

Innovation of Blockchain and Cloud Computing Technology in Financial Digital Management

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ABSTRACT

Financial digital management is a new type of financial management method. Through information technology, the financial management process has been digitized, and with the help of technical means such as data analysis and artificial intelligence, financial management automation has been achieved. Traditional financial management methods often require a large amount of manual intervention and processing, which is prone to problems such as cumbersome data processing, time-consuming and labor-intensive, and prone to errors. With the development of computer technology and network technology, digital management has become a new trend in financial management. This article analyzed the application of blockchain and cloud computing technology in financial digital management, and selected 12 enterprises as the research objects. The traditional financial management model and the financial digital management model of blockchain and cloud computing technology were respectively adopted to compare the differences in financial process efficiency, data accuracy, labor cost savings, digital management, and financial risk management between the two models. The experimental results of this article indicated that under the financial digital management mode using blockchain and cloud computing technology, the processing time of the revenue and expenditure process was 4.45 hours in terms of financial process efficiency. In terms of data accuracy, the accuracy rate of accounting was 99.7%. In terms of labor cost savings, the labor cost was 1.505 million yuan/year. In digital management, the data processing efficiency score was 92. In financial risk management, the accuracy score of risk assessment and prediction was 93, which was better than traditional financial management models. The adoption of blockchain and cloud computing technology in financial digital management can significantly improve multiple key indicators such as financial management efficiency, data accuracy, and security. This model has important value and significance for enterprises.

Keywords: Financial Digital Management, Blockchain Technology, Cloud Computing, Innovation Research

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1. Introduction

With the rapid development of information technology, digital financial management has become an indispensable means for enterprises to improve their competitiveness. Traditional financial management work often requires a large amount of paper materials such as bank statements, vouchers, and voucher attachments, which is inefficient and prone to errors. The adoption of digital financial management can achieve automation and digitization of financial management, greatly improving the efficiency and accuracy of financial management, while also reducing labor costs and work risks. At present, digital financial management mainly adopts cloud computing and blockchain technology. The emergence of cloud computing technology enables enterprises to manage financial data and information through cloud resources, reducing labor costs while also improving the accuracy and processing efficiency of financial data. Blockchain technology is a distributed database technology where data is stored on multiple nodes, with each node having a complete copy of the recorded data. Data sharing and circulation are secure and tamper proof. In financial digital management, blockchain technology can achieve digital credentials, hosting systems, and trust mechanisms, making financial data more reliable and secure.

Financial management is an essential management function for any small enterprise, and short-term financial management is particularly important for startups and established enterprises. Financial self-efficacy is an important incentive factor for enterprise financial management, and key training is very important in cultivating financial management skills. However, there is little research to determine whether this type of training can improve financial management skills and financial self-efficacy. Kirsten Corrinna L aimed to determine whether customized financial management training courses can improve the development of short-term financial management skills and financial self-efficacy of small business owners in South Africa [1]. Managers of commercial banks in Lebanon and similar countries can use the research results to better understand the knowledge management practices of banks and the skills acquired or existing by individuals working in their organizations, which also helps to improve their digital Financial innovation level. Al-Damour Ahmed investigated the unexplored impact of knowledge management on digital Financial innovation by adjusting the demographic characteristics of managers in commercial banks operating in Lebanon as developing countries [2]. The main purpose of Hasanaj Petrit was to determine, predict, and evaluate the best economic conditions and company performance in the future. At the same time, he analyzed the financial statements and provided information to finance managers so that they could make decisions through business decisions [3]. However, these scholars lack a certain degree of technical argumentation in their exploration of financial management. Through research, it has been found that blockchain technology is more helpful for financial management. Regarding this, relevant literature on blockchain technology has been consulted.

