

# Research on Data Governance of Public Health Emergencies Based on Blockchain Technology—Prevent and Control with COVID-19As an Example

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## ABSTRACT

The management of major public health emergencies has gradually become the focus of academic circles. In the context of big data, data, as an important element resource, plays an important role in the prevention and control of public health emergencies. To solve the problems of data islands, data security, and lack of trust in the management of public health emergencies. This article combines the blockchain with big data. Based on the analysis of the concept and characteristics of the blockchain, it discusses the compatibility of the characteristics of public health emergencies with the data governance supported by blockchain technology. Take prevention and control as an example, propose a blockchain-based secure data governance process and governance framework to further enhance the governance capabilities of public health emergencies.

**Keywords:** Blockchain, Big Data, Data Governance, Public Health Emergencies.

## 1. INTRODUCTION

With the rapid changes in the social structure and the rapid economic development, we are entering a "risk compression" society [1]. Various emergencies, natural disasters and social crises are intertwined and reborn, and public risk events are becoming increasingly self-derived and complex. Sex. At the end of the year, COVID-19 broke out in Wuhan, exposing many shortcomings and deficiencies in the country and the government's response to the epidemic, and it also brought serious damage to the economy and society. In the prevention and control of this epidemic, data as a factor resource, through the empowerment of digital technologies such as big data, the Internet of Things, artificial intelligence, and blockchain, has changed the previous single government in responding to and resolving public health emergencies. The traditional mode of management and offline management has shifted to a crisis response mode in which the government, enterprises, social groups, and citizens participate together, integrate online and offline,

and integrate front-end and back-end. General Secretary Xi Jinping emphasized when presiding over the twelfth meeting of the Central Committee for Comprehensively Deepening Reform, "It is necessary to encourage the use of digital technologies such as big data, artificial intelligence, and cloud computing in epidemic monitoring and analysis, virus traceability, prevention, control and treatment, resource allocation, etc. Play a better supporting role in the field," pointing out the extreme importance of digital technology in the emergency management of public health emergencies. Data is the core means and basis for government decision-making, and it is also the core basis for emergency management decision-making and command. The outbreak of the epidemic has exposed a crisis of data sharing coordination, triggering a crisis of public opinion and a crisis of trust. [2] As the core of current digital technology, blockchain technology provides powerful conditions for solving public crises with its technical advantages such as verifiability, tamper resistance, decentralization, and full trace retention.

## **2. ABOUT PUBLIC HEALTH EMERGENCIES AND BLOCKCHAIN**

### ***2.1. Concept and Characteristics of Public Health Emergencies***

A public health emergency refers to “a major infectious disease epidemic, a group of unknown cause disease, major food and occupational poisoning, and other events that seriously affect public health that occur suddenly and cause or may cause serious damage to public health.” [3] Suddenness and randomness are the salient features of sudden public health events. Sudden public health incidents generally occur in social group environments and involve a wide range of causes. They also have the characteristics of widespread transmission, complexity of harm, and comprehensive governance. The crises brought about by public health incidents are mainly manifested in: social crises caused by incidents that seriously affect the lives and health of the people, such as infectious disease epidemics, food safety incidents, and group unknown diseases. The outbreak of public safety incidents not only led to the occurrence of diseases and deaths, but also caused great panic in society. [4] Take this new crown pneumonia as an example. The epidemic spread throughout the country and even the world, hindering the development of social economy, and the subjects of all social strata have been affected to varying degrees.

### ***2.2. Overview of Blockchain***

#### ***2.2.1. The Concept of Blockchain***

As the underlying technology of Bitcoin, Blockchain technology is actually composed of two parts, one is a "block" and the other is a "chain", which essentially divides the data that needs to be stored in the database into a series of information areas. It is composed of blocks, each block is generated in chronological order, and all the value activities since its creation are recorded on the block, which supports multi-party cooperation and participation. [5] In a narrow sense, blockchain encapsulates data into blocks and connects the blocks in a chain to form a specific chained data block structure. In a broad sense, blockchain is a decentralized basic framework for verifying, storing, updating, programming and operating data using multiple technologies such as peer-to-peer network communication, encryption algorithms, consensus mechanisms, and smart contracts. A distributed computing paradigm. [6] In essence, the blockchain is a decentralized distributed database, which can be simply understood as a distributed "ledger" that is collectively maintained by multiple nodes. Each node can share and query this Ledger.

