

Blockchain Technology to Prevent Counterfeit COVID-19 Vaccine While Ensuring Proper Distribution in Bangladesh Perspective



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Abstract

In the context of the COVID-19 pandemic, while we're trying to slow down the spread of coronavirus, the success will highly depend on performing a successful vaccination program. In this case, some of the obstacles that may arise include but are not limited to, the risk of counterfeit COVID-19 vaccines, not transporting the vaccines in an expected way throughout their journey, the possibility of altering sensitive data, e.g., changing production or expiration date, etc. In this context, we propose a Blockchain-based solution. The proposed solution ensures end-to-end traceability and transparency in the supply chain while maintaining a proper distribution of the vaccine. As the government is highly concerned about managing healthcare during and after the COVID-19 pandemic, building trust and reducing costs by implementing a secure and transparent system to flatten the curve will have a promising impact on both public health and the economy of our country. Moreover, this system will help to increase revenue by reducing the loss of sales due to counterfeit vaccines. The private blockchain can have a promising impact on the supply chain environment and its relative sections.

Keywords: Blockchain, Hyperledger Fabric, COVID-19 Pandemic, Supply Chain, Coronavirus Vaccine, Public Health, Bangladesh.

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Chapter 1

Introduction

1.1 Essence of the Problem

As people around the globe are dying every day due to the coronavirus pandemic, the vaccine is probably the best chance for us to get rid of the pandemic. Having a long history of counterfeit or substandard drugs which is about 20% of the total sales per year [1], Bangladesh has already seen the illicit trade of medical equipment and fake coronavirus certificates during the coronavirus pandemic [2,3]. So, there is a huge risk that counterfeit vaccines may rise in the market anytime when the supply of vaccines will not meet the demand. We propose a system with end-to-end traceability that would ensure the authenticity of the distributed vaccine. Let's look at an example. *Martha*, a citizen of Bangladesh is listed for the COVID-19 vaccine produced by *Tannhaus Pharmaceuticals Ltd.* However, she has a few concerns before taking the vaccine, such as:

- The vaccine is originally produced by *Tannhaus Pharmaceuticals Ltd.*
- No unauthorized person in the supply chain was able to possess the vaccine.
- No sensitive data e.g., production or expiration date was altered.

Chapter 2

Proposal and Methodology

2.1 Overview

We are proposing a blockchain-based supply chain for end-to-end traceability of the COVID-19 vaccine. It will also ensure proper quality and secure distribution of the vaccine. In Bangladesh, according to a health ministry statement, the vaccines will be sent to civil surgeons at all of the 64 (administrative) districts, as practice goes, the vaccines will be transported to distributors for allocation to hospitals, clinics, and vaccination centers [4,5].

Suppose, *Tannhaus Pharmaceuticals Ltd* is a producer of the AstraZeneca vaccine, *Noah Distributors Ltd* is a renowned pharmaceutical distribution company, and *Martha*, a citizen from Sylhet is listed as one of the customers. We have implemented and showed this detailed supply chain in the appendix section. It can be shown below:

Tannhaus Pharmaceuticals Ltd (Producer) - Civil Surgeons - Noah Distributors Ltd - Hospital/Clinic - Martha (Customer)

2.2 Application Users and Their Role

A user must register with his/her name, email address, and role in the supply chain. A user can be a representative of a specific organization. However, users must be one of the three types:

1. **Producer:** Typically the organization that produces the vaccines.
2. **Distributor:** Those who deliver the vaccines to the next distributor or the customer.
3. **Customer:** Those who receive the vaccine at the end-point.

