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During Covid-19: The rule of Blockchain applications in healthcare management and potential barriers

Abbas Hussein Ali[1], Ahmed Burhan Mohammed[2], Amel Sulaiman Mandan[3]

[1] Department of Quality Assurance andUniversity Performance, University of Kirkuk, Iraq.
[2] Faculty of Arts , University of Kirkuk, Iraq.
[3] Faculty of Administration andEconomics, University of Kirkuk, Iraq .

Abstract

By 2020, the world economy, health and human life have been significantly damaged and have seen the spread of coronaviral disease (COVID-19). The COVID-19 pandemic has highlighted the existing healthcare systems' limitations in dealing with public health disasters in a quick , efficient and accurate way. Many of today's healthcare systems are centralized and lacking of absence the essential features such as security and privacy, data immutability, transparency, and traceability. In this case the detection of vaccination certification, antibody testing, and fraud on medical supplies may be difficult process to complete by the administrations during Covid-19 pandemic.Blockchain technology that is decentralized, trustworthy, traceable, and transparent can help prevent the COVID-19 pandemic by providing safe and dependable medical supplies and establishing a source of data to authenticate real personal protection equipment. In this paper, the possible blockchain technology uses for the COVID-19 pandemic were discussed. We explored some of the possibilities of blockchain technology that may help to fight COVID-19 pandemic. We address important open research key problems as well as basic restrictions that may limit the use of blockchain in COVID-19 combat.

Keywords: Blockchain; Covid-19; Healthcare; Pandemic; Vaccination; transparency; disasters

1. Introduction

Coronavirus disease (COVID-19) is a respiratory infection that has impacted a variety of industries throughout the world, including the economy, healthcare, transportation, and education. COVID-19 is especially dangerous for people with pre-existing medical problems and can quickly spread from one person to another (Kang, et al., 2020).

COVID-19 has infected about 170,812,850 persons with a death toll of 3,557,586 persons across the global (WHO, 2021). Health authorities like as the World Health Organization (WHO) have proposed a number of preventive steps to work quickly and minimize the unexpected worldwide spread of COVID-19. Due to a lack of medical supplies and hospital capacity, government officials have been driven to apply a partial or total lockdown in order to limit the spread of the virus. Preventing adverse consequences as a result of COVID-19 spreads needs coordination of effort and collaboration between health professionals, authorities, research institutes and the community (Chamola, Hassija, Gupta, & Guizani, 2020).

However, existing information management systems are generally disintegrated to hold critical COVID-19 data. The lack of effective data exchange channels in disintegrated systems might result in information gap for cooperating organizations. Due of a lack of information, collaboration prospects between collaborating organizations to tackle the COVID-19 pandemic may be limited. The usage of technology like blockchain can help businesses mitigate the negative consequences of the COVID-19 pandemic. The fundamental characteristics of blockchain technology can empower information exchange and give a consistent perspective of data, allowing corporations to better coordinate their operations and reduce the spread of COVID-19 (Shashank, Rakesh D., & Balkrishna E., 2020).

Many technological applications have recently been designed throughout the world to allow public health authorities effectively control the pandemic COVID-19. Many corporations, for example, such Google and Apple have launched contact tracking apps that allow authorities track infected COVID-19 individuals (Fred, 2020). However, the methods currently used require utilize personal information, such as location and COVID-19 test results of an individual, to detect spread rates and predict critical locations of the community (Laura, Mateo, & Kathleen, 2020).
The TraceTogether solution, for example, uses Bluetooth technology in Singapore to find out how a person has close contact with infected COVID-19 patients (Nadeem, et al., 2020). Contact service providers can access user data to compromise data privacy by being a centrally controlled solution. Likewise, data records and transactions are likely to modification, manipulation or elimination in centralized systems. In addition, centralized systems are less reliable because of the possibility of a single failure point (Maureen H. & Paul A., 2006).They offer limited options for cooperation between health, government and law enforcement organizations. Centralized systems also struggle to ensure that the data recorded and shared during various operational stages for COVID-19 pandemics is entirely traceable, transparent and immobile (Supakorn, 2009).
Blockchain is a distributed, decentralized, and unchangeable record of transactions that is stored on a distributed network of nodes spread throughout the global (Nguyen, Ding, Pathirana, & Seneviratne, 2020). Without a single point of failure attack, blockchain technology's decentralizing feature provides high levels of security and resilience for stored data and transactions. The blockchain's record of transactions and data is visible to all network members, generating trust in the data's dependability and availability (Mohamed & Aboul Ella, 2020). The transparency of blockchain-based records is guaranteed by a decentralized consensus protocol establishing rules to assure approval of all miners on the current status of blockchain-based records. New transactions are validated by the blockchain network's miner nodes and added to the existing blockchain ledger as a new block. Miners are often recompensed for their mining services with cryptocurrency (Yang, Miao, Chen, Tang, & Chen, 2017).
To confirm the authenticity and integrity of data, Blockchain utilizes asymmetric cryptography. To make the data on the blockchain unchangeable, blockchain technology uses hashing to link each block with its predecessor. Smart contracts can be used with blockchain technology to automate business procedures and manage conflict across healthcare agencies in a secure and trustworthy environment. A smart contract is an autonomous program, which builds credibility between contributing businesses (Dounia, et al., 2020). For example, in supply chain of COVID-19 polymerase chain reaction (PCR) testing kits are managed logistically using a blockchain-based system, Smart contracts have the potential to play a critical role in Tracking the location of the containers during shipping process and helping in Faulty test kits Identify procedure. Also, keep an eye on the condition of the testing kits while they are being shipped. Additionally, provide government authorities access to data in order to study the demand for and availability of testing kits in a certain location (Amirul, Muhammad, & Paul E., 2020).
In this work our efforts are entirely focused on health-related emergency services. This paper's primary contributions will be the discussing the possible blockchain application to countermeasure the COVID-19 pandemic especially in the context of a public health emergency