Blockchain, as a new technology, can effectively integrate financial resources to analyze and process data. According to customer needs, new financial formats or service models are generated from three aspects: data, rules, and applications, to upgrade the financial system and improve the efficiency and quality of financial operations and services. Blockchain technology can help the financial industry automatically and accurately identify customer credit status, restructure the financial market credit system, and improve cross-border payment efficiency. At the same time, this has also brought challenges to the development of the financial industry. Zhang Li systematically analyzed blockchain technology and its applications, current status, and challenges in the financial and economic fields, and provided constructive suggestions for promoting the development of blockchain technology in the financial and economic fields [4]. Public finance and economic development management are the art of improving the economic, political, and social welfare of a country's people. Finance plays an important role in every economy, and it must be managed and adapted to the digital age. The purpose of Mosteanu Narcisa Roxana was to attempt to identify and

encourage the use of scalable business reporting languages and blockchain to manage financial statements through artificial intelligence [5]. However, these scholars did not analyze the innovation of financial digital management based on blockchain and cloud computing technology, but only explored it from a shallow perspective.

In order to solve the problem of low efficiency in traditional financial management work, this article designed a new digital financial management model. This model has combined blockchain and cloud computing technology to improve the financial management efficiency and data accuracy of enterprises. This article conducted a series of experiments and found that adopting this model could significantly optimize financial and accounting processes and improve labor cost savings, digital management, and financial risk management. The comprehensive experimental results indicated that the financial digital management model using blockchain and cloud computing technology had significant advantages in multiple key indicators compared to traditional financial management models.

2. Application Methods of Blockchain and Cloud Computing Technology

2.1. Application of Cloud Computing Technology in Financial Digital Management

1) Data storage and processing. Cloud computing technology can provide large-scale cloud storage and computing resources, while also supporting data deployment and expansion, which can meet the needs of enterprises in financial data storage and processing [6-7]. Specifically, big data storage: The storage of financial data generally requires a large amount of storage space and powerful computing power, and cloud computing technology can meet these needs through horizontal scaling. Data security: Cloud computing technology can provide multiple authentication and encryption technologies to ensure the security and reliability of data.

2) Financial software services. Cloud computing technology can deploy and manage financial software, enabling enterprises to use financial software services on the cloud, thereby reducing costs and management risks for enterprises. The application of cloud computing technology in financial software services: It can reduce costs. Enterprises can use financial software services through cloud computing platforms, avoiding the high cost of building and maintaining financial software systems within the enterprise. It can be updated in real-time. Cloud computing platforms can achieve real-time updates and upgrades of financial software, improving the stability and reliability of the software [8-9].

2.2. Application of Blockchain Technology in Financial Digital Management

1) Digital voucher. Traditional financial management methods require a large number of paper vouchers, bills, and bank statements, which are often prone to errors and risks of loss and tampering during processing. Blockchain technology can achieve digital vouchers, record financial vouchers on the blockchain, and achieve digital management and data sharing. Application of digital vouchers in management: Voucher information cannot be tampered with. Due to blockchain being a distributed database technology where each node has a complete copy of data, modifying the data of one node is fed back by the entire network, thereby ensuring the integrity and security of credential information. It is easy to view and manage. Digital vouchers are stored on the blockchain and can be queried at any time, making it easy to query and manage vouchers.

2) Hosting system. Traditional financial management requires the custody of funds through banks or third-party institutions, and the custody system is often implemented based on centralized technology, which poses risks and trust issues. Blockchain technology can achieve decentralized hosting systems, improving the security and credibility of hosting. Specifically, it ensures asset safety. Due to the decentralized nature, managed assets can be securely stored on the blockchain. It

enhances transparency. The records on the blockchain can be viewed by everyone, ensuring that the hosting process is open and transparent.

3) Trust mechanism. Financial management involves multiple participants, such as enterprises, banks, third-party institutions, etc., and a trust mechanism needs to be established between all parties to maintain cooperation. Blockchain technology can achieve decentralized trust mechanisms to ensure data security and credibility, while reducing management costs and improving efficiency.

4) Asymmetric encryption. In blockchain technology, asymmetric encryption is an important encryption method that achieves public key encryption and private key decryption through pairing of public and private keys. This encryption method has high security and cannot be cracked or tampered with, making it widely used in fields such as financial digital management.

Firstly, asymmetric encryption technology can protect the security of financial information. Traditional financial management methods require a large amount of paper materials and manual processing, which can easily lead to risks such as financial data leakage and tampering [10-11]. In financial digital management, asymmetric encryption technology can encrypt financial data with a public key, and only those who know the private key can decrypt it, thus preventing data leakage and tampering.

