

Research on the Construction of Scenarios for Blockchain to Empower Government Governance

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Abstract. This paper delves into the potential and practical challenges of blockchain in government governance. As a cutting-edge development in information and communication technology, blockchain offers unique capabilities in data management and value transfer, presenting new solutions for government governance. The article begins with an overview of the definition, connotation, and current application status of blockchain technology, and then constructs typical scenarios where blockchain technology empowers government governance, including electronic credentials, government data circulation, data resource sharing, collaborative office work, and digital rural revitalization. By realizing these scenarios, the paper analyzes the main problems and challenges faced by blockchain technology in government governance, such as inadequate infrastructure, data leakage risks, and difficulties in inter-departmental collaboration. Finally, a series of suggestions and prospects are put forward to promote the effective application of blockchain technology in digital government affairs, enhancing the transparency, efficiency, and intelligent level of government governance.

Keywords: Blockchain; Government Governance; Scenario Construction; Data Sharing; Government Efficiency; Digital Government.

1. Introduction

On March 13, 2021, the "14th Five-Year Plan for National Economic and Social Development and the Long-Range Objectives Through the Year 2035 of the People's Republic of China" was officially released. "Accelerating digital development and building a digital China" was made into a separate chapter, and blockchain was included in the national five-year plan for the first time, listed as one of the seven key industries of the digital economy during the "14th Five-Year Plan" period. According to the "14th Five-Year Plan" and the long-range objectives of 2035, embracing the digital era, activating the potential of data elements, and promoting the construction of a strong network nation are the future directions of effort. Among them, strengthening blockchain technological innovation, focusing on the development of government services and other fields with Consortium Blockchain, will also usher in great development opportunities.

In response to the national policy guidance and to promote the upgrade of regional economic industries, provinces and municipalities such as Beijing, Hebei, Guizhou, Hunan, Hainan, Shanghai, Tianjin, Shandong, Henan, and Guangxi have successively issued blockchain development plans and actively promoted the "chain-up of government affairs." The Hainan Free Trade Port deeply implements the spirit of the instructions from the Party Central Committee, taking blockchain as an important breakthrough in the independent innovation of core technologies. In recent years, it has actively participated in the "Trustworthy Blockchain Promotion Plan." Leveraging the opportunity of building the Hainan Free Trade Port Blockchain Pilot Zone, it has built an open ecosystem for the development and application innovation of blockchain. Together, it promotes the formulation of standards in the government sector, the construction of BaaS (Blockchain as a Service) platforms, and the innovation of demonstration application scenarios, to foster the healthy development of the blockchain industry.

As an important evolution of new generation information and communication technology, blockchain offers new ideas in the management of data elements and the release of value. Blockchain is a distributed network data management technology¹, which uses cryptographic

techniques and distributed consensus protocols to ensure the security of network transmission and access, achieving multi-party data maintenance, cross-validation, global consistency, and tamper resistance. This technology is very well-suited to the current requirements of digital development that emphasize joint construction and governance, trustworthy sharing, and security control. It can effectively promote the joint governance and sharing of public data across departments and regions, achieve business collaboration, improve the efficiency of government services, and provide strong technical support for government governance.

2. Overview

2.1 Definition and Connotation of Blockchain

Blockchain is a chain-like data structure that organizes data blocks in a sequential order according to the timeline and ensures immutability and forgery-proof through cryptographic methods². In short, blockchain can be understood as a multi-party collaborative database, a type of distributed ledger technology. In a broad sense, blockchain technology is a distributed database technology that ensures the security of data transmission and access through cryptographic methods, making the data unalterable once written, thus achieving a decentralized way of data storage, sharing, and management. This technology is not limited to the financial sector but is also widely applied in various fields such as supply chain management, healthcare, smart cities, and more³. In a narrow sense, blockchain specifically refers to the underlying technical framework based on digital currencies like Bitcoin, utilizing asymmetric encryption technology, consensus mechanisms, smart contracts, and other technical means to achieve data immutability, transparency, and decentralization. The core of blockchain technology lies in its ability to provide a secure and trustworthy data exchange platform, allowing various parties to conduct effective data interaction and value transfer without a central authority⁴. Blockchain integrates distributed storage, cryptographic techniques, consensus algorithms, and smart contracts, achieving user anonymity and transaction confirmation through cryptographic methods such as hash encryption, asymmetric encryption, and digital signatures. It uses consensus mechanisms to reach agreement on jointly maintained data, proposing a new solution to the trust crisis, and features multi-party collaboration, immutability, and traceability.

