Blockchain Technology to Improve Health Care in the Republic of China

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Abstract:

Blockchain technology is an advanced technology that was initially used in the field of cryptocurrency and now it is being widely implemented in various industries and fields. In this paper, the implementation potential of blockchain in the healthcare service is outlined, a predictive model is built, and a blockchain-based framework that focuses on the electronic medical record (EMR) is built. An extensive study of journal papers on the blockchain framework is conducted in order to gain a basic understanding of blockchain technology. The idea of the EMR framework was developed with a blockchain-based application and database system. Patients, hospital providers, health care authorities, financial authorities and certification authority are among the five groups of participants

There are four proposed algorithms based on the procedures for viewing and writing electronic medical records, as well as two additional procedures aimed at improving the security of the blockchain framework. Finally, the generated predictive model is implemented along with the proposed application, which connects all groups of participants to the blockchain-based EMR system.

Keywords:

Blockchain, electronic health records, health care, health data, smart health care.

1 – Introduction

While Bitcoin introduced the world to blockchain over a decade ago, the buzz continues around the underlying technology, distributed ledger technology (DLT). Over the past decade, both the public and private sectors have continued to develop industry solutions and fund blockchain research and development. Reports project global blockchain funding will reach $11.7 billion by 2022 (Abbas, K.,

Afaq, M., Ahmed Khan, T., and Song, W.-C., 2020). As global spending on DLT increases, it is worthwhile to ask how and why global actors like China are using blockchain technology. How is DLT impacting their financial sectors and improving global market competitiveness? (Huang, G., and Foysal, A., 2021) Are there potential opportunities for collaboration? China has dedicated significant resources to blockchain and made strides in assessing its potential within their own industries (Kassab, M., DeFranco, J., Malas, T., Destefanis, G., and Graciano Neto, V., 2021). For China, DLT is part of a broader technology vision that aims to position the country at the forefront of the global community (Ballantyne, A., 2020). In this paper, we explain the technology and its significance, and assess how DLT is being developed in China (Narikimilli, N. R. S., Kumar, A., Antu, A. D., and Xie, B., 2020). The paper offers insight into China's vision for adopting blockchain technology and how it is building up an industry with a focus on domestic regulation, public/private sector use cases and an international vision of innovation initiatives. As a distributed technology, blockchain has attracted increasing attention from stakeholders in the medical industry (Beam, A. L., and Kohane, I. S., 2019). Although previous studies have analyzed blockchain applications from the perspectives of technology, business, or patient care, few studies have focused on actual use-case scenarios of blockchain in health care. In particular, the outbreak of COVID-19 has led to some new ideas for the application of blockchain in medical practice. Emerging technologies such as blockchain, a subset of distributed ledger technology, are not limited to a single region or use case (Azaria, A., Ekblaw, A., Vieira, T., and Lippman, 2020). Global powers are recognizing blockchain's power to surpass the use of cryptocurrency and its potential to shape critical processes in many fields, including financial, healthcare, government, and supply chain. In pursuit of global competitiveness (Agbo, C., Mahmoud, Q., and Eklund, J. , 2020) , China is a significant player in testing blockchain technology as well as implementing legal frameworks, regulations, and government initiatives around it (Narikimilli, N. R. S., Kumar, A., Antu, A. D., and Xie, B., 2020).

This working paper examines the country case of China and assesses how it has progressed in its attempts to test, adopt, and implement blockchain technology. It offers insight into how China's vision in blockchain technology has led to many innovation initiatives.

blockchain is a distributed ledger technology that works on the peer to-peer (P2P) network (Gervais, A., Karame, G. O., Wüst, K., Glykantzis, V., Ritzdorf, H., and Capkun, S., 2020), where the data are immutable once they are written and being stored as part of the blockchain. Each of the data is stored as a block and it is connected to another block by using hash function as the chain that links both of them together, which correspond to the name itself, blockchain. Besides that, decentralization is another property of blockchain technology which makes it special and stands out. The data stored in blockchain is controlled by every of the participants in the system, where they are able to access all the data and add in new data. From here, it gives the blockchain a transparent property. Blockchain technology also grabs the attention of people as the data are being stored securely. Flynt (2016) have stated that, this honor goes to the cryptography that protects the data from being tampered with and the level of security that protects blockchain contents is currently considered nearly impossible to break (Azaria, A., Ekblaw, A., Vieira, T., and Lippman, 2020).