Secondly, asymmetric encryption technology can improve the efficiency of financial management. In financial digital management, enterprises require a large amount of data transmission and processing, and using traditional encryption methods may lead to problems such as slow data processing speed and low efficiency [12-13]. By using asymmetric encryption technology, fast and efficient data transmission and processing can be achieved while ensuring data security, thereby improving the efficiency and accuracy of financial management.

Once again, asymmetric encryption technology can promote collaboration and traceability in financial management. In traditional financial management, it is difficult to achieve data collaboration and communication among various departments, which can easily lead to issues such as information asymmetry. Adopting asymmetric encryption technology can increase the trust of data sharing, making data communication and collaboration more efficient and convenient. In addition, asymmetric encryption technology also has traceability, allowing enterprises to easily trace detailed information such as data sources and transaction times through the pairing of public and private keys.

Finally, asymmetric encryption technology can reduce financial management costs. In traditional financial management, enterprises need to invest a large amount of human, material, financial and other resources to protect the security and effectiveness of data. Adopting asymmetric encryption technology can reduce the cost of financial management while ensuring data security and accuracy, thereby improving the economic benefits of enterprises.

Cryptographic design is used to ensure the security of all aspects of financial digital management. The elliptic curve cryptography encryption algorithm, like RSA encryption algorithm, is one of the representative algorithms in asymmetric encryption algorithms. The security of RSA algorithm depends on the difficulty of integer prime factorization. The elliptic curve cryptography encryption algorithm is based on solving the discrete logarithm problem and the elliptic curve discrete logarithm problem over a finite field.

The origin of elliptic curve is elliptic integral $\int_{R(c)}^{f_c}$. Among them, $R(c)$ is the third order polynomial of c . Elliptic curves can be described as:

$$u^2 + s_1cu + s_3u = c^3 + s_2c^2 + s_4c + s_6 \quad (1)$$

The set of the determined curve, point at infinity 0, is the solution of the formula.

Elliptic curves are usually represented by R , such that:

$$c = C / X, u = U / X \quad (2)$$

It can be obtained through substitution:

$$(U / X)^2 + s_1 (CU / X^2) + s_3 (U / X) = (C / X)^3 + s_2 (C / X)^2 + s_4 (C / X)^2 + s_6 \quad (3)$$

When $X \neq 0$, it is organized as:

$$(U)^2 X + s_1 CUX + s_3 UX^2 = (C)^3 + s_2 C^2 X + s_4 C^2 X + s_6 X^3 \quad (4)$$

The security of the elliptic curve encryption algorithm used in blockchain applications is also based on the elliptic curve discrete logarithm problem. Bitcoin uses a special elliptic curve and a series of mathematical constants, which is defined by the following functions:

$$u^2 = (c^3 + 7) \text{ over } (G_q) \quad (5)$$

$$u^2 \text{ mod } q = (c^3 + 7) \text{ mod } q \quad (6)$$

G_q indicates that the curve is within a finite field of prime order q . Most Bitcoin programs use encryption libraries for elliptic curve calculations.

In summary, asymmetric encryption technology is one of the most widely used technological methods in blockchain technology and has also played an important role in financial digital management.

2.3. Financial Digital Management Model of Blockchain and Cloud Computing Technology

Based on the application of blockchain technology and cloud computing technology in financial digital management, this article designed a financial digital management model that adopted blockchain and cloud computing technology. Figure 1 shows the overall framework of this article.