2.2 Current Status of Blockchain Technology Application

As of December 2023, the market size of China's blockchain industry has reached 6.7 billion yuan, with an average annual compound growth rate of 15.76% over the past three years. It is expected that by 2026, the market size of China's blockchain industry will reach 16.368 billion US dollars⁵. Currently, there are 48 blockchain industrial parks and more than 2,500 blockchain companies distributed across 18 provinces and municipalities. Ant Group, Baidu, China Construction Bank, Industrial and Commercial Bank of China, Tencent, and WeBank have been selected into the 2023 Forbes Global Blockchain Top 50⁶. Blockchain companies and industrial parks play an important role in the research and development of blockchain technology, application innovation, and standard setting, making a positive contribution to the development of China's blockchain industry.

Social governance is one of the most widely applied fields of blockchain. As of December 2023, the Cyberspace Administration of China has announced thirteen batches of a total of 3,647 domestic blockchain information service filings, among which the number of filings in the social governance field is the highest, reaching 1,314, accounting for about 36%. These applications include, but are not limited to, data sharing, optimizing business processes, enhancing collaborative efficiency, and building a trustworthy system⁷.

Since the beginning of the new century, the development of government informatization in China has been rapid, especially in the field of online services, which has reached a world-leading level⁸. However, problems such as government data silos, fragmentation of government data

resources, lack of mutual trust in government collaboration, and insufficient supervision of urban data are still important factors that restrict the improvement of government governance in terms of digitalization, intelligence, and precision. Blockchain, with its advantages of distributed collaboration, identity verification, traceability, and immutability, provides new methods for solving these issues. The distributed characteristics of blockchain technology help to break the government data silos and achieve resource sharing of data. By building a data sharing platform based on blockchain, it can promote the interconnection of data between government departments, eliminate administrative barriers, and improve the convenience and people-friendly level of government services. In addition, the transparency and traceability of blockchain technology can ensure the authenticity and security of data, enhancing the public's trust in government governance.

3. Construction of Typical Scenarios

3.1 Blockchain + Electronic Certificates

By leveraging blockchain, it is possible to effectively collect and analyze certificate information that is scattered across isolated systems in various departments. This ensures that electronic certificates do not leave the control of the issuing department while providing credible existence proof services to social organizations, enterprises, or individuals, thereby improving the quality and efficiency of government management 9.

Blockchain gathers electronic certificate data from multiple departments in a way that is built on equal rights, achieving the management, chain-based authorization access control, and traceability of certificate information, authorization, and certificate usage behavior. Government departments or third-party institutions can, upon the request of enterprises or individuals, allow the designated certificate data to be opened, called, and verified within a certain period through the authorization of the certificate owner. Blockchain ensures the authenticity of electronic certificates, eliminating the need for applicants to submit any materials. The process of certificate authorization and retrieval is recorded on the chain, allowing for complete retrospective auditing. The architecture diagram of the Blockchain + Electronic Certificates solution is shown in Fig.1.

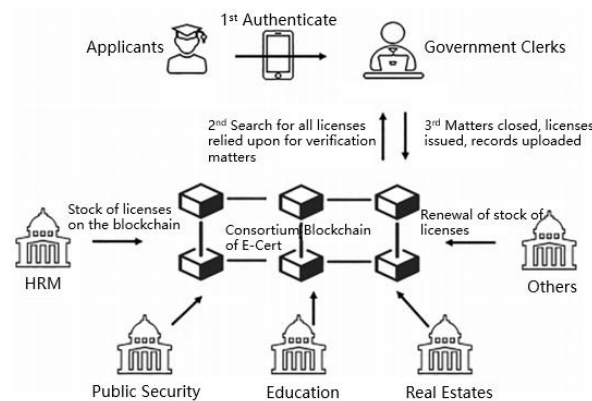


Fig. 1 Blockchain + Electronic Certificates Solution Architecture Diagram

3.2 Blockchain + Government Data Circulation

The efficiency of government affairs is related to the smooth operation of government policies and the interests of the public. The complete handling of a government affair involves the participation of multiple departments and stakeholders, and is a long chain, multi-step, and lengthy process. Through the use of blockchain technology, it is possible to track, supervise, and quantify the evaluation of government processing information from the source, in order to improve the efficiency of government affairs, enhance public satisfaction, improve the supervision and evaluation environment of government affairs, and promote government affairs to be more standardized, transparent, and standardized 10.