2. Blockchain in Healthcare Management

The term "blockchain" refers to a group of technologies known as "distributed ledger technologies." Its operation is mostly dependent on a network of blocks connected together in a register. Each transaction in a network block is verified by a mechanism based on a distributed consensus among all nodes. The transactions are the outcomes of the operations that take place among the network's subjects. The concept of blockchain is derived from the fact that each block keeps a reference to the preceding one via a cryptographic method. As with typical web application, the blockchain is not stored on a centralized server, but is spread among network devices called nodes. Eachone has a complete copy of the blockchain. There are two major features to blockchain technology: (a) the decentralization of consensus and (b) decentralization of the ledgers.As a result of the decentralization of consensus, Trustworthiness may not be essential between people participating in any type of transaction and a central authority (Michael, Peter, Oliver, & Dirk, 2017).In the same way, the second factor is important.The replication and preservation of distinct versions of various blockchains across the network's nodes ensures that the system is more secure and the users are treated equally. Who has simultaneous access to the same data and As a result, the approved transactions contained in the blocks have traceability and immutability. Blockchain is therefore a peer-to-peer network in which all network members may trust the system without needing to have trust in each other's (Andrea, Francesco, & Emanuele, 2019).In the context of a current COVID-19 emergency, integrating Blockchain to the healthcare sector can provide innovative and effective ways to improve multiple acts in the area of pathology prevention and control. Coronavirus has showed not only the inability of existing healthcare surveillance systems to react to public health emergencies in a timely manner. But also an obvious lack of modern systems based on large-scale exchange of clinical data, able to at least prevent or reduce such large-scale emergencies.Various researches highlight the use of blockchain in the healthcare system primarily for patient data exchange and management in electronic health records (EHR) and the management of medical device and drug supply chains in order to increase scientific research and knowledge sharing (Tsung-Ting, Hyeon-Eui, & Lucila, 2017) .Technology can facilitate the sharing of healthcare data which is an important step towards optimal interoperability across different EHR systems. Additionally, using of blockchain technology to handle EHR data may help to eliminate clinical bias. As a result, overall healthcare results are improved.The issue of interoperability challenge between various EHR systems can be solved by using various blockchain systems as a bridge in order to facilitate cross communication.Blockchain provides a chance to provide encrypted data transfers between two and more users. This has made an interest in this technology which largely aimed at facilitating connection across various secure networks. By employing Blockchain technology we ensuring that operations such as asset and communication exchange are trustworthy decentralized (Rebecca, 2019).

3. Use of Blockchain Applications In The Fight Against Covid-19

The Blockchain can enable the establishment of a trustworthy, verifiable, distributed and perfect-strength ledger technology for a transparent and efficient system (e.g. healthcare). Via a chain of linked devices, it can become the first level of protection. In this part, we will analyze some possible opportunities for blockchain technology to fight the COVID-19 pandemic.