2 – Case Study:

China emerged as one of the world's first civilizations in the fertile basin of the Yellow River in the North China Plain. China was one of the world's foremost economic powers for most of the two millennia from the 1st until the 19th century. For millennia, China's political system was based on absolute hereditary monarchies, or dynasties, beginning with the semi-legendary Xia dynasty in the 21st century BCE. Since then, China has expanded, fractured, and re-unified numerous times. In the 3rd century BCE, the Qin reunited core China and established the first Chinese empire. The succeeding Han dynasty (206 BCE – 220 CE) saw some of the most advanced technology at that time, including papermaking and the compass, along with agricultural and medical improvements. The invention of gunpowder and movable type in the Tang dynasty (618–907) and Northern Song dynasty (960–1127) completed the Four Great Inventions. Tang culture spread widely in Asia, as the new Silk Road brought traders to as far as Mesopotamia and the Horn of Africa. The Qing dynasty, China's last dynasty, which formed the territorial basis for modern China, suffered heavy losses to foreign imperialism in the 19th century (Figueroa, S., Añorga, J., and Arrizabalaga, S. , 2019) .

3 - Research Aims:

Blockchain is not only useful in the field of cryptocurrency but it can be applied in many different fields, in medicine, economics, Internet of things, software engineering etc. as well as healthcare such as pharmaceutical supply chain and health insurance claims. China has made several great technologies in these areas, especially in medical care and modern medicine technology in China Results in blockchain technology research in healthcare are increasing data sharing, health record management, and control of access to any hospital services. In recent years, blockchain technologies have been applied in electronic medicine and records systems (EMR) to provide control, supervision, accessibility, auditing, and interoperability on large-scale data management using a mass registry in China (Gervais, A., Karame, G. O., Wüst, K., Glykantzis, V., Ritzdorf, H., and Capkun, S. , 2020) . Electronic medical records (EMR) is the electronic version of patients' medical and treatment records, rather than using paper and pens to record and save details. Because some diseases cannot be identified in a clear way due to the lack of old records for them or because the main cause of the disease or its virus is not known, so there are no specific treatments that can be referred to in order to treat the patient and the patient may not fully recover after completing the treatment (Gervais, A., Karame, G. O., Wüst, K., Glykantzis, V., Ritzdorf, H., and Capkun, S., 2020).

Therefore, there is a need to constantly conduct research on the new or old disease together, and this is in order to solve it. By studying the implementation of blockchain on EMR for a specific unknown disease, so it will be useful for all clinicians and researchers to discover more treatments and vaccines (Maleshkova, M., Pedrinaci, C., and Domingue, J., 2018).

4 - Objective:

This paper aims to provide a systematic review of the current and projected uses of blockchain technology in health care, as well as directions for future research. In addition to the framework structure of blockchain and application scenarios, its integration with other emerging technologies in health care is discussed (Jayaraman, R., Taha, K., Park, K. S., and Lee, J., 2019).

There are two goals to be achieved during this research.

First: the first goal is to use patient data and analysis to build a model that will be useful for sharing in the blockchain system (Khatoon, A., 2020).

Second: The application of blockchain technology in healthcare service is proposed, with the following features added:

(1) The severity level of the patient model is shared in the blockchain system,

(2) Patient records are stored in the blockchain system and shared among healthcare entities in a more efficient and reliable manner (Khatoon, A., 2020),

(3) The patient becomes able to control access to his information and records at any time with a complete record of all medications or operations performed by the patient since the beginning of the disease, as well as the dates and duration of the disease, and thus knowing his condition and treatment in a correct manner (Lv, Z., and Piccialli, F., 2021).