Building a trustworthy chain-based support capability, by putting business on the chain, it avoids the possibility of human errors, delays, data tampering, and cheating, and improves the efficiency and enthusiasm of government personnel. By putting data on the blockchain, it prevents the lag of data in other related departments and units after the source data department's information is modified or updated, reducing errors caused by this. Tracing and clarifying the pain points of government governance, taking the initiative to standardize routine and operational business, avoiding illegal and irregular matters, and reducing public crisis events. The architecture diagram of the Blockchain + Government Data Circulation solution is shown in Fig.2.

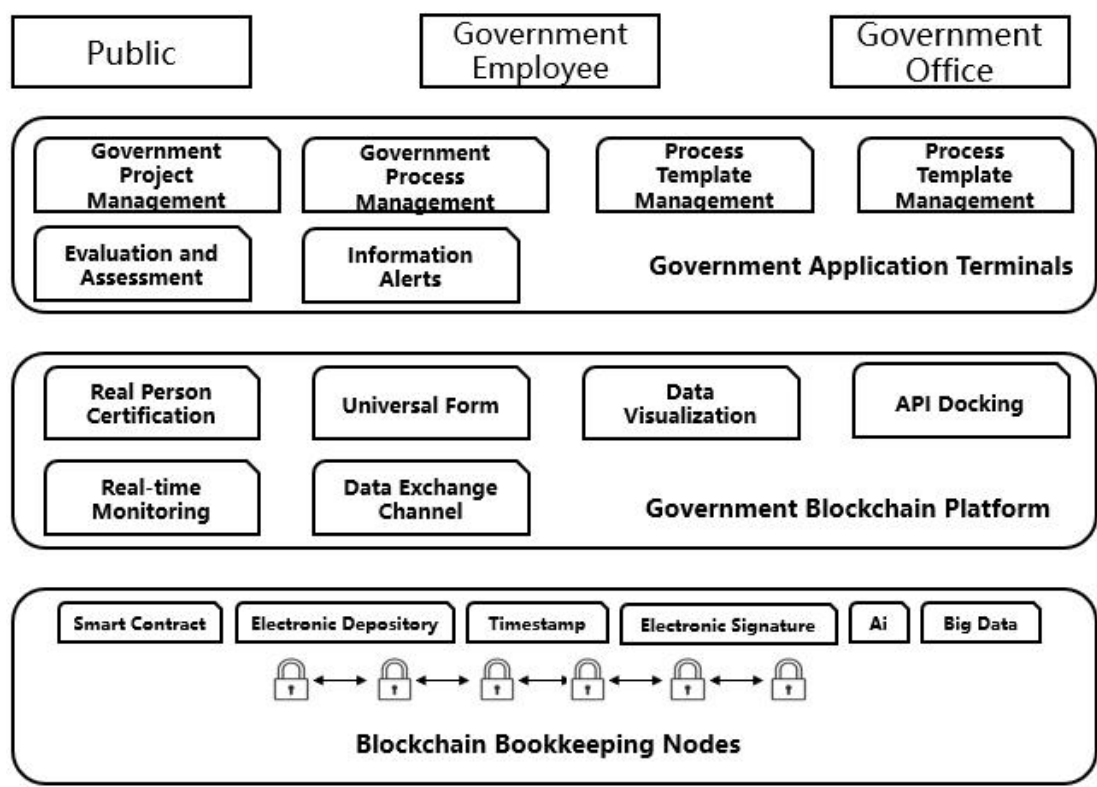


Fig. 2 Architecture Diagram of Blockchain + Government Data Circulation Solution Architecture Diagram

3.3 Blockchain + Data Resource Sharing

Utilizing blockchain to construct a trustworthy data sharing network among various government departments, it achieves distributed management, unified viewing, tamper-proof, dynamic authorization, and control of duty catalogs, data resource catalogs, and IT system catalogs.