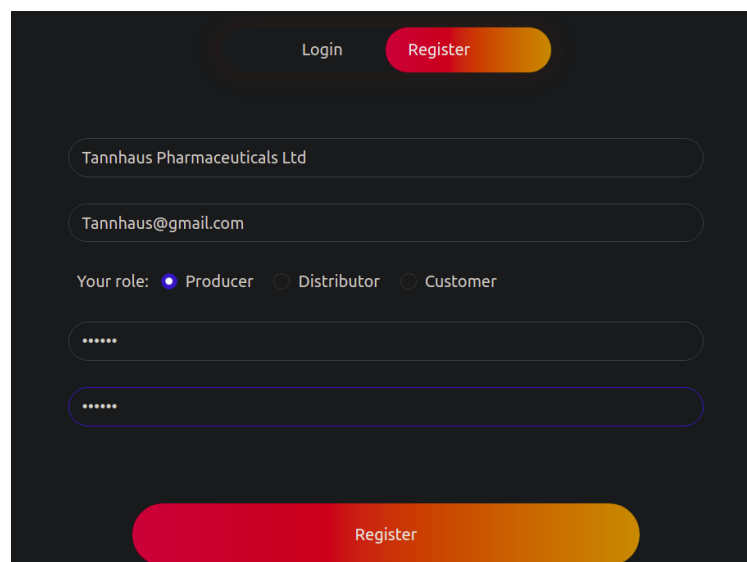
2.3 Application Features and Use Cases

Let's look at the following supply chain containing one producer, one distributor and one customer.

Tannhaus Pharmaceuticals Ltd (Producer) - Noah Distributors Ltd - Martha (Customer)

Some features of the application is shown below:

1. **Registration:** A user can create an account by providing necessary information e.g., name, email address, role, etc about him/her or the organization he/she is representing.

A screenshot of a registration form on a dark background. At the top, there are two buttons: 'Login' and 'Register'. The 'Register' button is highlighted with a red-to-orange gradient. Below these buttons are four input fields: the first contains 'Tannhaus Pharmaceuticals Ltd', the second contains 'Tannhaus@gmail.com', the third is for a role selection with radio buttons for 'Producer' (selected), 'Distributor', and 'Customer', and the fourth is a password field with masked characters. At the bottom, there is a large 'Register' button with a red-to-orange gradient.

2. **Login:** A registered user can log into the system by providing an email, password, and role.
3. **Adding Information about a vaccine:** Only a registered user whose role is Producer can add vaccine information. Say, we tag a vaccine with the number: 10021.

Create a vaccine info

Vaccine Number: 10021

Issue Date and Time of Vaccine: 04/22/2021, 04:33 PM

Current Owner's Name: Tannhaus Pharmaceuticals Ltd

Enter your Location

Latitude: 23.5417798

Longitude: 89.1738269

Find Current Location

Create

4. **Generating a QR code:** A QR code containing the vaccine number will be automatically generated after the vaccine information is added.

The QR code for this vaccine has been generated.



5. **Changing Ownership:** A registered user whose role is distributor or producer can change ownership of a vaccine. However, A user cannot change ownership of a vaccine that doesn't belong to him/her.

Change Ownership of a Vaccine

Only current owner of a vaccine can change ownership

Vaccine Number
10021

Date
04/24/2021, 09:35 AM

New Owner Name
Noah Distributors Ltd

Enter Location

Longitude
23.5390344

Latitude
71.1792234

Find Current Location

Change Ownership

6. **Scanning QR code:** A registered user can upload a QR image to know the QR code content which is the vaccine number.

Upload a QR Code Image

Choose File download (1).png

Your Vaccine number is:
10021

7. **Searching the detailed info:** A registered user can search the detailed information of a vaccine after giving the vaccine number. Then the system will show him the full supply chain of that vaccine.



2.4 Technology Used

1. **Framework:** Hyperledger Fabric v2.2.
2. **Frontend:** HTML, CSS, Bootstrap.
3. **Backend:** Node.js, JavaScript.
4. **Build Tools:** NPM.
5. **Database:** Apache CouchDB.

2.5 Vaccine Distribution Process

Say, 20 thousand vaccines need to be delivered to Sylhet at some point. First of all, *Tannhaus Pharmaceuticals Ltd* will tag the vaccines with unique codes.

Every distributor in the middle needs to scan the QR code of a vaccine to confirm the delivery. So, at some point, when *Noah Distributors Ltd* receives the vaccines, the QR code will be scanned and the owner will be changed to *Noah Distributors Ltd*.

As the vaccines go through the supply chain, these procedures will repeat, and as a customer, *Martha* will receive a vaccine at some point from a vaccination center or a hospital. When *Martha* receives the vaccine, she runs the application and only takes the vaccine if it ensures these 3 major concerns:

1. She scans the QR code from the vaccine and checks the supply chain to confirm if it was an original product of *Tannhaus Pharmaceuticals Ltd*.
2. She checks the date, time, and locations of transportations at each point to ensure it has maintained the expected path in the supply chain.
3. She checks if the production and expiration date are valid and as we use blockchain, alteration of these data will not be possible.