#### ***2.2.2. The Technical Characteristics of The Blockchain Are Compatible with The Governance of Emergent Common Health Incidents***

The point-to-point transmission technology, asymmetric encryption technology, hash algorithm, and time stamp technology in the blockchain are of reference significance for the governance of data in emergencies in accordance with smart contracts and shared decentralized databases under the consensus mechanism.

Blockchain point-to-point transmission technology. With decentralization. The traditional processing method must go through the central unified processor, once damaged, it is difficult to save. Under the blockchain technology, any node exchanges data through peer-to-peer technology without going through a third-party organization, reducing the flow of data and information, and any node can store a complete copy of the data locally, [7] narrows the main body. The time and distance of data circulation between the government departments breaks the shackles between the upper and lower levels of government departments, and is conducive to the rapid collection and sharing of data storage. Based on data analysis, emergency measures can be taken quickly when a crisis occurs.

Blockchain asymmetric encryption technology can be trustless. This technology requires both parties to have a public key and a private key in a transaction. The public key can be made public, and the private key is held by the individual. During the transaction, the information encrypted by one key (such as a public key) can only be decrypted by another key (such as the corresponding private key), which means that the decryption of data can only be decrypted or authorized to be used by the owner of the property rights of the data. This has successfully built a mutual trust mechanism between the two parties. The two parties do not need to disclose their identities to allow each other to trust, which solves the trust crisis that may occur in the transaction process. [8] provides a reference for the unclear ownership of data and lack of trust responsibilities in public opinion.

Blockchain time stamp technology and hash encryption technology. Blockchain technology uses cryptographic hashing algorithms to compress and encrypt the data information of the previous block, then stamp the current block with the current time stamp, and finally record the current block information, [9] is beneficial to data Traceability and safety. The combination of data link and time stamp can trace data

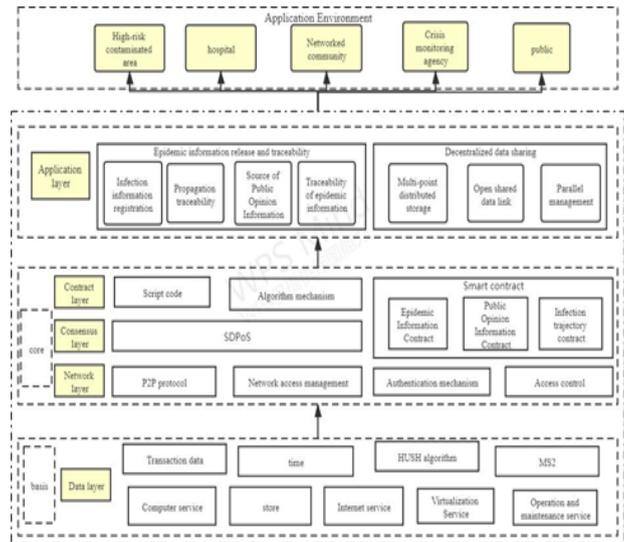
history, anti-counterfeiting traceability, and complete analysis of historical data and real data. Hash technology can also compress node data and verify it. It helps to reduce the scale of data storage and the authenticity of data in crisis prevention and control.

**Collective maintenance.** Due to decentralization, all nodes need to work together to maintain the system. The blockchain system stores data in the form of blocks. When data is encapsulated into blocks and connected into chains, all nodes in the entire network need to participate and maintain. Collective maintenance is not only embodied in the storage and backup of data by all nodes, but also the verification, update and recording of data.

**Consensus mechanism.** The consensus mechanism mainly solves the problem of block structure and data unity between blocks. It is a digital algorithm that establishes a trust mechanism between many nodes in the block chain and realizes information exchange. It is a digital algorithm that realizes distributed autonomy under the block chain system. Foundation and premise. The consensus mechanism includes the traditional distributed consensus algorithm (BTF), proof of work (PoW) and proof of authorized shares (DPoS).