Strictly based on departmental responsibilities to determine departmental data responsibilities, it realizes a strong correlation and strict binding between responsibilities, catalogs, and data. On the chain, "household registration" is provided for data, systems, and applications, forming a "data catalog" account for the whole city, solving the problem of data absence and overstepping 11.

Relying on the "data catalog blockchain," the sharing relationships and processes between departments are locked on the chain, establishing new rules and order for data sharing, and solving problems such as arbitrary data transfer and disordered business collaboration. All data sharing and business collaborative actions are jointly built and managed on the "blockchain," and departments without data responsibilities will be adjusted, establishing a new "closed loop" for departmental business, data, and performance of duties, solving problems such as the disconnection between applications and data, and the loss of control over technology and management. The architecture diagram of the Blockchain + Data Resource Sharing solution is shown in Fig.3.

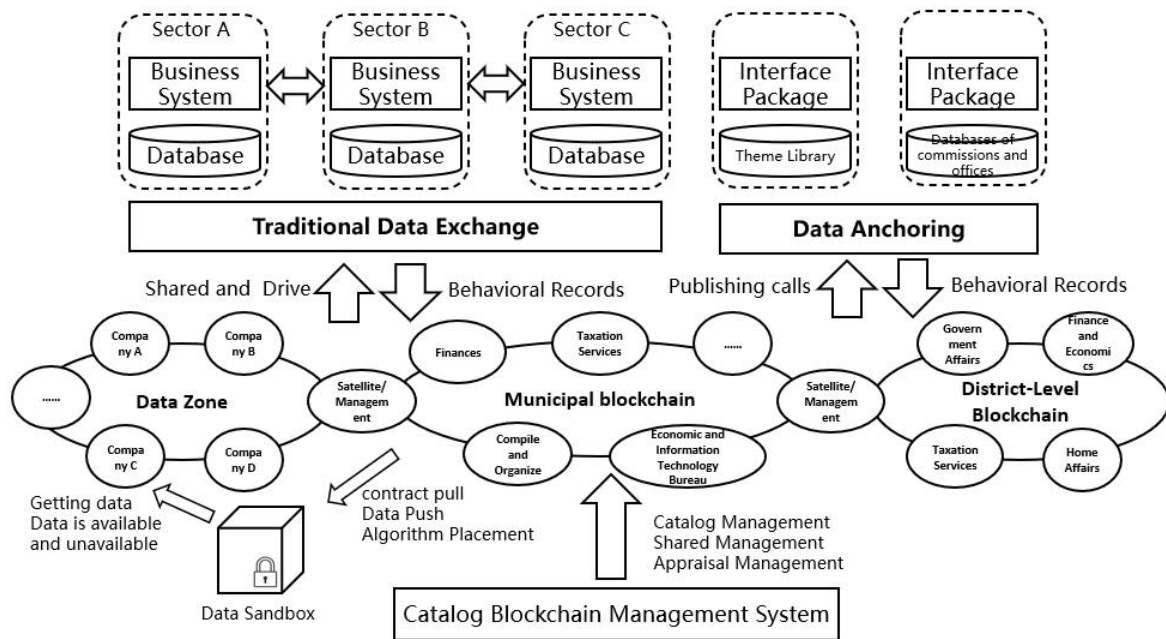


Fig. 3 Blockchain + Data Resource Sharing Solution Architecture Diagram

3.4 Blockchain + Collaborative Office

Currently, governments at all levels are deeply promoting reforms to streamline the government, delegate power, and improve government services, further strengthening the transformation of the government's service-oriented functions, implementing supply-side reforms in services, to enhance the performance of government service, consolidate service responsibilities, and provide enterprises and the public with comprehensive, standardized, open, fair, and convenient and efficient government services 12.

