

Blockchain Based Covid Vaccine Booking and Vaccine Management System

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Abstract—Immunization is all about using Block chain for managing and tracing the vaccine stocks, logistics and transparent distribution. Immunization gives you continuous visibility and enables actionable insights to track vaccine distribution and ensure a fair and equitable distribution. Immunization allows you to book your vaccination appointments and will also allow you to keep track of the vaccine being distributed. Block chain helps in maintaining the integrity and transparency of the whole process right from inception of the vaccine.

Keywords-Vaccine Distribution using Blockchain; COVID-19; Immunization programs; Transparent Vaccine Distribution.

1. INTRODUCTION

The prevalence of corona virus which leads to respiratory infections with symptoms ranging from the common cold to more severe diseases such as Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS). Since then, the eyes of the world have been on the pharmaceutical sector as industry leaders race to test, produce and distribute a vaccine to combat COVID-19. On March 11, WHO concluded that COVID-19 could be a pandemic. Worldwide the partners are working together to reduce the spread of disease by developing multiple vaccines. Once a vaccine is approved by WHO for common people's disposal, attention will turn on to the orchestration and the planning done by the respective Governments for the vaccine distribution and the methods to be used by them such as shipping, storage and distribution, especially if special storage condition is required. The most challenging factor is the demand for vaccine. The immunization campaign is critical due to vaccine roll out and its success depends upon the transparent supply chain. The vaccine registration can be done using blockchain consensus algorithm. The algorithm creates a new block to the chain and confirms the transaction. The blockchain algorithm is necessary for security while registering for vaccine, which prevents fraud and enables trust. It requires more computational power and time. Real time visibility can be obtained by providing detailed information about cost and security analysis incurred by the stakeholders within the chain. In terms of latency and efficiency, the proposed blockchain system shows promising results. The healthcare industry is loaded with

immense data and those data are stored independent, hence there would be no collision among the information stored. The test detail collection helps reduce pressure among the healthcare and hospitals. In this project we are implementing a website for transparent and tamper-proof vaccine distribution system. Patient can register, then login and may share the knowledge in our website. We also keep tracking the transactions and on the vaccine being used. Blockchain technology could be a distributed ledger that ensures a transparent, safe and secure exchange of data among supply chain stakeholders. Smart contracts are used for observing and tracking the right vaccine distribution. This enables people to believe that the vaccines are effective and do their daily chores without any fear.

COVID-19 AND NAMES OF VACCINES

The corona virus disease is an infectious disease which affects people of different ages. People with respiratory diseases, diabetes, high blood pressure are likely to develop serious illness. Since the outbreak all the Governments have been working hard to reduce the spread of the pandemic. It was by March,2020 that WHO declared Covid-19 as a Pandemic, an PHEIC (a highest level of global emergency). The best way to slow down transmission is to protect yourself by maintain social distancing, washing your hands using an alcohol-based sanitizers or soap in regular intervals, wearing face masks and getting vaccinated at the right time. Globally countries are working together to cease the spread of the virus by making their people aware of the virus, its transmission and spreading speed, imposing rules and interventions and developing and distributing vital medical supplies and therapeutics.

Name Of Vaccines Approved and Used in India are:

1. Covaxin
2. Covishield
3. Sputnik

SUPPLY CHAIN

Blockchain improves efficacy by delineating and envisioning the methods of the

commercial distribution chain or supply chains. A growing number of consumers demand about the vaccine information. Blockchain assists in developing a transparent network which includes the bottom level applicants to the top-level administrator this in turn develops a trust as each transaction or action taking place each member of the node is being notified making the people trust the efficacy of the vaccine more and in turn this will increase the number of people taking the vaccine and will completely wipe the inhibitions and misconceptions people have about the vaccine.