5 – Methods:

We searched databases such as PubMed, EMBASE, Scopus, IEEE, and Springer using a combination of terms related to blockchain and health care. Potentially relevant papers were then compared to determine their relevance and reviewed independently for inclusion. Through a literature review, we summarize the key medical scenarios using blockchain technology (Kumar, R., Marchang, N., and Tripathi, R. (2020).

6 - Results and Analysis:

We found a total of 1647 relevant studies, 60 of which were unique studies that were included in this review. These studies report a variety of uses for blockchain and their emphasis differs. According to the different technical characteristics and application scenarios of blockchain, we summarize some medical scenarios closely related to blockchain from the perspective of technical classification. Moreover, potential challenges are mentioned, including the confidentiality of privacy, the efficiency of the system, security issues, and regulatory policy (Musamih, A., Salah, K., Jayaraman, R., Arshad, J., Debe, M., Al-Hammadi, Y., et al., 2021). A type of blockchain has been worked out in this research and work on this technology is limited to those who have the authority to access the blockchain. The participants in the blockchain are divided into five groups: patients, healthcare providers of patients such as doctors and administrators, other healthcare authorities such as medical researchers and the Ministry of Health (Li, H., Zhu, L., Shen, M., Gao, F., Tao, X., and Liu, S., 2018), and financial entities such as employees of banks, in-

surance and certification authority (CA). The blockchain system focuses on functions that can be performed based on patient records and EMR (Pilkington, M., 2019). Patient records and EMR are stored in the blockchain-based database in a secure manner and can be seen by all of the participants due to the transparent property of the blockchain it has (Musamih, A., Salah, K., Jayaraman, R., Arshad, J., Debe, M., Al-Hammadi, Y., et al., 2021).

Figure (1) The Proposed Framework
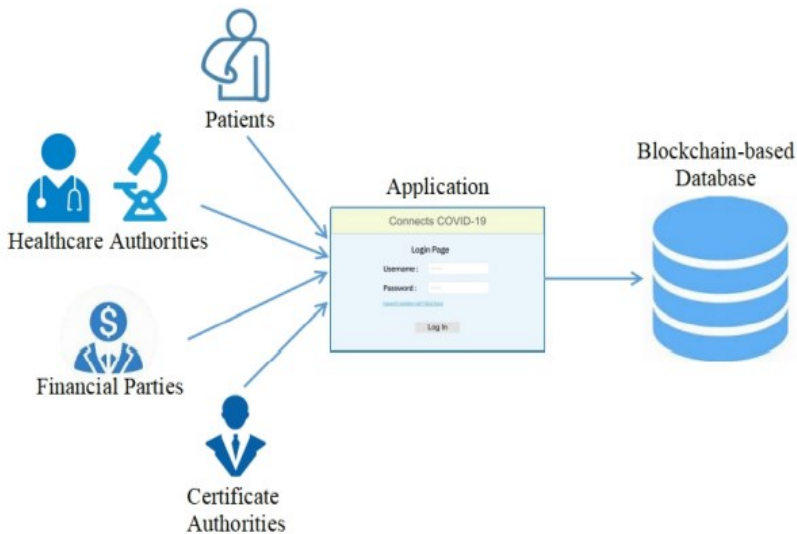
The patient registration process is not only open to patients, but also available to healthcare providers, healthcare authorities and financial parties who wish to access the data in the blockchain (Maleshkova, M., Pedrinaci, C., and Domingue, J. (2018) . With the registration process (Pilkington, M., 2019), they are added to the blockchain as participants and receive ID, public key, private key and electronic certificate. Generally, the public key is used to encrypt the data while the private key is used to decrypt the data. For ID and e-certificate, they are the name and identity card of the blockchain participant, respectively (Omar, I. A., Jayaraman, R., Debe, M. S., Salah, K., Yaqoob, I., and Omar, M., 2021).

