

Blockchain application in the distribution chain of the COVID-19 vaccine: a designing understudy

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Abstract

The impact of COVID-19 has challenged science in its quest to control and mitigate it through a new vaccine. This is why the world's research centers and laboratories are in serious competition over time to offer humanity an effective vaccine that prevents the spread of this virus. From a technological point of view, the challenge is to manage the distribution of this next vaccine, from its generation anywhere in the world, to the site of application to the population. The research results approximate the solution to the design of a secure Blockchain-based supply chain surveillance design, to control the variables and critical points of the next distribution of vaccines worldwide. The expected impact of the application of this new design will be the confidence of the population in the quality of the vaccine, in the generating laboratory, and its supplies.

Blockchain application in the distribution chain of the COVID-19 vaccine: a designing understudy

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Abstract: The impact of COVID-19 has challenged science in its quest to control and mitigate it through a new vaccine. This is why the world's research centers and laboratories are in serious competition over time to offer humanity an effective vaccine that prevents the spread of this virus. From a technological point of view, the challenge is to manage the distribution of this next vaccine, from its generation anywhere in the world, to the site of application to the population. The research results approximate the solution to the design of a secure Blockchain-based supply chain surveillance design, to control the variables and critical points of the next distribution of vaccines worldwide. The expected impact of the application of this new design will be the confidence of the population in the quality of the vaccine, in the generating laboratory, and its supplies.

Research question: Is it possible to implement Blockchain to track and control the delivery of the COVID-19 vaccine?

Introduction: The different actions of society and its governments demand an appropriate distribution chain.

The number of infected and demand for instruments: by the beginning of April 2020, almost one million people were diagnosed as carriers of COVID -19 (González Jaramillo et al., 2020); currently, many countries continue with their borders closed and this causes the closure of imports that causes a shortage of various medical supplies, such as masks, gloves, disinfectants, toilet paper, among others. In addition to a significant

change in the income of families, who request humanitarian aid, reduction of taxes, freezing of incomes, among others. (Otoya-Tono AM, García M, Jaramillo-Moncayo C, Wills C, 2020).

Humanitarian donation and search for vaccines: During this confinement, the gap between rich and poor is much more noticeable, where thanks to donations, NGO support, government, and humanitarian aids, many countries with social problems are supported with the delivery of clinical supplies and groceries. (Poole, Escudero, Gostin, Leblang, & Talbot, 2020).

On the other hand, the most developed countries that have already passed the contagion curve increased investment in health and scientific research, to find a cure that would end the pandemic. (Hugo & Avendaño, 2020).

Home deliveries and distribution of aid: During this period of confinement, the provision of home services is very important, because the population receives food subsidized by governments at home. In Colombia, a mobile application was designed to allow the registration of any citizen and to verify if he or she is a beneficiary of the aid or not. (Marina Garriga & Vieta, 2020).

Delivery problems: In Colombia, even though the government's intentions to bring financial aid to those most in need is good, the numerous errors in the digital platform due to the lack of tightness in the authentication of the population, have generated several cases of impersonation and corruption during the pandemic crisis (Cepaluni & Dorsch, 2020). With this scenario, the distribution of vaccines is an institutional challenge for the entire population to benefit and to monitor their impact (Cetina, 2020).

Some Concepts:

Blockchain: Unique record of data divided and stored in blocks, which store the information, along with the data of the same block as the data of its previous block, thus generating an unbreakable blockchain class that ensures the integrity of the information contained in any moment. (Zheng, Xie, Dai, Chen, & Wang, 2018).

Big Data: It is the handling of a large volume of digital or analog data, which are important and relevant for a project or company. (Wang, Kung, & Anthony, 2016).

Laboratory: It is the entity that is dedicated to the manufacture and sale of medicines at industrial levels, which participates in any of the phases of its development or sale. (Clarke, 1994).

Drugstore: Drug stores are all those companies that are dedicated to import and purchase medicine wholesale and then distributing them to different pharmacies or hospitals. (Kralewski, Pitt, & Dowd, 1983).

Pharmacy: It is the warehouse that is located within the hospitals which are in charge of the management and delivery of medication to patients who have a clinical prescription. (Bond, Raehl, & Franke, 2002).

Kardex: Organized digital or analog record, which stores stock and account information of a company or entity (Cueto & Nuñez, 2009).

The research of the TIGUM Group and the solution for the logistics monitoring of vaccines: Even today, there is not a tool for tracking the delivery of medical supplies and a future vaccine for COVID-19, the telemedicine research group at Universidad Militar Nueva Granada in Colombia has been developing applications with the use of tools such as Blockchain and Artificial Intelligence to monitor and predict the distribution of resources, aids, medical assistance and supplies to combat both viruses and corruption (Beltran et al, 2019).

Blockchain model applied to the distribution chain of the COVID-19 vaccine

Two possible supply chains are considered through which the vaccine will have to pass:

Emerging chain: This supply chain aims to deliver the vaccine as quickly as possible to all countries that require it, for a quick application to all those infected, shown in *Figure 1*, in three phases (A: Sent, B:

Storage, C: Application) the entire distribution is divided until it reaches its final recipient. Figure 1 shows the distribution in the emerging chain.