Healthcare departments in tie with blockchain induced supply chain ensures:

- a. Proper functioning of delivery and storage ensuring successful safety and efficacy readouts of the vaccine.
- b. Developing a decentralized impartial network between the common people and the administrators and thus increasing the trust in the methods from inception to injection of any vaccine.
- c. Individuals would be an integral part of the blockchain ledger and will be aware and well informed about each of the activity that is taking place in the entire supply chain network.

2. RELATED WORKS

For optimal distribution of vaccines, ICT solutions used to support immunization campaigns [1],[2],[3]. A drive through vaccination stimulation tool was utilized to manage time efficiency, requirements of staff and intervals for immunization which was based on event processing and agent-based modelling [2]. During the outbreak of influenza, distribution of vaccine for a heterogenous population has been done using mathematical modelling to ensure fairness and managing the number of doses [2],[3]. To optimize distribution network design, a number of heuristics and custom optimization algorithms were utilized [4],[5],[6]. In various domains, including healthcare, contemporary technological advancements such as Internet of Things (IOT), machine learning and blockchain have paved the way for innovative methodologies [7]. To increase maximum utilization of vaccine in remote places with transparency, and also to identify the location of the carrier, the researchers propose to use IOT devices [8]. Blockchain based decentralized system is an important to maintain privacy and confidentiality in problems related to healthcare sector [9],[10]. During the Covid-19 pandemic, various studies have pointed out the usage of blockchain for decentralized tracking of contracts to ensure safety, tracking the movement of people

in quarantine and monitoring the containment zones to prevent further spread of the disease [11],[12]. IOT and blockchain has also been implemented to enhance supply chain the pharmaceutical industry. Recent studies have proved that blockchain drug supply chain management can be combined with machine learning recommendation system [13]. In incentive-based approaches, blockchain has been used to provide incentives for rewarding patients to remain in quarantine [14]. The machine learning models have been used to choose different immunization methods and vaccine and these have ensured the expiry of vaccination and fraud recording [15]. Finally, blockchain method has also helped in tracking the vaccine records of patients and enhancing vaccine certificates for proof [16]. The existing system for Vaccine distribution is based on using a huge database for storing and processing huge data and introducing Block chain to this system helps in enhancing the transparency and trust in the system and also helps in maintaining a tamper-free and hassle-free records of the people taking the vaccine shot and the number of vaccines being manufactured and distributed.

3. BLOCKCHAIN SYSTEM FOR VACCINE DISTRIBUTION

3.1 WORKING OF A BLOCKCHAIN

Blockchain basically works for holding a set of information like a ledger. All the actions taking place in the blockchain is known as the transactions that serves the purpose requested by the user. The user or the peer in the network form the node. And all the nodes combined together forms a peer-to-peer decentralized chain/network. Once a node requests for service the miners mine solving the puzzle creating a block and in return they get rewarded based on the complexity of the puzzle. The network follows consensus protocol like proof of stake algorithm or proof of work algorithm. Each and every block created is visible to all the nodes in the network and each node is supposed to validate the block being created and once validated the block is added to the existing network and the transaction requested is completed and the same procedure is followed for each and every request made by one or the other node.

3.2 COMPONENTS OF BLOCKCHAIN

- **Node** – The user or the people associated in the blockchain network and each of the node is supposed to be provided with the

copy of the whole blockchain ledger.

- **Transaction** – The requests given by the node for certain service to be done.
- **Block** – A data structure used for keeping track on the activities recorded in the ledger.
- **Chain** – Blocks arranged in a specified order to form a sequence.
- **Miners** – Miners are specific nodes which performs the validation of the transactions and the new blocks being created and added to the existing blockchain network.
- **Consensus protocol** – A set of agreements followed while carrying out operations in the blockchain network.

3.3 How use Blockchain for Vaccine Supply Chain

Decentralized Consensus (or) Proof of work: An algorithm that requires miners, the specific nodes in the network to take the effort of solving an arbitrary mathematical puzzle to prevent anyone from mastering the system. Mining a block is considered to be typically very expensive (computationally) as it serves as “Proof of work” or “Decentralized Consensus”.