Blockchain shines in many fields by virtue of its own characteristics. In terms of public security data governance, decentralization and collective maintenance mean that various entities can realize the interconnection of public security big data, which is beneficial to breaking the dilemma of data islands, difficulties in inter-departmental coordination, and no public participation. [10] Trustlessness and difficulty in tampering means that the information interaction between nodes is safe and reliable, which helps to ensure the quality of public safety big data and improve the security of data storage. [11]

At present, the academic circle generally believes that the blockchain can be divided into five levels, namely, the data layer, the network layer, the consensus layer, the contract layer, and the application layer. This paper proposes a data sharing framework for health emergencies under the blockchain based on these five levels.



**Figure 1** Blockchain data release and sharing framework for epidemic prevention and control

The data layer mainly includes the underlying data block and its basic data structure. The shared layer is used to record and store information on the chain. Technologies such as hash function, asymmetric encryption algorithm and timestamp ensure the certainty, immutability and modification of information. Traceability; the network layer is used for the transmission and verification of data between nodes, the peer-to-peer network guarantees the accuracy of the propagation mechanism and verification mechanism, the consensus layer is used to ensure the consistency and authenticity of the data; the contract layer is used to provide smart contracts Development environment; the network layer, consensus layer, and contract layer are the key to the blockchain, including the data transmission mechanism, transaction verification mechanism, and access control mechanism on the blockchain. Through the collection and verification of distributed node data, an appropriate P2P protocol, information resource access control method and identity verification mechanism. The consensus layer maintains the consistency and authenticity of data among distributed nodes. In the crisis management, it cannot be completely decentralized due to its particularity. The DPoS mechanism is used to select representatives and get accounted. Right to ensure the consistency of distributed data. Complete function combing and design a smart contract that collects epidemic information, collects relevant public opinion data and traces the trajectory of the infected person; the application layer is used for the implementation of blockchain technology in specific scenarios, such as high- risk infection areas, medical institutions, Grid community, etc., to realize data transmission and governance.

**3. APPLICATION SCENARIOS OF BLOCKCHAIN TECHNOLOGY IN PUBLIC HEALTH EMERGENCIES PROBLEMS WITH INFORMATION DATA IN PUBLIC HEALTH EMERGENCIES**

Taking the new crown pneumonia as an example, from December 2019 to January 10, 2020, the internal processing of relevant departments in Wuhan City is unknown. Data is missing and the information disclosure in the society is insufficient, resulting in delayed prevention and aggravation of the epidemic; On December 25, 2019, medical institutions have reported cases of medical staff infections, and there have been reports of medical staff infections. After 6 days of information reporting, review, screening, and joint research and judgment, the National Health Commission began to intervene in investigating the incident on the 31st, and there was a lack of diagnostic evidence and detection methods for infected persons. The judgment of the front-line medical staff on the infection situation needs to be reported and differentiated level by level. [12] key nodes are collected in a timely manner and not precise enough; charity is not transparent, the orientation of donating medical supplies is not clear, it is not clear whether the donated materials meet the standards and the front-line supply situation, the information is not transparent, and effective decision-making and judgment cannot be made; in In the early stage of epidemic prevention and control, the itinerary of confirmed patients was complicated, and it was difficult to identify close contacts. In the later stage of epidemic prevention and control, the use of "blockchain + big data" effectively solved the problem of traceability. However, in the era of big data, how to integrate and use data and ensure that information is not leaked still faces challenges; the proliferation of false public opinion information causes public panic, public panic, and government credibility crisis.