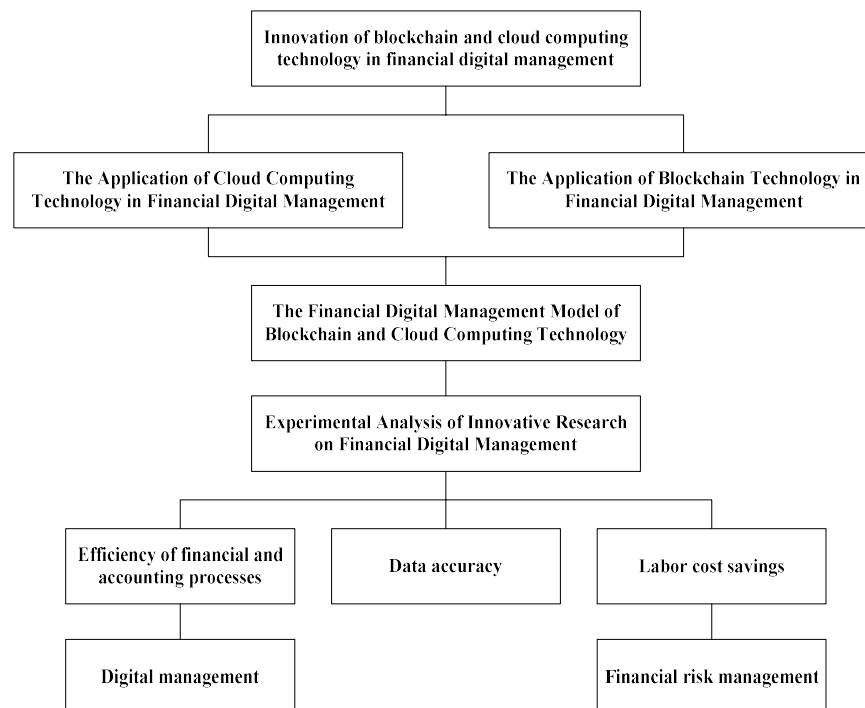


Fig. 1. Overall framework

- 1) Data collection and input. When adopting this financial digital management model, enterprises need to obtain various financial data through banks and other institutions, and input the data into the system. At the same time, data can also be obtained through cloud computing platforms.
- 2) Blockchain storage and processing. After data entry, it is stored on the blockchain and automatically processed and analyzed through smart contracts. Through this approach, data security and credibility can be achieved, while improving the efficiency of financial data processing.
- 3) Cloud computing services. Enterprises can also analyze and process financial data through cloud computing platforms. Through cloud computing platforms, enterprises can use various financial software services and monitor data in real-time to achieve global management and control of data.
- 4) Digital voucher. After adopting this mode, enterprises can record all bills, vouchers, etc., on the blockchain, achieving the management of digital vouchers, thereby improving the security and operability of voucher information.
- 5) Smart contracts. In digital financial management, smart contracts can achieve automated operations such as financial approval, bill entry, and invoice registration, avoiding manual intervention and errors.

3. Experimental Results of Innovation in Financial Digital Management

3.1. Experimental Design

With the continuous development of information technology and the global economy, digital financial management is becoming an important means of enterprise management. Digital financial management refers to digitizing financial business processes, financial data storage, query, analysis, etc., and realizing the automation, intelligence, and efficiency of enterprise financial management with the help of information technology, so as to improve the level and efficiency of enterprise financial management, reduce operational risk, and increase enterprise competitiveness. Blockchain and cloud computing technology, as important components of modern information technology, are playing an increasingly important role in financial digital management. Blockchain technology, through its decentralized and distributed ledger characteristics, can improve data security and reliability, effectively preventing the tampering and forgery of financial data. Cloud computing technology can achieve elastic expansion and high availability of enterprise financial management systems, improving the efficiency and accuracy of enterprise financial processing. Therefore, this article aimed to study the application of blockchain and cloud computing technology in financial digital management, and explore how to use these two technologies to innovate financial digital management strategies and improve the level and efficiency of enterprise financial management.

This article selected 12 large-scale enterprises with a large amount of financial data as experimental subjects and divided into two groups, with 6 enterprises in each group. Its financial management department has been transformed into digital management.

Blockchain technology was applied to the internal recording of income and expenditure information, account reconciliation, and audit processes of enterprises, establishing an information sharing platform and authorizing relevant staff to input, modify, and view data. At the same time, the financial management system of the enterprise has been migrated to the cloud, where a complete financial management platform has been built to achieve functions such as employee information sharing, process collaboration, and intelligent report generation.

The experimental group (6 companies) and the control group (6 companies) were designed. The experimental group used blockchain and cloud computing technology for financial digital management, while the control group still used traditional financial management models.

The differences between the experimental group and the control group were compared in the following aspects: accounting process efficiency, data accuracy, labor cost savings, digital

management, and financial risk management. Data analysis and statistical processing were conducted.