In order to hack the system or add a new malicious block built using Decentralized Consensus algorithm a hacker must have 51% more powerful system than the network owner. Block chain connects the normal user along with the network administrators and each individual user will get an update on what is happening in the system ensuring complete transparency between the members of the network.

3.4 How Proof of Work works:

The client requests for a service or a function and the request is sent to the server and the server chooses a random puzzle or challenge which the client has to solve or mine and send the response to the server and then the server verifies whether the solution is legitimate and if it is the service is granted.

So, in our application every time any user of the network logs in a node is created each transaction gets a separate hash value and each transaction is notified to each and every member of the network

and along with this each node in the chain is unique and cannot be altered.

4. EXPERIMENTAL SETUP

The idea was conceived to be used as an web-based application to create a more trustworthy and hassle free platform for vaccination appointment booking. This module includes home page, user registration, user login, doctor login and about blockchain transaction. The user registers himself and takes the preliminary tests and can check the details of the disease and videos uploaded by the Hospital staffs and can book the appointment for taking vaccines and in the token confirm page can check whether his booking has been confirmed or not by the hospital management. A Doctor logs into his account and can check about his information in the home page, the home page also shows the number of visitors he has had and the appointment verify page shows the appointments booked by patients and the doctor can either confirm or cancel the appointment. In the blockchain page the blocks and the transactions are shown and the time and date of the actions are shown. The hash and the transaction values are shown.

In this module patient can register, can login, fill the information related to the medications taken for other sickness and the doctor can decide when the person needs to take the vaccine. Meanwhile the patient can book appointment for the preferred hospital. Patient can see the appointment status in their login. The information related to COVID is visible in the patient’s login in both video and text information too.

The user registers himself and takes the preliminary tests and can check the details of the disease and videos uploaded by the Hospital staffs and can book the appointment for taking vaccines and in the token confirm page can check whether his booking has been confirmed or not by the hospital management.

In the Admin module, admin can add the doctor’s information along with doctor’s information along with vaccination count. Administrator can view all the entire login details of action and time of login. He or she can monitor the patient test details too.

In the Doctor module a doctor can add text information and videos relating to the disease. View user test information and confirm user information.

a. USER MODULE:

The user registers his/her account using their respective Aadhar number which makes it easier to keep track on the people getting vaccinated. Once the user registers and books for the test he/she is requested to take some preliminary test which gives the doctor insight about the user who is going to take the vaccine. As the Fig 4.a.1,