3.1. Personal Protective Equipment (PPE) Tracking and Tracing :

Persons exposed to a transmissible virus should use personal protective equipment (PPE) to prevent and control the spread of the virus. For example, the use of PPEs can help decrease the exposure of front-line healthcare workers to infected persons in the case of a COVID-19 related health emergency. Gloves, safety goggles, boots, face masks, helmets, and protective clothing are examples of PPEs that are primarily used to avoid contact with infected people or materials (Edward, Angel, & Michael, 2020). Many counties reported a shortage of PPEs in hospitals during the COVID-19 pandemic due to a lack of a reliable mechanism to deliver accurate data about PPE supply and availability. In some situations medical professionals had to use tape to bind broken masks in order to avoid COVID-19 contact due to the limited supply of PPEs against the rapid increase in demand in the health sector (Howard, Phil B., & Edward H., 2020). PPEs with low quality, including face masks, have been supplied to a number of countries and organizations. One of the explanations for the distribution of low-quality PPE is the limitation of transparency in the logistic supply chain management process. The present centralized PPE supply chain management system is incapable of reliably and effectively tracking the data in the supply chain process (Cohen & Rodgers, 2020).The possibility of healthcare systems to control the supply chain of PPE's using blockchain technology will significantly help in detecting fraud related to PPE's. It can contribute in the building of a more reliable PPE supply chain (Kalla, Hewa, Mishra, Ylianttila, & Liyanage, 2020). Using blockchain-based technologies, participating organizations can validate personal protective equipment (PPE) and detect any indicators of fraud or illegal handling during shipment. All transactions are recorded in an immutable and transparent way while using blockchain technology. With this way Blockchain technology can help PPE's accreditation and safe supply chain operations, avoid infractions of the legislation, Identify false PPEs through data source,and can help to face Individuals fines in case they do not follow safety procedures. In addition, smart contracts built with the ability of controling access and automation may track and trace the PPE in order to predict the demands of governments, authorities and medical organisations.Moreover, data on the available stock in the warehouse may be collected using registered and approved sensor and smart contracts may immediately warn the supply chain management in order to place an order for additional PPE in order to minimize any possible shortage effect (Kevin, Elizabeth, Cameron, & Timothy, 2018).

3.2. Blockchain Support for Vaccine Logistics

In order to limit COVID-19 spread, the provision of an active vaccination must be effectively immunized against the virus. Many research centers and laboratories are undertaking many vaccine candidates' clinical studies at the time of this study (Kevin, Elizabeth, Cameron, & Timothy, 2018).

Authorities,governments, and research institutes are concerned about the vaccination's effectiveness, safety, and sincerity since the newly administered vaccine may have a negative impact on individual health (Binbin, Jun, Xin, Fucun, Huaming, & Qingguo, 2020).The current centralized vaccination management systems face a variety of challenges, including the possibility of vaccines not being properly secured and delivered. Also, putting the vaccine logistics supply chain at risk for illegal purpose.Counterfeit pharmaceutical businesses see this technical disadvantage as a chance to sell and distribute fake and imitation vaccines to COVID-19 patients. The most of unauthorized, illegal, or inadequate vaccines are made with poor materials (Chuanxi, 2020). Poor manufacturing procedures used during vaccine production also result in faulty vaccinations. Invading the black market with fake, fraudulent, or defective vaccinations can seriously harm human life (Laurence, 2010).

Blockchain technology can keep constant data from numerous COVID-19 vaccination processes steps for example, development, production and certification. Moreover, Distribution for immunization purposes to recognized organizations.Medical practitioners in hospitals may access blockchain to recognize, track, and check data on vaccinations beforeusing it. It may also be utilized in real time using light weight smart contracts for notification handling. Smart contracts give chances for the detection of vaccine fraud, guarantee zero downtimes and remove the role of third-party services for monitoring Vaccine Logistics. The immutability function assures that the information on the vaccine cannot be modified by attackers or removed. Smart contracts may rely on information such as the date of manufacturing and the warranty period to identify and verify the expiry date of the vaccination (Kalla, Hewa, Mishra, Ylianttila, & Liyanage, 2020). To secure the COVID-19 vaccine throughout transportation, smart contracts may be established to detect the status of the container for temperature, humidity, pressure, and other parameters which will be an important add to the supply chain logistics services(Laurence, 2010).

3.3. Support Telehealth and Medical Material Delivery

Sophisticated remote health practices such as telehealth and telemedicine can allow symptomatic patients to interact with health care specialists using IT infrastructure to minimize the chances of contagious virus transmission. Online diagnosis and treatment of patients might significantly minimize patient and staff access to healthcare facilities, allowing remote health services to efficiently control and limit the global spread of COVID-19 cases (Jeff, 2019). Remote health systems are vulnerable to a single failure point since they are governed and managed by a centralized authority which has an influence on the health record's integrity and confidence. Remote services can, in a variety of ways, benefit from the inherent features of the new blockchain technology.Establishing the source of electronic health records, verifying the user's identity while requesting patient records, preserving patient privacy, and instant payment automation are all key benefits of blockchain use. The traceability feature assists in determining the source of medical self-test kits for COVID-19 testing. The traceability mechanism assists in establishing the source of COVID-19 self-testing medical kits. Individuals with negative test results are frequently required to perform self-quarantine procedures in order to restrict diseases from being transmitted across the community (Randhir & Rakesh, 2019).