Blockchain + Collaborative Office is a way to modernize government governance capabilities, improve the level and efficiency of government services, and enhance the public's sense of gain. Blockchain can solve the trust system issues in collaborative office, ensuring that the collaborative office processing process is genuine and effective. By putting various collaborative office items on the chain, adding timestamps and distributed storage to the documents on the chain, and recording the entire process traceably, it fully realizes a collaborative office path where office processes are trustworthy, document content is credible, opinions and instructions are reliable and verifiable, and problems can be traced. The architecture diagram of the Blockchain + Collaborative Office solution is shown in Fig.4.



Fig.4 Blockchain + Collaborative Office Solution Architecture Diagram

3.5 Blockchain + Digital Rural Revitalization

With the development and maturation of technologies such as artificial intelligence, 5G, IoT, and blockchain, agriculture is entering a new era of development and moving into the era of smart agriculture. This modern agricultural development model and form is supported and facilitated by IoT technologies for comprehensive perception, accurate transmission, and intelligent processing. It features key production methods such as automated production, optimized control, intelligent management, systematic logistics, and electronic transactions, aiming for high yield, high efficiency, low consumption, high quality, ecological sustainability, and safety 13.

Data sharing, multi-party collaboration, and traceability are practiced to embody digital villages, break down information barriers, implement green control, and achieve digital rural revitalization.

In the wave of digital transformation, focusing on the "three-in-one" reform of production, supply and marketing, and credit, a digital rural blockchain intelligent management platform is constructed. Utilizing the trustworthy and tamper-proof technologies of blockchain, it realizes functions such as information collection and evidence preservation, helping agricultural enterprises to accelerate digital transformation and upgrading. It achieves precise traceability for agricultural products with "one product, one code," ensuring full transparency from the field to the table.

Through trustworthy IoT devices, the cultivation and breeding process becomes transparent and orderly, with real-time control over the conditions, achieving full lifecycle management of agricultural products. Through an information management system for agricultural operations, the production process is made digital, informational, and intelligent, promoting rural e-commerce. Through full-process traceability, it maintains the company's brand image and enhances product trustworthiness. Finally, it provides consumers with a visual interface, allowing them to scan a code to obtain traceability information at a glance. The architecture diagram of the Blockchain + Digital Rural Revitalization solution is shown in Fig.5.

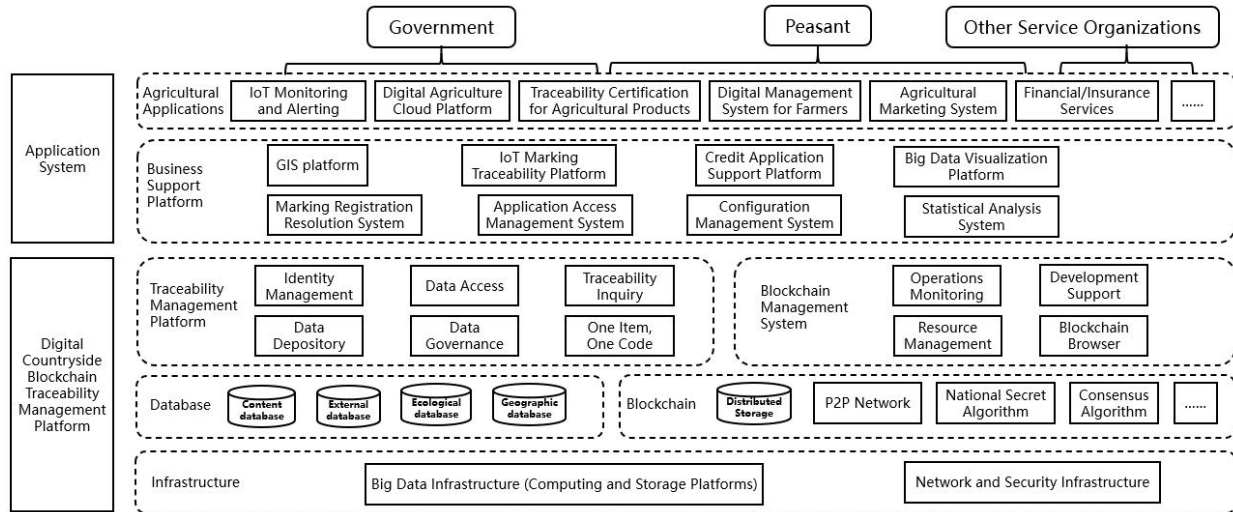


Fig. 5 Blockchain + Digital Rural Revitalization Solution Architecture Diagram

3.6 Blockchain + Urban Comprehensive Governance

Urban governance is an important aspect of the modernization of the national governance system and capabilities, reflecting the level of local government management and the image of the city. For regional economic development, it is essential to rely on an appropriate government governance system that is adept at using modern technological means to achieve intelligence and scientific management, while also paying attention to details to craft the city's image and brand 14.