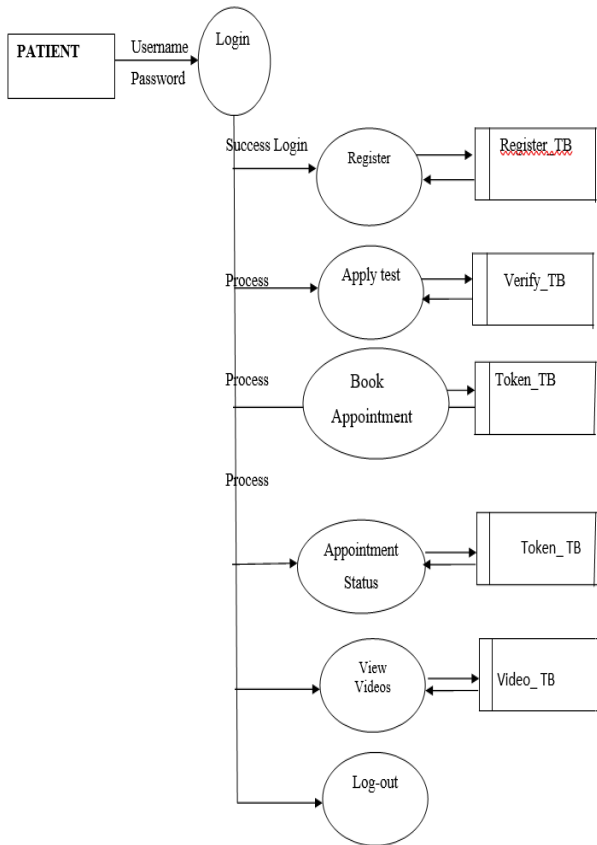


Fig 4.a.1 User Module data flow diagram

Once the user books for vaccine appointment they wait for the doctor to confirm the vaccine appointment which can prevent overcrowding at the health center. They can also view the videos and information uploaded by the doctors and through this way trusted and reliable information can be passed to people.

b. HEALTHCARE OFFICIAL MODULE:

The Healthcare worker registers themselves along with the count of vaccines available in the particular health center and also is given the privilege of uploading video and information and can view the complete test details of the users as shown in Fig 4.b.1 Using blockchain makes the system tamper proof and maintains proper record of all the transactions which has taken place. Providing the vaccine booking confirmation can help in controlling the count of people coming to the hospital.

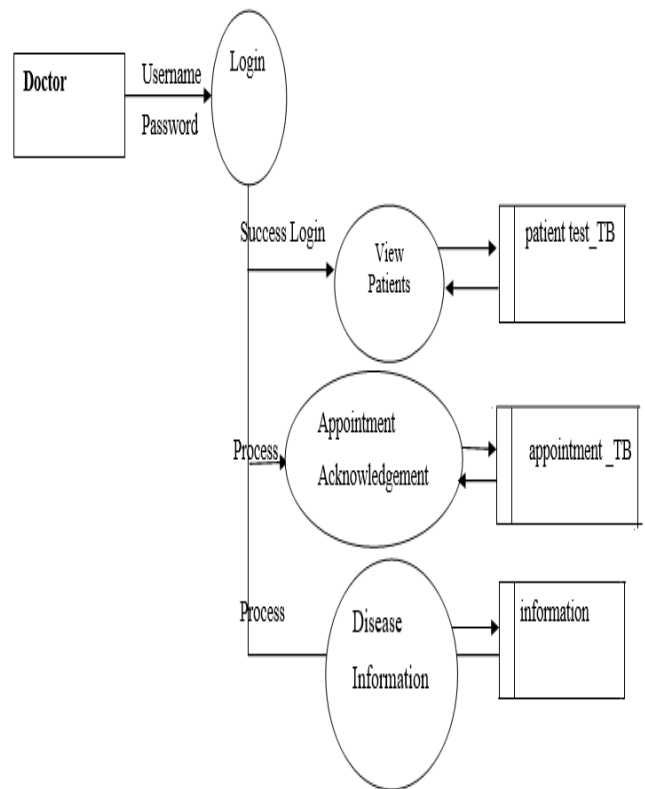


Fig 4.b.1 Healthcare official Module data flow diagram

c. ADMINISTRATION MODULE:

The admin module as in Fig 4.c.1 stores the hash value of each transaction. This makes it easy to track all the operations in the app like the test details, user registration, health care official registration, vaccine booking, count of vaccine available in the hospital. The admin holding the maximum network power in this system becomes the governing authority according to the proof of work algorithm used.