3.2. Comparison of Financial and Accounting Process Efficiency

The efficiency of financial and accounting processes refers to the time and cost required to complete certain financial tasks in financial management. The higher the efficiency of the financial and accounting process, the lower the time and cost required to complete financial work, which means that enterprises can quickly obtain relevant financial information and make timely decisions to improve their competitiveness. The efficiency of the financial and accounting process can be compared from the following three indicators. Revenue and expenditure process processing time: It records the time taken from receiving financial data to final review and confirmation. Accounting cycle time: It records the average settlement time within the accounting cycle. Report generation cycle time: It records the average time required to generate financial reports. As shown in Figure 2, the efficiency comparison of financial and accounting processes is presented. Figure 2 (a) shows the experimental group, and Figure 2 (b) shows the control group.

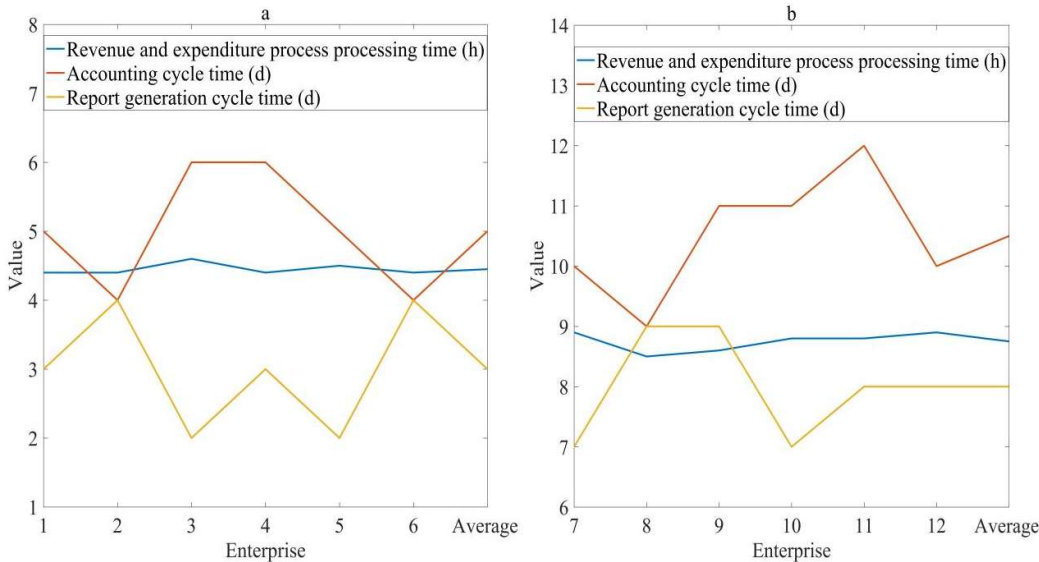


Fig. 2. Comparison of financial and accounting process efficiency

Figure 2 (a) shows the experimental group.

Figure 2 (b) shows the control group.

It can be seen that under the financial digital management mode using blockchain and cloud computing technology, the processing time of the revenue and expenditure process was 4.45 hours, the accounting cycle time was 5 days, and the report generation cycle time was 3 days. Under the traditional financial management model, the processing time of the revenue and expenditure process was 8.75 hours, the accounting cycle time was 10.5 days, and the report generation cycle time was 8 days. Compared to traditional financial management models, the financial digital management model using blockchain and cloud computing technology can significantly shorten the processing time of revenue and expenditure processes, accounting cycle time, and report generation cycle time, thereby achieving an improvement in the efficiency of financial and accounting processes.

3.3. Comparison of Data Accuracy

Data accuracy refers to the accuracy and reliability of financial data in the process of financial management. In financial management using digital management methods, as data input and

processing are completed in computer systems, it can greatly reduce human interference and errors in data, making it easier to ensure data accuracy than traditional financial management. The accuracy of data can be compared from the following three indicators. Error rate: It records the error rate of data entry, calculation, verification, and other processes. Processing misreporting rate: It records the proportion of unprocessed or underreported data to the total data volume. Accounting accuracy: It records the ratio of the number of accurate accounting entries to the total number of times. Among them, Table 1 shows the accuracy analysis of enterprise data under the financial digital management model based on blockchain and cloud computing technology. Table 2 shows the accuracy analysis of enterprise data based on traditional financial management models.