Figure 1. Emerging Chain for the Covid-19 vaccine

Commercial chain: Although many countries work together to discover a vaccine, this vaccine is not guaranteed to be free in its entirety, either because it is very expensive to make for laboratories, or because it is simply not a cure but a pain reliever that reduces symptoms of the virus just like the current flu. *Figure 2* shows how the supply chain increases its phases to a total of 5, unlike the emerging chain, where each one corresponds to the work of a different actor (A: Laboratories, B: suppliers, C: drug stores, D: hospitals, E: patients) where the chain highlights the importance of monitoring each phase and its corresponding distribution.

Figure 2. Commercial Chain Diagram for the Covid-19 vaccine

Blockchain design model

A Blockchain model was designed to allow monitoring each phase of the vaccine supply chain, from its development to its application, as shown in *Figure 3*, whereby five basic processes in a supply chain, several blocks are extracted of important information to follow thanks to data mining, besides, each block is reliant on another, thus generating a chain of information blocks (Blockchain) that will be stored in a Blockchain network located in the cloud (Cloud Computing) inasmuch as this information it is open to the public globally via the internet and does not belong to a single user.

Figure 3. Blockchain design approach for the Covid-19 vaccine

Nowadays, the implementation is carried out with the Ethereum business protocol which audits each process as if it were a smart contract with its corresponding digital signature, thus allowing authenticating each process and registering changes in the information (Cong & He, 2018), information that is selected, cleaned and analyzed employing data mining processes (Pinto, López, & Cuesta, 2011), all this stored in a database located in the cloud, with its pertinent display interface for the interaction of the information previously mentioned. (Javaid, Haleem, Vaishya, Bahl, & Suman, 2020).

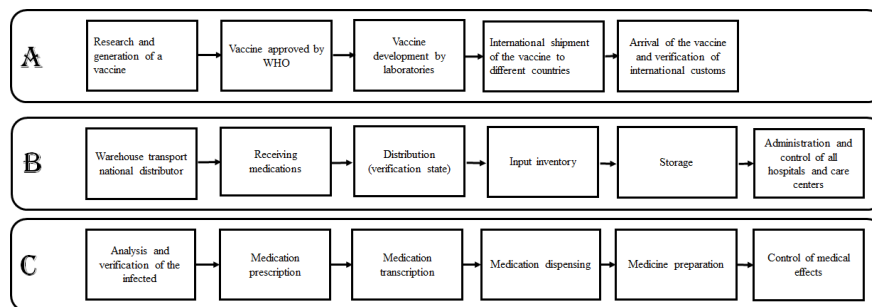


Figure 1. Emerging Chain for the Covid-19 vaccine

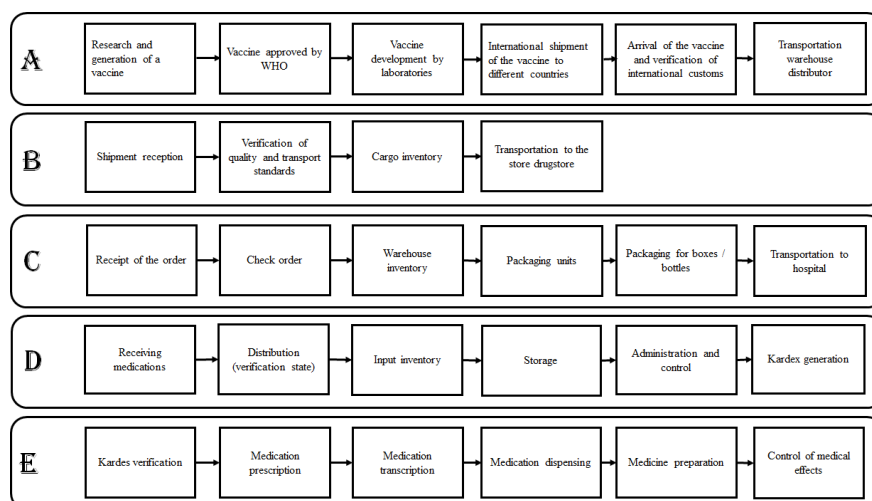


Figure 2. Commercial Chain Diagram for the Covid-19 vaccine

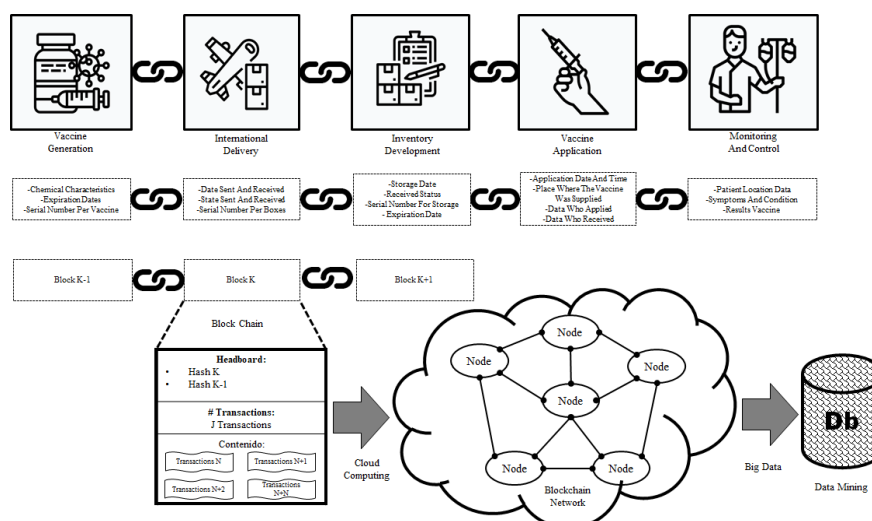


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