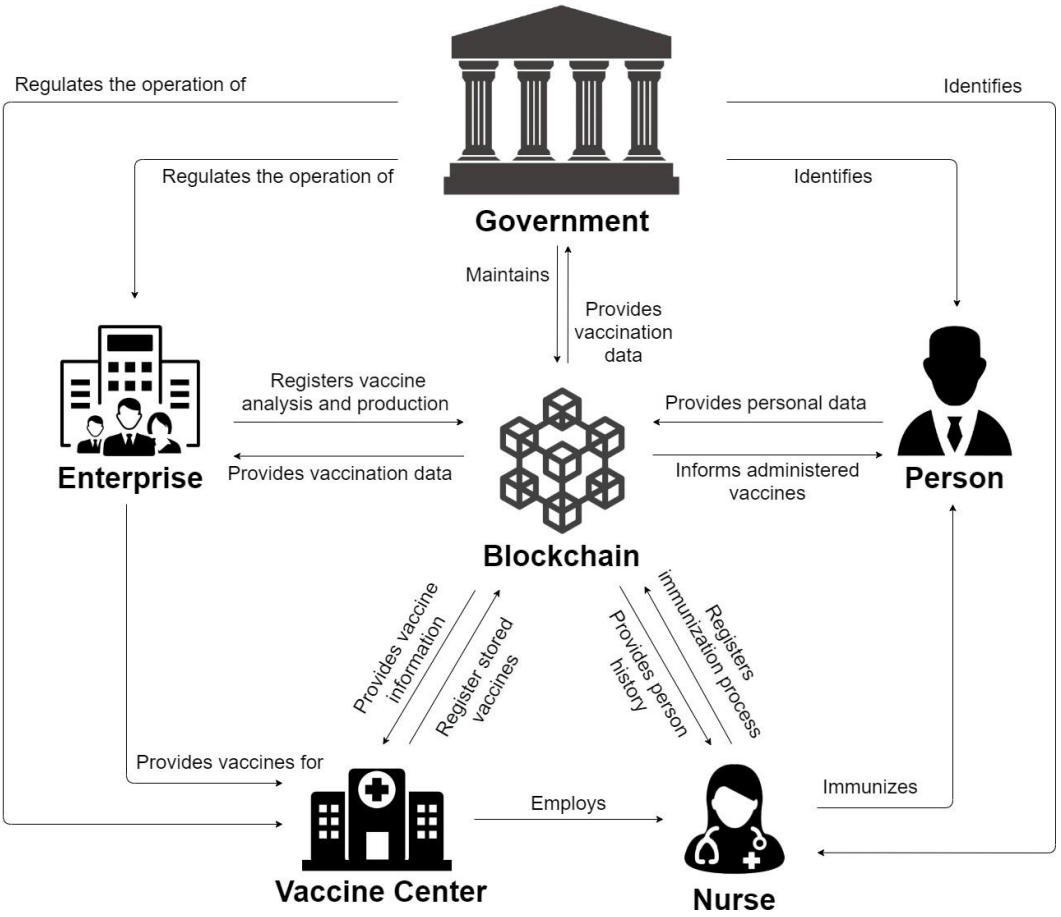

Figure 1:Blockchain approach for vaccination[7]

A blockchain-based system can bring the following contributions: -

1) A blockchain-based solution for data immutability, transparency and correctness of beneficiary registration for vaccination, eliminating identity thefts and impersonations

2) A decentralized smart contracts-based monitoring solution for assuring proper vaccine transportation conditions in a cold chain and real-time awareness of all peers about the fulfilment of COVID-19 vaccine delivery and storage conditions.

3) A blockchain solution for vaccine administration and transparent andtamper-proof self-reporting of side effects, person identification and vaccine association.

The main objective of this study is to develop a blockchain-based system for transparent tracing of COVID-19 vaccine administration, side effects self-reporting and issuing of vaccine certificates.

3. LITERATURE SURVEY[4][5][6]

VACCINE ADMINISTRATION:[1]