In the process of urban governance, fully utilizing modern information technologies such as the internet, big data, and blockchain deepens the sharing of data resources and business collaboration between government departments. This leverages comprehensive data for monitoring, forecasting, and early warning of urban operations and social development, which is beneficial for the

government to more accurately grasp the overall situation, scientifically judge trends, and make decisions and management. It also helps comprehensive departments and professional functional departments to more comprehensively and promptly grasp data information, better prevent and reduce the risk of data distortion, and further enhance the government's innovative management capabilities, improving the level of modern government governance. The architecture diagram of the Urban Comprehensive Governance Blockchain solution is shown in Fig.6.

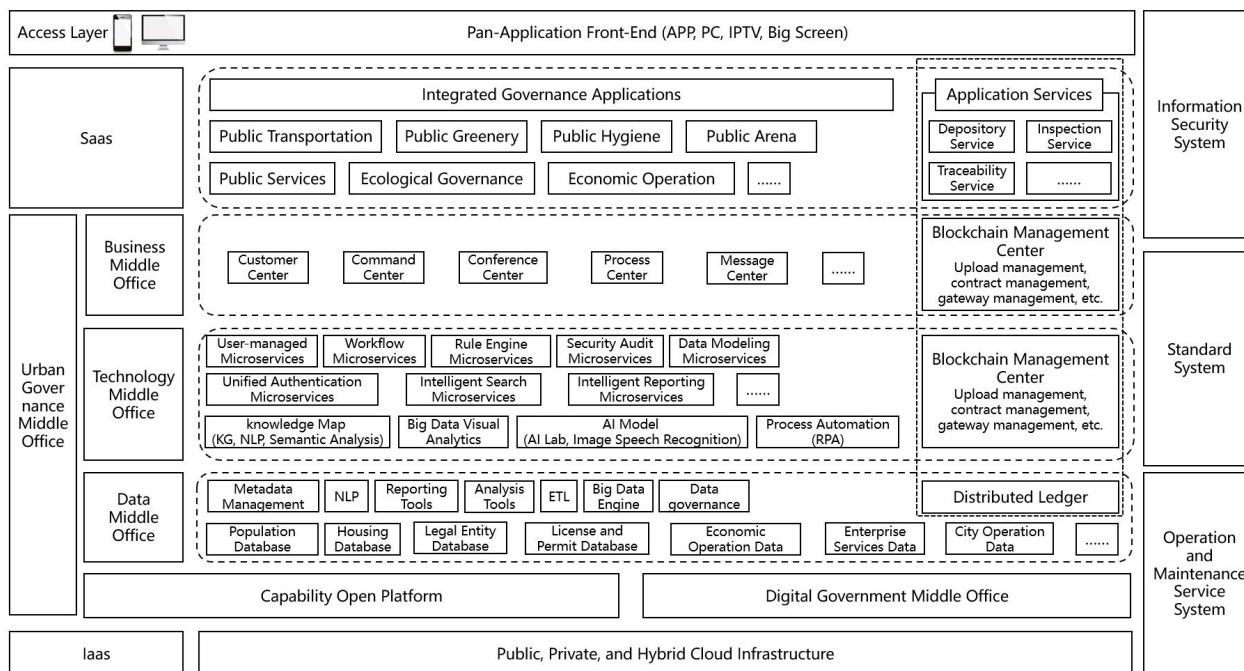


Fig. 6 Blockchain + Urban Comprehensive Governance Solution Architecture Diagram

4. Issues and Challenges

4.1 Lack of Robust Infrastructure at the Implementation Level

Blockchain technology, in empowering government governance, requires robust infrastructure support, including secure data storage, efficient network connectivity, reliable identity verification mechanisms, key technical standards and platforms, and regulatory mechanisms. Currently, China has 14 national supercomputing centers located in cities such as Tianjin, Shenzhen, Changsha, and Guangzhou. However, many regions still lack the network infrastructure needed to support large-scale blockchain applications, with limitations in data storage and processing capabilities. Since blockchain technology is relatively new, government agencies have not yet established a technical framework and operational standards to match it. This leads to obstacles in the integration of blockchain systems, data sharing, and interoperability in practical applications. For instance, different government departments may have inconsistent data standards and formats, which makes data integration and interoperability a challenge even though blockchain provides a decentralized data-sharing platform. Additionally, the lack of a unified regulatory framework and policy guidance results in a lack of coordination and consistency when different levels of government departments adopt blockchain, further increasing the difficulty of implementation.

Of course, the relative scarcity of blockchain industry talent also greatly limits the widespread application of blockchain technology in digital governance. In July 2020, the Ministry of Human Resources and Social Security (MOHRSS), the State Administration for Market Regulation, and the National Bureau of Statistics officially recognized "blockchain engineering technicians" and "blockchain application operators" as new professions, reflecting the emergence and demand for new professions driven by economic and social development and technological progress, and encouraging the cultivation of talent for new types of professions.