From a data point of view, there are several data-level relationships in epidemic prevention and control: one is the data relationship between government emergency decision-making and health and medical institutions; the other is prevention and control emergency command and health transportation , The system relationship and data relationship between various public security departments; the third is that the mobile Internet plays the role of the spreader of epidemic information, but the data relationship between the "true and false basis" and "trustworthy basis" of the data and the control of public opinion; the fourth is The data governance relationship between the government's social governance system and the information system of related departments. Based on the characteristics of the

relationship at the data level and the analysis of measures in the epidemic prevention and control process, it can be judged that there is a problem of "data information islands" between various government departments, and there is a lack of real-time data sharing and coordination mechanisms; there is a relationship between health management departments and hospitals and medical institutions. There may be a "data information island problem", and there is a lack of real-time data sharing and coordination mechanisms; the governance and control of official data, non-platform data, and social communication data by public opinion management departments lack comparison standards and standards for "true and false basis" and "trustworthy basis". Related means.

Coupling between blockchain and public health emergencies. Relevant scholars' research shows that data governance has outstanding advantages in terms of people, things, technology, and data in public governance. [13]

Data relationship dimension	Technical prevention and control applications (select typical applications among them) are not specified
Data relationship between government prevention and control decision-making and health and medical institutions	"Blockchain + Medical Information Sharing"
Data relationship between prevention and control emergency command and health, transportation, and public security	"Block Connect + Public Safety Inspection"
The data relationship between the Internet and public opinion supervision	"Blockchain + Information Deposit Certificate"
The relationship between social governance and related departments informatization	"Blockchain + Charity"

Coupling explanation: In "blockchain + medical problem of patients The pain point of the lack of access control rights for medical data makes the patient's health information not concentrated in one or several medical institutions, but shared in each node of the blockchain. The patient himself has control over the data, and solves the problem of data quality. High, there are many problems such as information islands, tampering and

distortion, omission of records, leakage of personal privacy, and data gray transactions. [14] Digital signatures and encryption technologies are used to ensure that different institutions share information while protecting the privacy of patients; use the geographic location information collected by the monitoring network to quickly locate the location of the infected person, which helps to grasp the trajectory of the infection and the overall trend of the epidemic;

Use the decentralized trust mechanism and P2P network environment in emergency command and public transportation safety to speed up the response speed of public health and transportation systems in emergency situations, improve the epidemic monitoring and early warning network and decision-making process to prevent the falsification of related information, and maintain the transparency of information. Form a multi-sector response "blockchain + public safety inspection"; "Blockchain + Information Deposit Certificate" uses blockchain technology to store information data, especially public opinion data, as electronic evidence, bind the public opinion data and the ownership relationship of the publisher, so as to prevent tampering, leave traces in the event, and post audit , To ensure the credibility and authenticity of electronic evidence, effectively identify the identities of participants in network incidents, reduce the cost of spreading rumors, and improve the efficiency of news management and control information sharing", the health information of patients since entering the chain is stored through the distributed technology of blockchain, so that each user has his own medical health data account from birth, and solves the use the blockchain public chain technology and the charity field to create a new application model [15] Each node in the blockchain network will be attached with a copy of the public ledger. There are numerous and consistent data backups, and the data remains unchanged. A single point of failure will not affect global data. Transparent, the information on the chain is open to the public, can be checked and traced, charitable donors, recipients and the general public can monitor the source and flow of charitable funds by themselves. The irrevocable and irrevocable characteristics indicate that every time-based transaction and fund flow record on the blockchain cannot be modified again, so that the true history of charitable activities is recorded in the blockchain (if someone does False, the written false record cannot be deleted and modified as well), the data can be changed by a person without super authority.

#### **4. DATA GOVERNANCE PROCESS FOR PUBLIC EMERGENCIES BASED ON BLOCKCHAIN**

The outbreak of the new crown epidemic has exposed a data sharing coordination crisis, which has led to a crisis of public opinion and government credibility. New requirements have been put forward for the management ability of public health emergencies in our country. The emergency response ability of the community and the level of handling public health emergencies are directly related to the success or failure of crisis management. [16] Cross- department, cross-institution, and cross-domain. The data sharing and collaboration between the two has always been subject to the constraints of the institutionalization and centralization of security and controllability. Data producers and controllers, as well as administrative system developers and executors, may often be integrated; it is also possible that the data controller has management power, which makes data largely vulnerable to system interference and power interference. , The main reason for the inability to report and disclose in time is also the main reason for the formation of data information islands on the grounds of system regulations and data security, and the failure to achieve data sharing collaboration.