Table 1. Analysis of enterprise data accuracy under the financial digital management model based on blockchain and cloud computing technology

Enterprise	Error rate (%)	Handling Misreporting Rate (%)	Accounting accuracy rate (%)
1	0.3	0.3	99.8
2	0.6	0.3	99.7
3	0.5	0.4	99.7
4	0.7	0.2	99.9
5	0.4	0.3	99.6
6	0.5	0.3	99.5
Average	0.5	0.3	99.7

Table 2. Analysis of enterprise data accuracy based on traditional financial management models

Enterprise	Error rate (%)	Handling Misreporting Rate (%)	Accounting accuracy rate (%)
7	1.3	2.2	98.8
8	1.4	2.1	98.6
9	1	2.4	98.9
10	1.2	2.1	98.6
11	1.3	2.3	98.7
12	1.3	2.1	98.6
Average	1.25	2.2	98.7

Under the financial digital management model using blockchain and cloud computing technology, the error rate was 0.5%, the handling rate of underreporting was 0.3%, and the accuracy rate of accounting was 99.7%. Under the traditional financial management model, the error rate was 1.25%, the handling error rate was 2.2%, and the accounting accuracy was 98.7%. Compared to traditional financial management models, the financial digital management model using blockchain and cloud computing technology has significant advantages in indicators such as error rate, processing omission rate, and accounting accuracy, indicating that this model can significantly improve data accuracy.

3.4. Comparison of Labor Cost Savings

Labor cost savings refer to the effect of reducing related expenses by reducing the use of human resources in the financial management process. The use of digital management can achieve financial automation processing, and multiple financial tasks can be automatically completed by specialized software or artificial intelligence systems, reducing the amount of manual intervention and achieving the effect of labor cost savings. Labor costs can be compared from the following three indicators. Labor cost: It counts cost factors such as the number of financial employees and compensation. Financial processing efficiency: It records the management efficiency of financial personnel and compares the number of financial transactions that each employee can handle. Per capita revenue and expenditure process processing time: It records the time required for each financial employee to process the same type of financial revenue and expenditure process. Figure 3 shows a comparison of labor cost savings. Figure 3 (a) shows the experimental group, and Figure 3 (b) shows the control group.

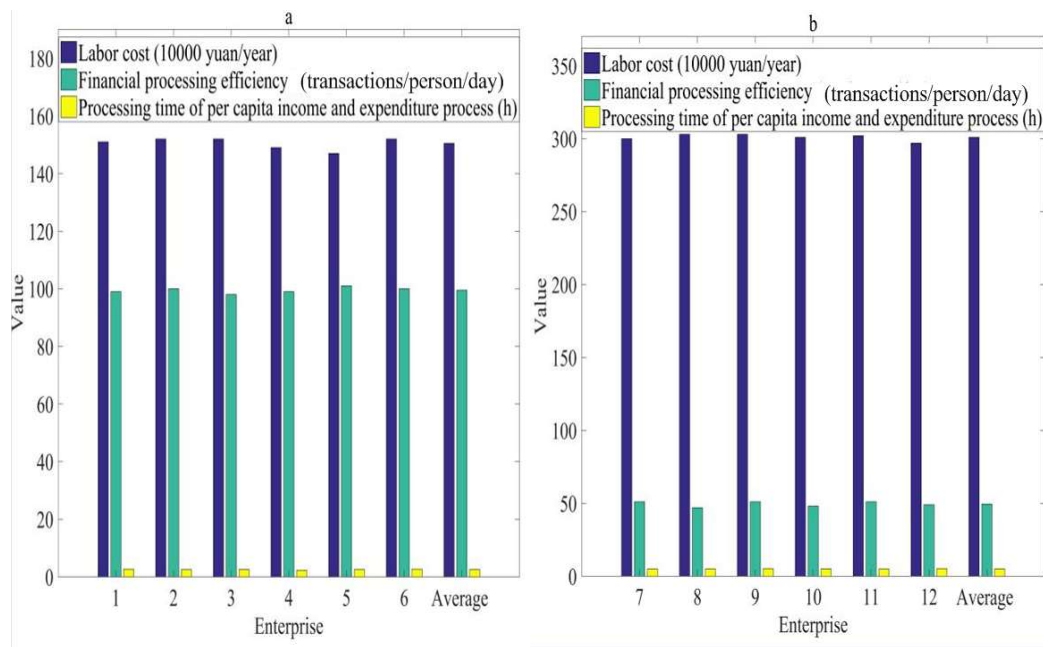


Fig. 3. Comparison of labor cost savings

Figure 3 (a) shows the experimental group.