To overcome these challenges, it is necessary for the government, enterprises, and academia to work together to strengthen infrastructure construction, formulate clear guidance policies and standards, cultivate professional talent, and promote cross-departmental and cross-industry cooperation, in order to achieve effective implementation and widespread application of blockchain technology in digital governance, empowering the efficiency and quality of government governance.

4.2 Risks of Data Leakage and Misuse

Blockchain, with its decentralized and immutable characteristics, provides a new safeguard mechanism for data security, but it also brings challenges to privacy protection. Since transaction records on the blockchain are visible to all network participants, although these records are usually anonymous, they can still potentially be traced back to the real identity of the user through analysis, threatening the user's privacy security through the misuse of data. Once government-related data is on the chain, in addition to the risk of data leakage, the irreversible nature of blockchain technology also means that once data is incorrectly recorded or leaked, it will be difficult to revoke or correct. Therefore, how to ensure data security while effectively protecting privacy has become a challenge that blockchain technology must face in the application of government governance.

Therefore, when designing and implementing blockchain solutions, it is necessary to consider not only the encryption of data and access control but also to establish strict data governance policies and compliance standards to ensure that the collection, storage, processing, and sharing of data comply with legal regulations and ethical standards. At the same time, it is also necessary to strengthen the supervision of blockchain technology and formulate corresponding privacy protection measures to prevent data misuse and unauthorized access. Through these measures, the advantages of blockchain technology in the construction of digital government can be fully utilized on the premise of ensuring data security, providing the public with safer, more transparent, and more efficient government services.

4.3 Lack of Strong Willingness for Inter-Departmental Collaboration and Data Sharing

Inter-departmental collaboration and data sharing are among the core strengths of blockchain, but they also face challenges and difficulties. Firstly, government departments may lack sufficient motivation to promote data sharing due to concerns over interests, power distribution, or data privacy protection; secondly, while blockchain technology has advantages in ensuring data security and privacy, how to achieve true open sharing without the misuse of data requires meticulous policy design and technical solutions; finally, issues such as the cost of technology implementation, lack of professional talent, and system stability also affect the efficiency of inter-departmental collaboration and the breadth and depth of data sharing. To overcome these challenges, it is necessary to build a mechanism of mutual trust for collaboration, strengthen the construction of laws and regulations, clarify the responsibilities and rights of data sharing, and increase investment in the training of blockchain technology talent and technology research and development, in order to achieve the optimal enabling effect of blockchain in the construction of digital government.