**Figure (2) The Process of Adding Participants into BC**
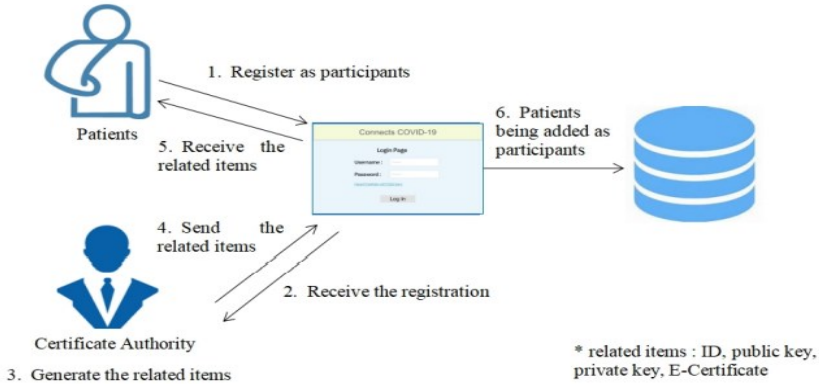
After the patients meet with their doctors, their consultation details and diagnosis result need to be updated on the EMR and stored into the blockchain. Besides from consultation type of records (Qiu, J., Liang, X., Shetty, S., and Bowden, D. ,2018), surgeries that are performed on the patients are also being recorded. Relevant images such as scanned X-ray or reference pictures are able to be uploaded into the blockchain. In this process, doctors need to have the permission from patients in order to update their patient medical records. The overview process of updating EMR into blockchain (Tith, D., Lee, J.-S., Suzuki, H., Wijesundara, W. M. A. B., Taira, N., Obi, T., et al. ,2020)

Figure (3) The Process of Updating Patient Records and EMR into Blockchain
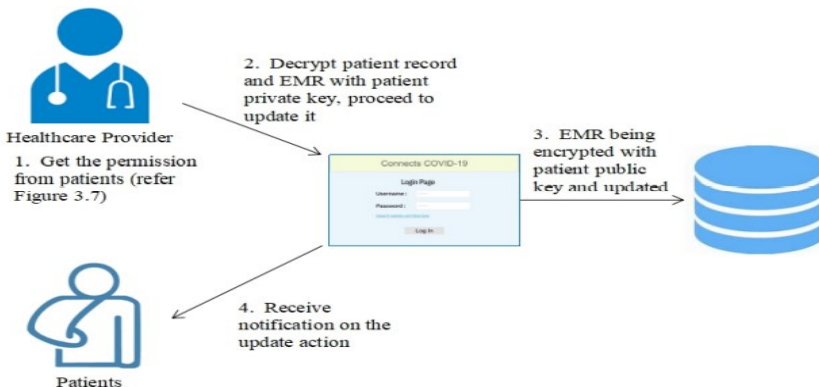
As part of the blockchain system, healthcare authorities would like to view patient and EMR records in order to learn about their symptoms and treatment method (Chen, Y., Ding, S., Xu, Z., Zheng, H., and Yang, S. , 2019). This can help them gain a better understanding of the disease profile and aid in their research (Agbo, C., Mahmoud, Q., and Eklund, J., 2020). Financial parties are the people who assist the patient with financial and health checks - so they may wish to view the relevant patient documents to proceed with their business. Before going through patient records and EMR, health care authorities. The financial parties need to obtain permission from the patients in order to proceed with their work (Riso, B., Tupasela, A., Vears, D. F., Felzmann, H., Cockbain, J., Loi, M., et al., 2017).

**Figure (4) The Process of Sharing Patient Records and EMR in Blockchain**
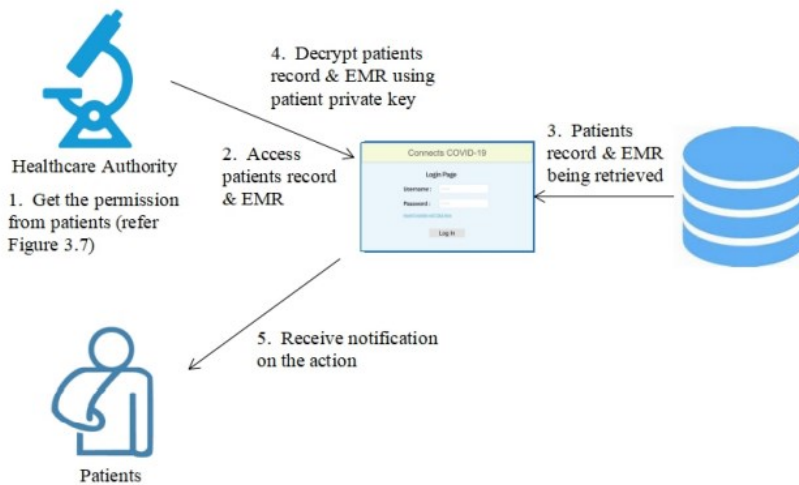
Patients in this blockchain system have complete control themselves over all their processes and the ability to access the patient's records at any time. Anyone who wants to view or update the entire patient history (Huang, G., and Foysal, A., 2021), needs to request permission from patients. Since patient details and medical records