3.4. Digital Contact Tracing

Following social distancing instructions that governments issued can greatly reduce people's social connections, helping to limit the spread of COVID-19. A public health technique called digital contract tracking is achieving social distance, which can stop the virus from spreading from person to person (Luca, et al., 2020). Digital contact tracking tracks infected individuals constantly in order to quickly and effectively recognize all social interactions throughout COVID-19. It primarily employs GPS or Bluetooth to recognize social connection with a virus-infected person. Therefore, a person's having close contact with a confirmed case of COVID-19 must be tested, monitored and isolated (Robert & Colin, 2020).The requirements for designing and deploying a contact tracking system for identifying social interactions between people are important.Transparency, immutability and privacy are required characteristics to create and deploy a contact tracking system. Patients' health information, such the COVID-19 test results, is must be visible and immutable against manipulation or deletion by attackers or healthcare employees. Additionally, preserving the privacy of user's data to match with privacy rules like announced in general data protection regulation (GDPR) (Joseph, et al., 2020). Encrypting a person's location and contact history, as well as preventing public access to sensitive health information's, protects data privacy. When users come into close contact with a COVID-19 infected patient, they can be notified about a recent social contact with a COVID-19 infected patient without revealing the COVID-19 infected individual's identity (Qiang, 2020). TraceTogether from Singapore, Google-Apple's contact tracing utilizes Bluetooth to track a personal close physical contact with a virus-infected person through smartphone contact tracking applications (Uichin & Auk, 2021).Non-blockchain-based solutions are less trustworthy due to the high privacy and sensitivity of users' data, since they are subject to data tamper by the application's administrator.For digital contact tracking, the immutable and decentralized blockchain technology is a suitable alternative. By offering anonymity, it protects the privacy of the user's data. The blockchain platform may be used to track digital contact tracing that can only be accessed by authorized individuals, and maintaining high level of privacy (Mohamed & Aboul Ella, 2020).

3.5. Immunity Passports and Vaccination Certificates

Antibody testing, commonly known as serology, evaluates if a person is immune to a virus after return to health recovery. The vaccination certificate outlines a person's diseases vaccinated against. The vaccination certificate uses to prevent the spread of COVID-19 and to regulate it, by enabling authorities and administrations to set regulations enabling people to travel between countries using this certificate (Dana, 2020). Thus, the prevention against forgery, high cost-effectiveness and data protection of the certificate are essential criteria of the authorities for minimizing travel related fraud.Antibody testing and vaccine certification on the blockchain give a simple, unforgeable, and cost-effective data management solution (Marc, Manoharan, Niaz, Allan, & John, 2020). Blockchain employs asymmetric encryption/decryption techniques and digital signatures for preserving antibody testing and vaccine certification data. In addition, decentralization ensures the protection of vaccination certificates against single failure points or other harmful activities. This enhances client trust by enhancing data security and trustworthiness (Hong-Ning, Muhammad, & Noman, 2020). Antibody certificates may be evaluated in a safe way, while guaranteeing user data privacy. As an example, many businesses can develop and implement policies that enable only workers with a valid digital immunity passport based on antibody testing and vaccination to return to work once the COVID-19 pandemic has ended. In this scenario, blockchain technology ensures that an invalid immunity passport cannot be submitted to authorities to get entry to the workplace according to the immutability feature of blockchain.Blockchain's unique transparency and traceability characteristics contribute in establishing the data source of the COVID-19 lab reports. Furthermore, it may enable organizations to verify the authenticity of the COVID-19 PCR test kits(Marios Angelopoulos, Damianou, & Katos, 2020).

4. ObstaclesFace Blockchain Technology In Telehealth

In this section, we address key open research challenges as well as the basic constraints that may be limitation for blockchain deployment for COVID-19 fighting.

4.1. Security Review of Smart Contracts

Smart contracts automate business by applying contractual terms and conditions between participating organizations. For example, personal protective equipment (PPE) tracking and tracing, COVID-19 hotspots localization using digital contact tracing, examining vaccination records and providing immunity passports to traveling people in a traceable, transparent, and responsible way. Despite the various benefits of smart contracts, such as support for automation, debugging flexibility, cost effectiveness, and requiring the least volume of human contact to manage corporate processes, they are not without limitations. The existence of errors in a smart contract's code might have a negative impact on its regular functioning, resulting in significant losses and interruptions. A smart contract on a decentralized platform could be exposed to a number of security issues from anonymous, bad actors that can control the smart contract for harmful reason (Yongfeng, Yiyang, Renpu, J. Leon, & Peizhong, 2019). On public blockchain networks, smart contracts are commonly open-source. Therefore, the blockchain network's data and transactions potentially expose the system to malicious users. Due to immaturity and a lack of understanding of blockchain technology, smart contract design can potentially lead to problems (Sarwar, Hector, & Tom, 2020).