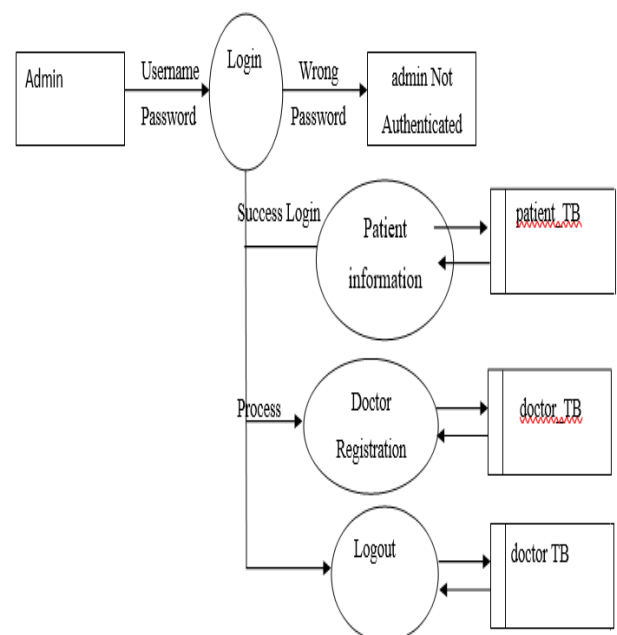


Fig 4.c.1 Admin Module flow diagram

5. RESULT:

Implementation is the step in the project development where the theoretical flow is turned into a fully functional working system for the user that it will work effectively than the existing system. It involves careful observation, examination of the current system and its curb on current implementation, outline methods to achieve the change, and a regular inspection of change over methods to make sure the project is working well as expected.



Fig 5.1 Home page

In Fig 5.1, is about the layout of the home page explaining about the abstract of our application and there are three modules designed in our concept an user module for the common people, the module for Health care officials where the doctors can log in and confirm the appointments and check the user test details, and administrator module for the health care officials and the administrative people and once the flow of vaccines are known another login for vaccine tracking can be created for monitoring the distribution and storage of the vaccine this system can also be implemented in future for any vaccine coming for rollout. The doctor can view the test details of the user as shown in Fig 5.2 allowing better diagnosing of the User's Health conditions with the test taken by the user while registering for the vaccine.

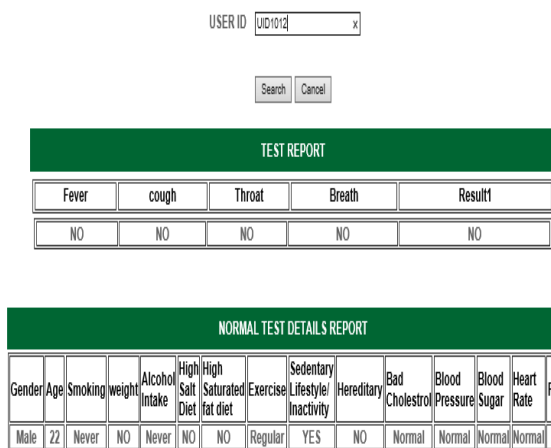


Fig 5.2 User test details

The user registers the vaccine appointment and waits for the confirmation of the appointment from the health care official and since the user logs in with his/her Aadhar number it makes it easier to keep in track of people who have taken the vaccine.

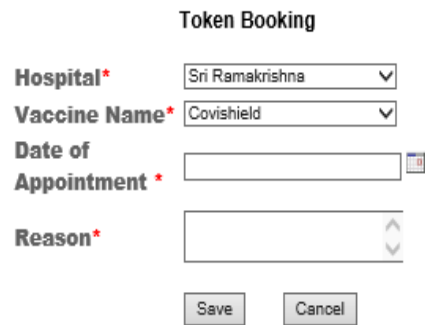


Fig 5.3 User token Booking Page

The doctor confirms the appointment of vaccine making it easier to control the crowding of people at the health care centers.