In terms of the administrative system, a non-vertical administrative system will be subject to interference from local authorities. Similarly, under the framework of the legal system, information must be disclosed in accordance with the law, and the authorizing party's determination of data requires a large number of external factors to be combined with management rules and regulations to determine, for example, an important law involved in the epidemic, the "Law on the Prevention and Control of Infectious Diseases". From the perspective of social data, the complex data messages generated by society, there is no governance method to verify the data, the centralized public opinion review mechanism, and the filtering of public opinion data is monotonous, causing rumors to cause public crises. Eliminate the interference of the standard system and power, establish a cross-validation data governance model, and at the same time make the data more authentic, credible, timely and accurate under the conditions of legality, institutionality, security, as well as the laws and regulations of citizen privacy and data privacy, the matching "blockchain" technology can be realized.

The core of the blockchain is the top-level design of the consensus architecture of systems and relationships, rather than a simple technical architecture. The top-level design architecture of the blockchain is multi-node (multi- department, multi-structure, and multi-party

participants) to make the data marginal and Diversity extends towards flattening, forming a paradigm system of system and data integration. Based on this, this article exploratively proposes a data governance process based on blockchain.

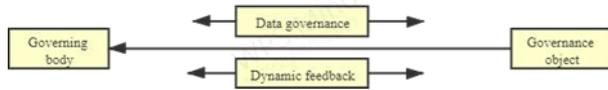


Figure 2. Data governance logic under the blockchain

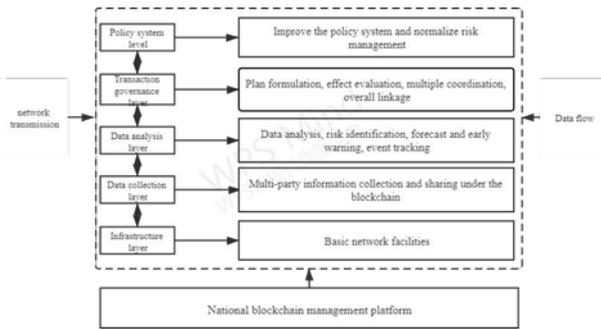


Figure 3. Data governance process under the blockchain

Based on the national blockchain platform, the governance process is as follows: network transmission and data flow are governance logic that is supported by the network infrastructure layer, so it needs to be maintained by all management entities to ensure the normal operation of the big data management platform. The data support layer is the resource foundation of governance, covering various aspects of data and data from all aspects, satisfying data collection, processing, storage and interaction, and realizing data sharing between governance entities; the data analysis layer is for data processing and Analyze data mining and evaluate early warning, accurately sense, identify public safety risk types and their influencing factors, predict risk cycles, early warning risk levels, realize source prevention, real-time tracking of risk trends, accurate decision-making, and provide support for the government to make decision- making plans; business layer It is a code of action. According to the division of responsibilities between subjects and the ownership relationship, the government formulates multiple coordination, and the overall linkage governance strategy realizes cross-level, cross-organization, and cross-field communication and cooperation between government departments, corporate units, social media, and ordinary people, and clear division of labor , Rationally deploy government and social resources, optimize institutional settings, and establish an overall linkage mechanism; after implementation, timely evaluate the governance effect, collect public opinions, and then systematically organize risk data to promote normal risk management. The policy system layer is the comprehensive guarantee for governance. According to

the data governance full life cycle theory, policies and systems for pre-prevention management, in-process emergency management, and post- event risk management are made based on data, and the data governance mechanism is improved and perfected.

## 5. CONCLUSION

Comprehensively considering the technical characteristics and application profile of the blockchain, blockchain-based data governance can solve the problems of data trust, data confirmation, data security, data traceability, and data integrity. It can be applied to public health emergencies. Conductive to the improvement of governance capabilities. This article is only an exploratory theoretical research, and related applied research needs to be further explored.

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