Figure 3 (b) shows the control group.

It can be seen that under the financial digital management model using blockchain and cloud computing technology, the labor cost was 1.505 million yuan/year, the financial processing efficiency was 99.5 transactions/person/day, and the per capita revenue and expenditure process processing time was 2.55 hours. Under the traditional financial management model, the labor cost was 3.01 million yuan/year, the financial processing efficiency was 49.5 transactions/person/day, and the per capita income and expenditure process processing time was 5 hours. The financial digital management model using blockchain and cloud computing technology has significant advantages over traditional financial management models in terms of labor costs, financial processing efficiency, and per capita revenue and expenditure process processing time, indicating that this model can significantly improve the effectiveness of labor cost savings.

3.5. Comparison of Digital Management

Digital management is a way of digitizing data and information, and using technological means for management and processing. Digital management can improve work efficiency, data quality and decision-making effectiveness, and reduce costs. This article evaluated and compared data processing efficiency, data processing efficiency, data transmission, and processing speed. The digital management is shown in Figure 4. Figure 4 (a) shows the experimental group, and Figure 4 (b) shows the control group.

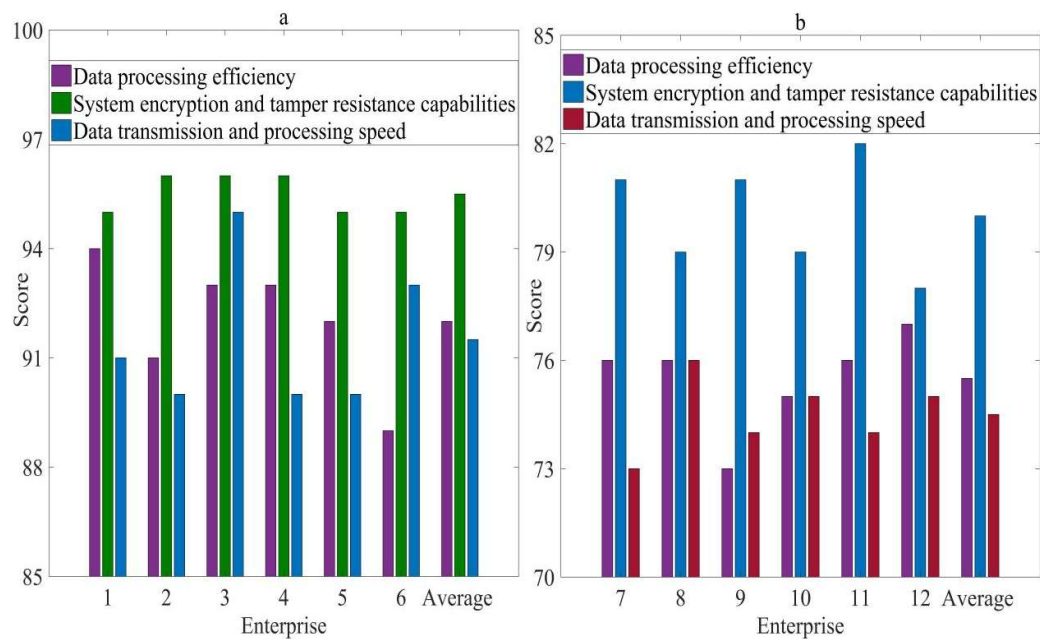


Fig. 4. Digital management

Figure 4 (a) shows the experimental group.

Figure 4 (b) shows the control group.

It can be seen that blockchain and cloud computing digital management performed well in terms of data processing efficiency (92), system encryption and tamper resistance (95.5), data transmission and processing speed (91.5), and scored significantly higher than traditional digital management (75.5, 80, 74.5). This is because blockchain and cloud computing digital management integrate the advantages of blockchain technology and cloud computing technology, making it faster, safer, and more reliable in terms of system security, data processing, and storage.