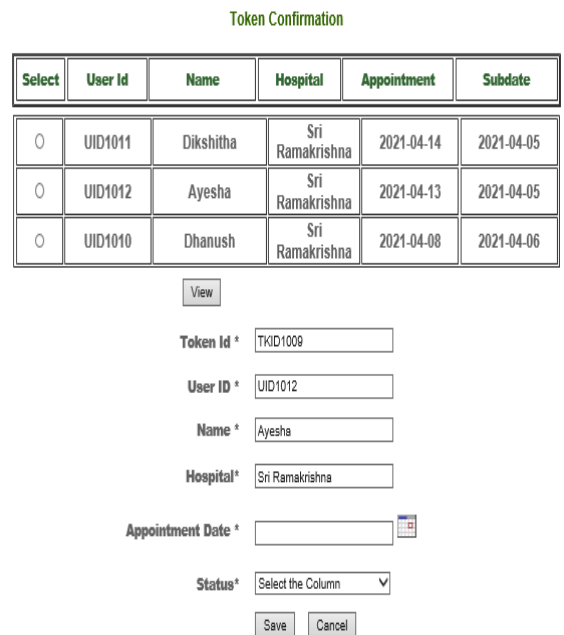


Fig 5.4 Token Confirmation

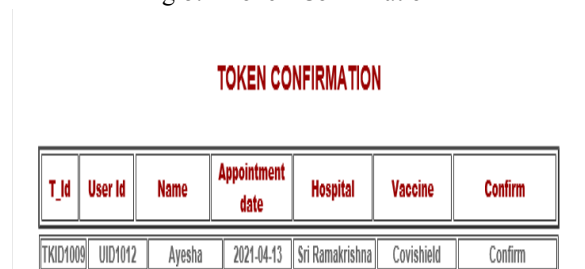


Fig 5.5 Token Confirmation

In our project we also verify whether a transaction (user login, registration, addition of details all

activities) is valid or invalid. Blockchain sets a restriction on how much data can be part of a block. It also sets up rules on how a transaction can be verified.



IMMUNIZATION Inception to Injection

hash_block	transactions	Username	Date	Status	Form
-375760955	Transaction@674cd284	admin	2021-4-06 12:42:47	Valid	Admin Login
-205296985	Transaction@674cd284	admin	2021-4-06 12:42:40	InValid	Admin Login
-451233659	Transaction@3728d58a	DID1000	2021-4-06 12:32:06	Valid	Doctor Login
-451233659	Transaction@3728d58a	DID1000	2021-4-06 12:24:41	Valid	Doctor Login
110468261	Transaction@3728d58a	did1000	2021-4-06 11:53:06	Valid	Doctor Login
-375760955	Transaction@674cd284	admin	2021-4-06 10:33:00	Valid	Admin Login
-2104903067	Transaction@1c144d99	DID1001	2021-4-06 10:32:03	Valid	Doctor Login
-451233659	Transaction@3728d58a	DID1000	2021-4-06 10:28:40	Valid	Doctor Login
-375760955	Transaction@674cd284	admin	2021-4-05 12:56:40	Valid	Admin Login

Fig 5.6 Blockchain Transaction Page

Each hash_block in the Fig 5.6 represents the entry or any transaction taking place and actions or requests by each individual node is given a particular transaction ID and the username the date and time they logged in the status of actions done by them whether the transaction they wanted to do was validated or not and the account which requested the particular transaction is logged in the blockchain Ledger and making it easy for back tracing any step when needed making the system transparent and efficient.

The efficiency of the system depends on the level of implementation of the blockchain in the system and how much we can utilize this supply chain for our benefit.

6. CONCLUSION

In the research, the blockchain based system was implemented to trace the registration, transparency, storage and delivery of Covid-19 vaccine. Based on the findings, a blockchain solution is proposed for transparent vaccine distribution which manages the following:

1. Tracing the storage and delivery of Covid-19 vaccine with increased efficiency and transparency.

2. Assuring valid registration and monitoring the waiting test for immunization.
3. Providing a clear public reporting system.
4. Monitoring the storage temperature for different Covid-19 vaccine.
5. Building a transparent system where each user will be updated of the vaccine transactions along with the network administrator.

Thus, Immunization is all about managing and tracing the vaccine stocks, logistics and transparent distribution. Immunization gives you continuous visibility and enables actionable insights to track vaccine distribution and ensure a fair and equitable. Immunization allows you to book your vaccination appointments and will also allow you to keep track of the vaccine being distributed.

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