4.2. Network Latency and Transaction Productivity

The pandemic of COVID-19 increases demand on the existing systems of health care to react fast and effectively to public health risks. Typical and close coordination and cooperation of entities involved in emergency health operations is essential in the fight against the COVID-19 pandemic. Strong cooperation and coordination in fighting COVID-19 will require consistent and synchronous data records to improve the activities of cooperating organizations (Salathé, et al., 2020). However, Organizations generate massive amounts of data. For example, Users of digital contact tracking must constantly checking and update their time-stamped georeferencing data on the blockchain. Therefore,the data volume increases and makes it harder to fulfill the data processing standards of COVID-19. The time it takes to mine a block is what defines the blockchain network's response time. The degree of latency varies according to the type of blockchain platform utilized and its features (Kalla, Hewa, Mishra, Ylianttila, & Liyanage, 2020). The higher network latency result is to decrease transaction efficiency. The Ethereum platform, which is open to the public, offers limited transaction privacy and throughput. It can process twenty transactions per second (Gavin, 2014). Private Blockchain networks can process thousands of transactions per second and are fast and secure (Suporn, Chaiyaphum, & Suttipong, 2017). The growing transaction rate would have an influence on transaction costs, percentage of network energy usage and the time it takes to complete transactions. In order to mine large-sized blocks, the increasing transaction rate needs more resource-rich blockchain nodes (Mazin, Khaled, Muhammad, & Davor, 2019).

4.3. Ethics and Data Privacy

Blockchain technology has the ability to tackle important difficulties in traditional data management approaches for clinical trials such as inconsistency in data and duplication using distributed ledger technology. It distributes clinical trial data and allows all miner nodes to have full access to the complete database (Kalla, Hewa, Mishra, Ylianttila, & Liyanage, 2020). Organizations have expressed concerns about data privacy and security as a result of the database's open nature (Teck, Hannah, & Clarence, 2020). According to data privacy, the clinical trial data housed on the blockchain network should be inaccessible to unauthorized individuals. That is ensures the health information is shared only with approved organizations, as well as compliance with GDPR privacy standards and the terms and conditions of the consent form (Agam, Chandan, & Rana, 2020). Due to the public nature of data and transactions on Bitcoin and Ethereum public blockchain platforms, it is hard to protect the privacy of clinical trial data. Another use case that requires data privacy guarantee from unauthorized users is issuing immunity passports to persons based on vaccination certificates. By using methods for protecting the privacy of COVID-19 related patient information include zero-knowledge proof, attribute-based encryption (ABE), and multi-party homomorphicobfuscation the possibility of the informationof been subject to any kind of social discrimination will decrease. Although the privacy of COVID-19 data has been adequately secured by current medical passport production procedures, certain ethical issues may restrict its application(Teck, Hannah, & Clarence, 2020). For example, the environmental effect of Blockchain as a result of high power usage causes important problems that need to be resolved (Denisova, Mikhaylov, & Lopatin, 2019).

5. Conclusion

In this study, we discussed how the properties and benefits of the emerging blockchain technology may be employed to combat the COVID-19 pandemic. We examined the various uses of blockchain technology to address the vital role that blockchain may play in a health emergency during the COVID-19 situation. We explore the possibility for blockchain technology to be used in PPE distribution and shipment, vaccine logistics, medical material delivery, digital contact tracing, and immunity passport vaccination certificates, as well as the obstacles that blockchain technology adoption by health organizations may face in the fight against the covid-19 pandemic.Blockchain technology is intended to create a cooperative, accountable, and collaborative environment for workers involved in the management of the PPE or vaccine supply chain management. Additionally, Authorities may use immutable data on COVID-19's spread in a given area to correctly identify infection hotspots. When government agencies use blockchain technology to access and use public health and location data to develop rules for people's health and safety, it's difficult to comply with GDPR requirements. The privacy constraint can have a significant impact on the adaptability of blockchain technology. In the other hand, having such vital information can allow authorities to plan future actions to stop the spread of the infection. Moreover, features such as great trust, safety, traceability and transparency of blockchain technology can empower authority to find solutions to the COVID 19 pandemic.

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