Chapter 3

Impact of Blockchain Solutions on Markets

3.1 Market Size

Bangladesh is about to buy a total of 50 million vaccines for 6 months and it will cost \$6.25 for each dose of the vaccine. According to the Minister of Health and Family Welfare, the government will be able to vaccinate 5 million doses to 2.5 million people each month [6]. To vaccinate 160 million people, Bangladesh will face a cost of around \$2,000,000,000 (Two Billion USD) for Bangladesh. So, it's a huge market. According to the officials of the Bangladesh Pharmaceutical Industry Association, the annual sales of counterfeit or substandard drugs in the country is over Tk 1,500 crore which is 20% of the total sales [1].

3.2 Why Blockchain?

A blockchain-based supply chain enhances traceability, increases efficiency and speed by eliminating middlemen, and reduces disruptions. Organizations can digitize physical assets and create a decentralized immutable record of all transactions. If an organization or distributor finds any counterfeit or substandard product, blockchain permits the organization and its supply chain partners to trace the product, find suppliers involved with it, determine production and shipment batches related to it. So, a counterfeit vaccine can be traced to its source using the blockchain trail.

Chapter 4

Competition and Risks

4.1 Types of Competitors

We consider 3 types of competitors here such as:

1. **Very Direct Competitors:** Very direct competitors are other blockchain solutions that have the same goal. In this case, we currently have no other blockchain solutions in the market that showed or implemented the same goal as us.
2. **Direct Competitors:** Direct competitors can be referred to the products or services that have the same goal. The Government of Bangladesh has launched a web application named “Surokkha” so that people can get the vaccine. However, let’s look at the differences between these two solutions:

Feature	Surokkha Application	Our Proposed Solution
Supply chain	Traditional Centralized	Blockchain-based and temperature controlled
Transparency, traceability, and verification	Rare and difficult	Visual and applicable
Cost	Comparatively higher	Comparatively lower because of deduction of middlemen
Tracing back to counterfeit vaccine producer/supplier	Not applicable	Applicable
Verifying original vaccine	Rare and difficult	Visual and applicable

3. **Indirect Competitors:** Indirect competitors refer to those who deliver completely different products or services but share the same target audience. In this case, maintaining a food chain, drug chain, product authentication, etc can be examples of indirect competitions. As we are in a world-wide pandemic, the COVID-19 vaccine is a must to get rid out of this situation. Thus, the indirect competitors, in this case, can be taken care of.

4.2 Risks

No business or technology is beyond risks. Blockchain is no exception. We have identified a few risks such as:

1. **Strategic Risk:** Blockchain is certainly not a universal solution. Being a new technology, it may take some time to cope up with the other technologies. Thus the acceptance of blockchain over other technologies should be considered.
2. **Operational and Technical Risk:** Changing from one solution to another can be hard to adapt sometimes. For example, if someone in the middle of the supply chain ruins the QR code by accident, he won't be able to scan it for transactions.
3. **Lack of Expertise:** If a problem occurs in the system e.g. while distributing the vaccine, it should be considered that people with blockchain expertise are limited.
4. **Smart Contract Risks:** Smart contracts are self-executing agreements between the dealers being written into lines of code. Some risks in smart contracts are data confidentiality risk, consensus method risk, legal risk, risk due to mapping evidence from physical to digital, value transfer risks, etc.
5. **Non-Cooperation Risk:** If a syndicate forms in such a way that organizations would not participate in the supply chain, the system will lose control. Then the government has to find alternative parties, which might be difficult.
6. **Conflict Between Governing Bodies:** The government may be pressured not to introduce the system since many corrupted people have their self interests and want their self-fulfillments.

Chapter 5

Conclusions and Future Work

5.1 Conclusion

As we are writing this paper, we don't know how many people are dying across the country, in the meantime, due to COVID-19. Maybe we could not save our people before we had vaccines but with our proposed solution of distributing vaccines securely, we might be able to save them now. As we are trying heart and soul to defeat the coronavirus, our future scope as project expansion is to implement the system in other countries as well.