3.6. Comparison of Financial Risk Management

Financial risk management is a series of risk management measures and methods adopted by enterprises to avoid financial risks, which need to be comprehensively and systematically carried out. At the same time, collaboration and cooperation among various departments of the enterprise are needed to ensure the effective implementation and sustainable development of the entire risk management process. This paper compared the risk assessment and prediction accuracy, data privacy protection and disclosure risk control ability, risk data visualization and decision support ability. Figure 5 shows financial risk management. Figure 5 (a) shows the experimental group, and Figure 5 (b) shows the control group.

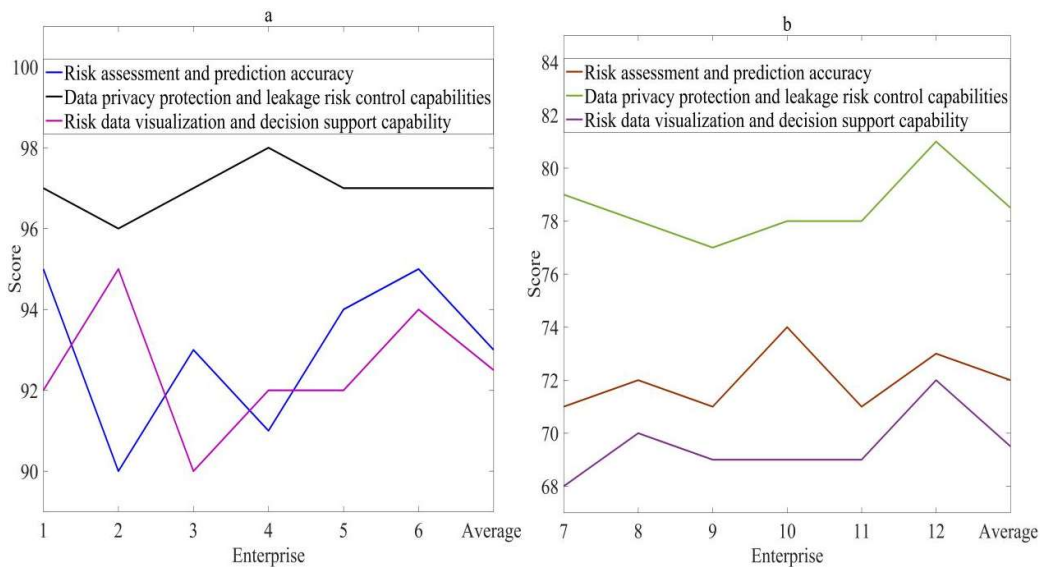


Fig. 5. Financial risk management

Figure 5 (a) shows the experimental group.

Figure 5 (b) shows the control group.

It can be seen that the financial risk management of blockchain and cloud computing was better in three aspects: risk assessment and prediction accuracy (93), data privacy protection and disclosure risk control ability (97), risk data visualization and decision support ability (92.5), and has significantly higher scores than traditional financial risk management (72, 78.5, 69.5). This is because blockchain and cloud computing technology can improve data security, reduce risks, and provide better support in processing and analyzing data, making risk assessment more accurate and conducive to enterprise decision-making.

4. Conclusions

With the intensification of market competition and the continuous development of informatization, digital financial management has become an important means for enterprises to enhance their competitiveness. Currently, most enterprises still adopt traditional financial management models, which often face problems such as chaotic processes, low data accuracy, high labor costs, and poor security, resulting in many difficulties and challenges in financial management. This article studied the application of blockchain and cloud computing technology in financial digital management, and found that adopting this model could significantly improve the efficiency of financial and accounting processes, data accuracy, and labor cost savings. At the same time, it can also improve the performance of digital management and financial risk management. Specifically, adopting blockchain and cloud computing technology for financial digital management can shorten the processing time of revenue and expenditure processes, improve accounting accuracy and data privacy protection capabilities, and reduce labor costs, providing better data analysis and decision support capabilities. Therefore, this model has important significance for enterprises and is worth trying and promoting.

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