are written within a particular hospital (Buterin, V., 2019), viewers may also need to obtain consent from healthcare providers as in a hospital before asking patients (Vyas, J. D., Han, M., Li, L., Pouri-yeh, S., and He, J. S., 2020).

Figure (5) The Process of Asking Patient Permiss
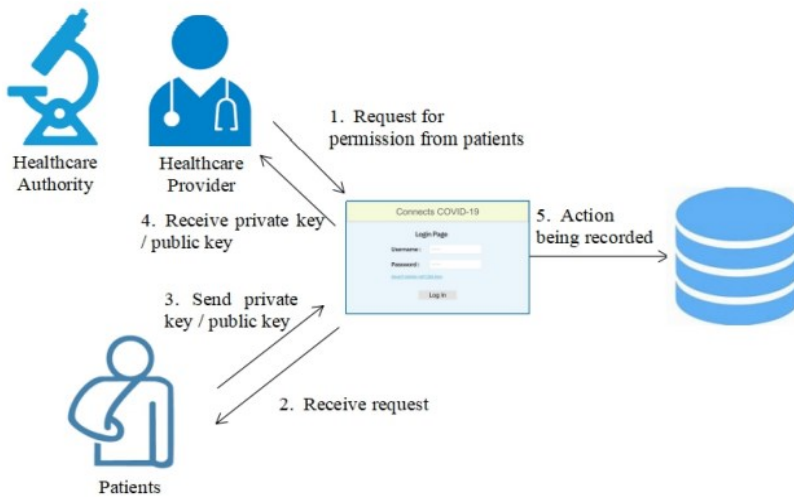
7 - Conclusion:

Blockchain technology can improve health care services in a decentralized, tamper-proof, transparent, and secure manner. With the development of this technology and its integration with other emerging technologies, blockchain has the potential to offer long-term benefits. Not only can it be a mechanism to secure electronic health records, but blockchain also provides a powerful tool that can empower users to control their own health data (Ballantyne, A., 2020), enabling a foolproof health data history and establishing medical responsibility. In this study, EDA, data pre-processing, model development and model validation are implemented in order to build a reliable predictive model that gives accurate results. The composite logistic regression model is then combined with the proposed application tools to make users' decisions based on the expected outcomes (Buterin, V., 2019). Moreover, a multifunctional framework with the implementation of blockchain technology is

proposed. First, people who work in the healthcare industry or are involved in the COVID-19 field are identified and identified as participants in the blockchain system. Next, a blockchain-based framework has been proposed that is capable of storing, retrieving and updating the electronic medical record and making use of COVID-19 patient data to give prediction of their level of severity (Kassab, M., DeFranco, J., Malas, T., Destefanis, G., and Graciano Neto, V. , 2021) . An application to connect participants to a blockchain-based database, and a proposed blockchain-based application that stores files and provides EMR convenience in data sharing, so that users can directly access patient data without third parties sharing. Activities that involve data sharing include researchers who want to use data to develop it or refer to medical records when patients move from one hospital to another. It saves a lot of time and increases overall productivity in healthcare. Patients are also given the possibility to control their data in a way that others can only access by using the private key with the patient (Gervais, A., Karame, G. O., Wüst, K., Glykantzis, V., Ritzdorf, H., and Capkun, S., 2020).

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