5.2 GitHub Link of the Project

The GitHub repository link of this project along with instructions can be found here:

[GitHub: COVID-19 Vaccine Supply Chain.](#)

References

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Appendix A

Sample Supply Chain

A sample supply chain timeline for distributing COVID-19 vaccine in Bangladesh.

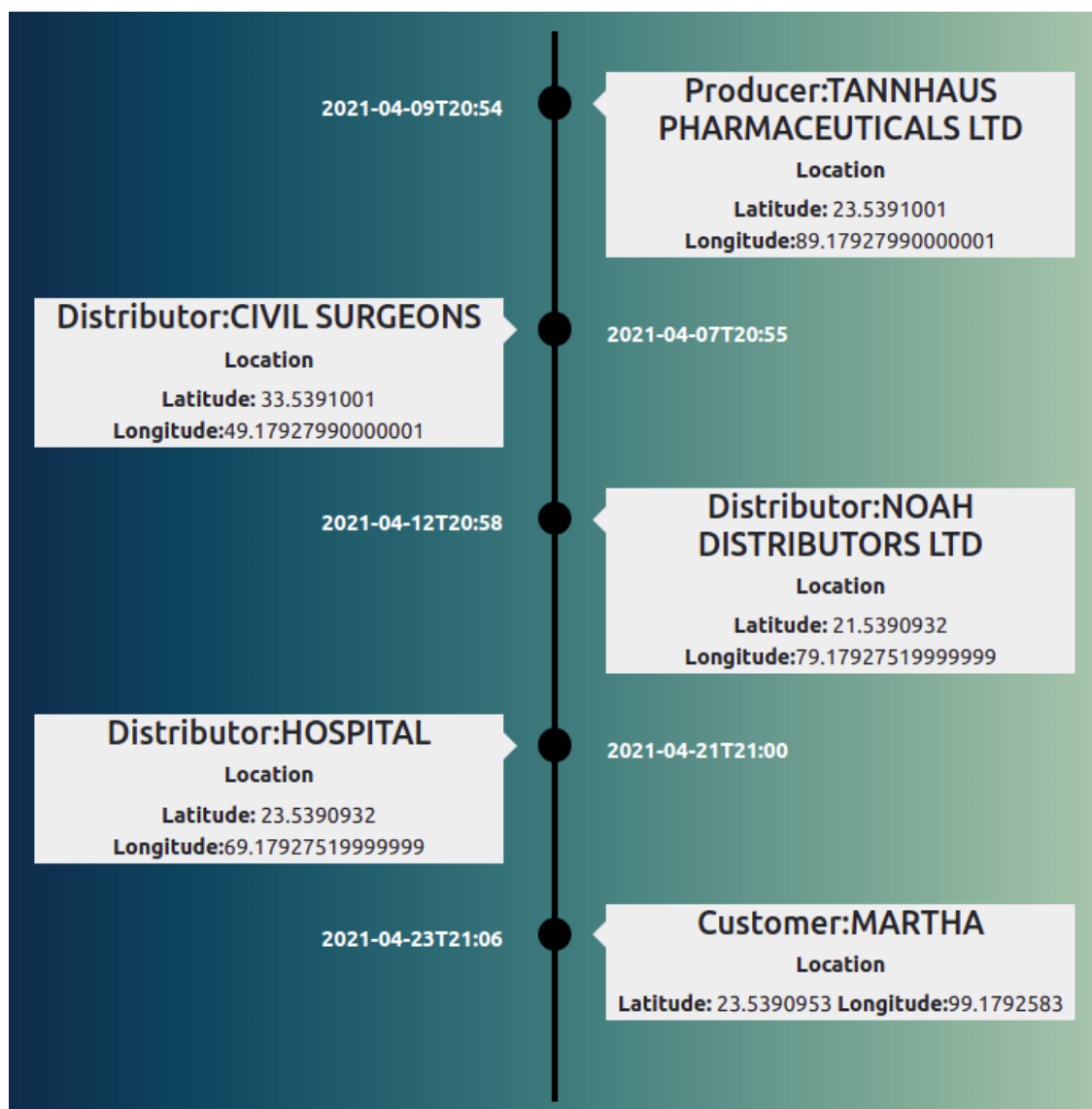


Figure A.1: A Sample COVID-19 Vaccine Supply Chain Timeline

Appendix B

Supply Chain Architecture

Below shows how blockchain can enhance the vaccine supply chain architecture.