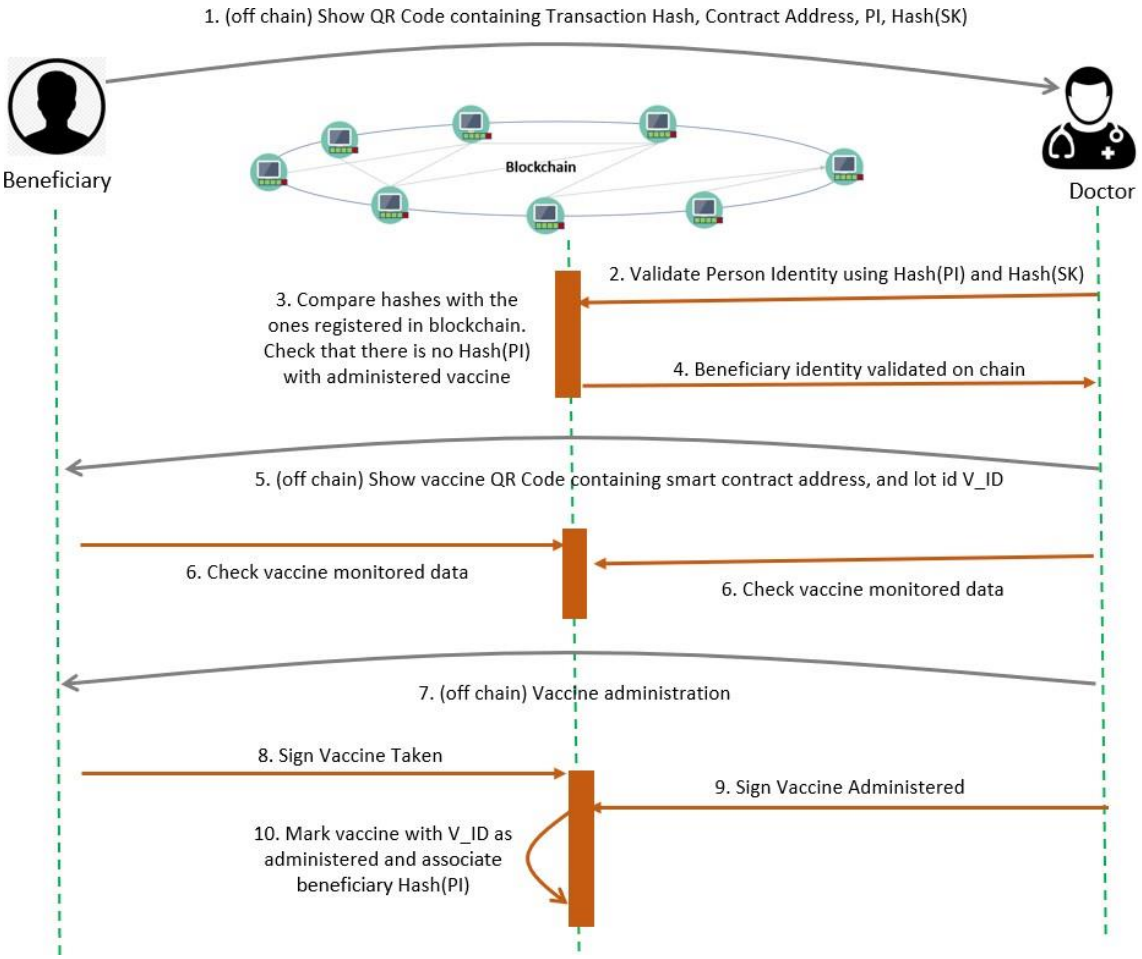

Figure 2: Vaccine Administration Sequence Diagram

Before a vaccine can be administered, two details need to be checked: identity of beneficiary and conditions of vaccine handling.

Validation of beneficiary identity is performed by the doctor using a QR code generated during the registration process. The QR code contains the blockchain transaction hash, smart contract address, Hash of beneficiary's Personal Identification(PI) number and hash of a secret key (generated by the beneficiary during registration to prove their identity). During the verification process, Hash of the PI number and secret key is compared with the Merkle root stored in the blockchain.

After beneficiary identity is verified, QR code is scanned to extract vaccine information and smart contract address. If all conditions for vaccine storage and transport mentioned in the smart contract are met, the vaccine can be administered.

After administration, signatures from the doctor and beneficiary are used to mark the vaccine as administered on the blockchain. This is done using the Hash of the PI number of the beneficiary. Vaccine count is decremented, and the association between beneficiary and vaccine is registered on the blockchain.

HEALTH RECORDS AND SIDE EFFECTS:[1]

Before administration of a vaccine, the beneficiary's health records are collected and verified to check if the beneficiary is eligible to receive the vaccine.
Any beneficiary that has received a vaccine can register feedback and the eventual side effects encountered. By registering the side effects directly on the chain, the possibility of having the information censored is made impossible. The beneficiary will sign a blockchain transaction that is authenticated and authorized and verified against the vaccine administered from the specified lot and correlated with reports of the other beneficiaries. If so, the side effect registered is stored on the chain. Once the side effect is registered by the beneficiary, the information is stored as an immutable log, thus any attempt of third parties to alter it will be unsuccessful.
Based on the side effects registered, this data which is stored in the network can be used to conduct specific studies and analysis, in benefit of all roles. For instance:

- Number of people immunized by a given vaccine
- It provides evidence about preference or usage of a specific vaccine type
- Number and location of people immunized by a given vaccine

VACCINATION CERTIFICATE:[3]

The system collects vaccination data online through a dedicated application. Third-party system that processes the creation of each transaction and storing it in the Blockchain is needed to expedite the development process.

Each vaccination record is assigned a unique hash generated at the beginning of the vaccination transaction and the hash is then deposited in the Blockchain. Data is encrypted so that Blockchain records are kept private and secured. Thus, the root chunks are securely stored in smart contracts through the Blockchain, and released only under specific conditions.

The document recognizes the signature by combining a hash produced with a private key issued to the beneficiary to generate one unique digital signature code. The code will be combined with timestamps to create a unique digital signature, which is then indicated in the paper. In addition, the signature is secured by a combination of hash, private/public keys and timestamps.

Four elements of the certification consisting of the following :-

1. Hash generated by the hash generator

2. Public key
3. Private key
4. Timestamps indicating the accuracy of time the certification is issued.

4. CURRENT SCOPE

- Implementing a blockchain based system for covid-19 vaccination makes post-covid management easier. All the countries are now working on administering the vaccine to their citizens. Currently, besides selling vaccine doses, people on the darknet are even giving vaccination records to help their customers travel easily. The need for secure and consistent management of beneficiaries and a fully digitalized system is highly required.
- Even after the pandemic is under control, we need a system of securely sending and receiving Health Records and maintaining an immutable ledger to store data privately. The suggested system can provide a bridge to a distributed, immutable, and decentralized health care system.
- Our proposed Blockchain vaccination system shall preserve and deposit vaccination data in the Blockchain in a secure private manner. The system helps health care agencies to record and track the number of vaccinations scheduled, delivered, and any possible side effects that each type of vaccine may have on the general population.

5. SOFTWARE REQUIREMENTS

- Windows 10 OS
- Google Chrome
- Metamask Extension
- nodeJS
- Solc-JS
- Ganache Client
- Truffle Suite
- VS Code

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