5. Recommendations and Prospects

5.1 Define the Overall Architecture and Improve the Top-Level Design of Blockchain-Empowered Government Governance

Firstly, establish a clear policy framework and standard system to ensure the compatibility and integration of blockchain with the existing government governance structure. For instance, establish unified technical standards, data formats, and interaction protocols, and formulate corresponding laws and regulations to guide the secure application of blockchain technology and data governance. Secondly, the top-level design should also include planning for inter-departmental collaboration mechanisms, encouraging various stakeholders to participate in the design and implementation of

blockchain projects, forming a synergistic effect. Thirdly, attention should be paid to talent cultivation and technology popularization, enhancing government employees' understanding and application capabilities of blockchain technology. Lastly, through pilot projects and case studies, continuously optimize and adjust the top-level design to ensure that blockchain technology can exert its maximum effectiveness in government governance, promoting the development of government governance towards a more transparent, efficient, and intelligent direction.

5.2 Unify the Construction of Public Infrastructure Chains, Standardize the Digital Government Platform Construction Standards

By unifying the construction of public infrastructure chains and standardizing the construction standards of digital government platforms, data sharing and business collaboration between different government departments can be achieved, reducing the phenomenon of data silos, and enhancing the cross-departmental information integration capability, providing more comprehensive and accurate data support for government decision-making. The unified standardization of public infrastructure chains or government platforms can ensure seamless connection and collaborative work between data and services of different government departments, improving government efficiency, reducing operational costs, and also helping to achieve consistency and accuracy of data, providing reliable information support for government decision-making. It also lays the foundation for subsequent government regulation of data flow, ensuring data security and personal privacy. Of course, it also helps to promote standardized construction, laying a solid foundation for future technological upgrades and application expansion.

5.3 Improve the Legal and Regulatory System, Strengthen Grassroots Governance and Regulatory Capacity

Due to the risks of data security and personal privacy breaches, it is particularly urgent and important to improve the legal and regulatory system and strengthen grassroots governance and regulation. A robust legal and regulatory system should include regulations on the application of blockchain technology, protection of data security and personal privacy, and prevention of misuse of technology. This requires the joint efforts of government departments, legislative bodies, technology experts, and all sectors of society. The improvement and perfection of relevant laws and regulations are the prerequisites for the widespread application and in-depth development of blockchain technology in government governance.

In addition to laws and regulations, reliance on grassroots governance and public supervision is also needed. First, the government should classify and share management of data. Data should be shared at different levels according to different types and the degree to which they relate to national security; second, it is necessary to comprehensively improve government employees' understanding and application capabilities of blockchain technology to promote its popularization and application; third, efforts should be increased to cultivate blockchain talent to meet the needs of social development and provide talent support for blockchain to empower government governance; fourth, public supervision channels should be opened to guide and encourage public participation in data governance, to maintain network security and civilization, and to promote the positive role of blockchain technology in improving government governance transparency, enhancing service efficiency, and building a trust system, thus promoting the construction of digital government to a higher level.

5.4 Advocate for Digitalization and On-Chain Scenarios, Construct a Multi-Party Trust System

Advocating for the digitalization and on-chain of scenarios means that various government services and governance processes will gradually migrate to the blockchain platform, achieving transparency of data, sustainability of traceability, and automation of processes. This not only enhances the efficiency and quality of government services but also reduces intermediate links and

costs through decentralization, while strengthening the security and immutability of data, providing the public with a more reliable and safe service experience.

To achieve this goal, it is recommended that when formulating relevant policies and standards, the government should fully consider these characteristics of blockchain technology and promote cross-departmental data sharing and business collaboration. At the same time, strengthen cooperation with all sectors of society, such as enterprises, research institutions, and the public, to jointly explore the application models of blockchain technology in different governance scenarios and form an open and shared ecosystem. In addition, attention should be paid to the education and popularization of blockchain technology, to enhance the public's understanding and trust in blockchain technology, laying a solid foundation for building a multi-party trust system. Through these measures, blockchain technology will more effectively empower government governance and promote the construction of a more open, transparent, and efficient digital government.

6. Conclusion

As technology continues to mature and policies are refined, blockchain is poised to become a significant force in propelling the modernization of government governance. Looking ahead, blockchain is set to integrate deeply with digital governance, creating a more transparent, efficient, and intelligent system of governance that will deliver a higher quality of service to the public and inject new vitality into societal management. We have every reason to believe that, with the concerted efforts of multiple stakeholders, blockchain technology will empower government governance and initiate a new chapter in digital transformation.

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