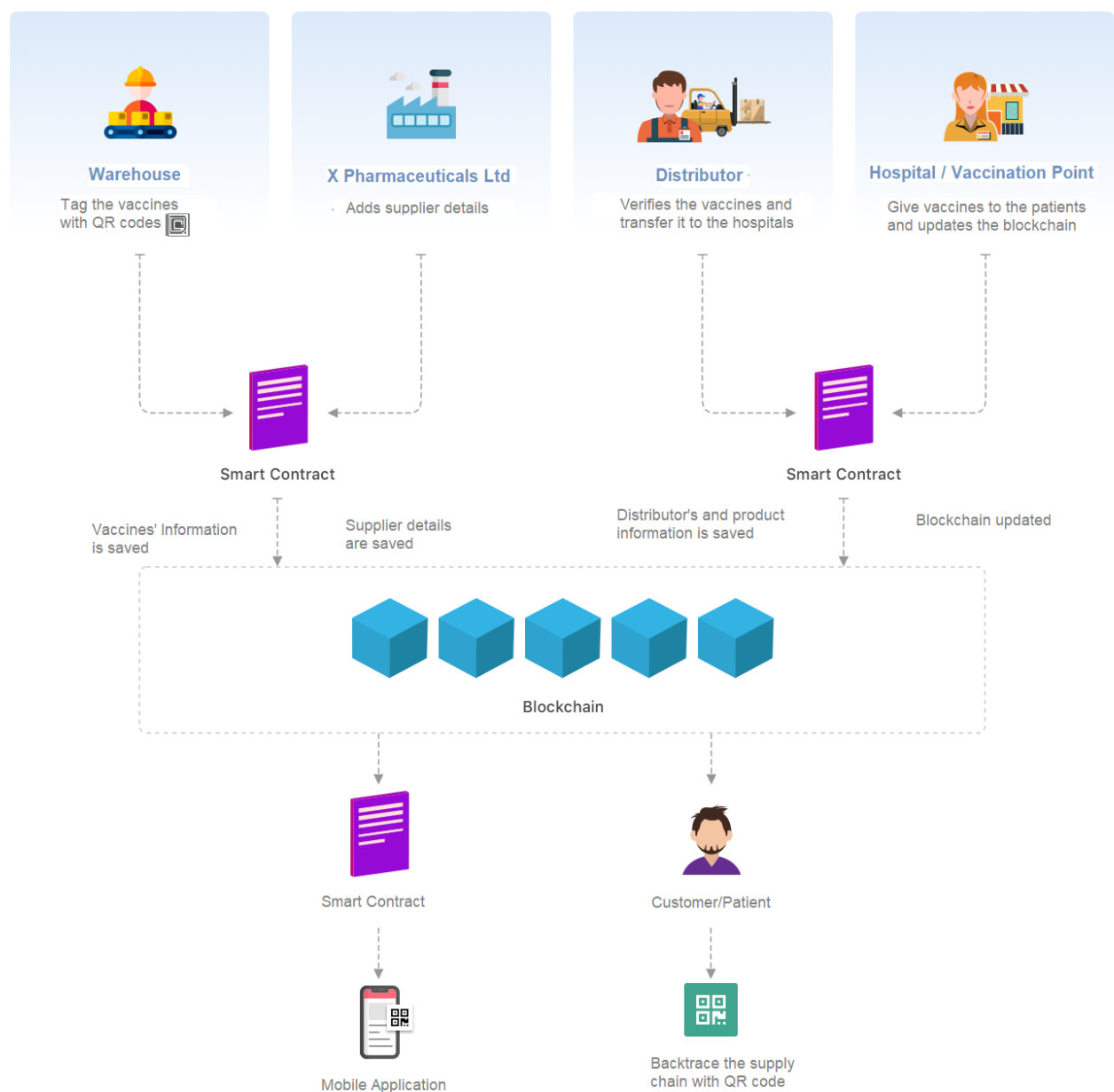


Figure B.1: Vaccine Supply Chain Architecture Based on Blockchain