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A Study on the Application of Blockchain-based Secure Accounting Information Systems in Enhancing the Transparency and Auditability of Financial Reports

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Abstract The development of blockchain technology has driven improvements in the traceability of corporate financial data. To effectively track the review and modification of relevant business data by responsible parties in financial reports. This paper integrates blockchain technology with the Delegated Byzantine Fault Tolerance (DBFT) algorithm and Proof of Work (PoW) algorithm to construct a multi-tiered enterprise management secure accounting information system. The DBFT algorithm is used to perform user transaction queries in the blockchain-based relational database, while the PoW algorithm is employed to achieve audit consensus on financial report information, thereby enhancing enterprise financial security. Research shows that the error rate of accounting information in the blockchain-based secure accounting information system is as low as 11.62% across seven nodes, with error handling efficiency reaching up to 93.74%. Performance tests demonstrate a 35%-466% optimization in business processing, and enterprise application systems achieve a 60%-109% improvement in business efficiency.

Index Terms blockchain technology, financial report audit, DBFT, Pow, accounting information system

I. Introduction

In accounting work, manual recording of accounting source documents can easily introduce human subjectivity into the recorded accounting data [1], [2]. By delegating repetitive tasks that do not require human emotion to machines, accounting work efficiency can be effectively improved, thereby promoting social and economic development. As a result, the importance of accounting information systems in business operations has become increasingly significant [3]-[6]. An accounting information system (AIS) is a structured framework used by enterprises to collect, store, manage, process, and retrieve organizational financial information [7]. The input of an AIS exists in the form of data related to business activities, while the output is generated as financial reports [8].

In the current accounting recording model, the processing of information and financial data generated by enterprise economic activities is predominantly carried out by accounting information systems. Halushchak, I. Y., and Lutsiv, N. L. indicate that in an increasingly competitive environment, enterprise accounting information systems based on analysis and control play a crucial role in information support, justification, and decision-making. They also emphasize that a company's financial accounting system should be subject to appropriate regulatory oversight to enhance the effectiveness of accounting and management functions [9]. Odoyo, C. O., and Ojera, P. B. use enterprise resource planning (ERP) systems as an example to illustrate that accounting information systems are influenced by senior management support during the implementation phase, and that optimizing management and promoting communication can enhance organizational performance [10]. Haleem, A. points out that accounting practices play an important intermediary role between enterprise accounting information systems and corporate performance, meaning that accounting practices can be enhanced by introducing new AIS applications and functions, thereby improving accounting information quality and organizational performance [11]. Siqani, S. and Vokshi, N. assessed the impact of accounting information systems on the efficiency of public enterprises, finding that such systems significantly improve operational efficiency by providing high-quality financial reports, management decision-making tools, and convenient transaction methods [12]. Appelbaum, D., et al. analyzed the impact of accounting information systems on management accountants. A new system integrating the Management Accounting Data Analysis (MADA) framework provides management accountants with comprehensive performance evaluation and decision-making information, significantly enhancing their business analysis capabilities [13]. However, due to factors such as outdated system configurations, data tamperability and replicability, limited functionality, and varying levels of operator proficiency, AIS development has been slow, affecting the scientific rigor and timeliness of accounting information management, and preventing the full realization of professional management accounting functions. To address the shortcomings in the current state of management accounting development, integrating blockchain technology with management accounting can help enterprise management accounting overcome these challenges.

Blockchain technology not only facilitates the transmission of information but also enables the transmission of value, offering new solutions to the practical issues currently faced by accounting information systems [14], [15]. Utilizing blockchain technology to build a localized management accounting information system can help stimulate corporate market vitality, promote corporate value maximization, and drive regional high-quality development [16]-[18]. Since blockchain stores and verifies transaction data through chain-linked blocks, it can be used to achieve secure distributed data management, ensuring trust, transparency, and account traceability, and automatically defining, managing, and executing agreements through smart contracts [19]-[22]. At the same time, smart contracts on the blockchain make it possible to create decentralized applications [23]. Therefore, conducting research based on blockchain technology and integrating a management accounting system that combines multiple disciplines such as financial management, financial accounting, and cost accounting can provide support for enterprise operations [24]-[26].

The design of enterprise management accounting information systems supported by blockchain technology is a relatively new research direction, with some scholars attempting to systematically organize and summarize it. Fullana, O. and Ruiz, J. discussed the advantages and disadvantages of applying blockchain technology to accounting information systems and its applicability, pointing out that blockchain technology provides important advantages for the development of accounting information systems in terms of governance, transparency, and trust [27]. Inghirami, I. E. studied the impact of distributed ledger technology on accounting information systems, noting that accounting information based on distributed ledger technology can eliminate or redefine the roles of external entities, thereby assisting in corporate financial reporting and auditing processes [28]. Baiod, W. et al. addressed the issues of record tampering and fraud in traditional accounting information systems, proposing the introduction of blockchain technology to enhance the transparency and reliability of accounting information, while also potentially enabling real-time accounting [29]. Giang, N. P., and Tam, H. T. investigated the specific factors influencing blockchain technology on enterprise accounting information systems, finding that information security infrastructure (SI) has a significant impact, as blockchain technology enhances the security, reliability, and transparency of accounting information to ensure the effectiveness and efficiency of accounting information systems [30]. Han, H., et al. found that blockchain protocols can provide real-time feasible data for accounting audit work, thereby enhancing transparency and trust in accounting practices, and offering quality and efficiency guarantees for corporate accounting and audit work [31]. Tan, B. S. and Low, K. Y. argue that financial statements formed using blockchain technology constitute a digital verification process that reduces the core authority of auditors and lowers audit error rates through automated systems, thereby reducing incentives for accounting fraud and making significant contributions to the development of the accounting industry [32]. However, current research primarily focuses on discussing the concepts of AIS and blockchain, emphasizing the potential of blockchain technology in enhancing security, transparency, and immutability, as well as its advantages in managing financial transactions and asset tracking. These theoretical analyses have not yet been translated into specific model construction or experimental applications. The lack of concrete model construction and simulation implementation prevents a direct understanding of the actual effects of integrating AIS and blockchain.

This paper establishes a secure accounting information system for enterprise management based on blockchain technology and relational database management, achieving transparency in the processes of modifying, querying, and transmitting financial report data during the audit process, thereby enhancing enterprise financial security. Digital signature schemes are used for user authentication and transaction data tracking, and the DBFT algorithm with a binary tree structure is introduced during financial report audits to enable efficient query and duplicate detection of block data. During financial report audits, the Pow algorithm is used to participate in multi-stage financial data packaging and block node verification, providing data support for auditors to reach a consensus on enterprise financial security risks.

II. Blockchain-based technology for improving corporate financial security

II. A. Building a secure accounting information system for enterprise management based on blockchain technology

The implementation process of enterprise safety management accounting functions involves transmitting information based on data and identifying decision-making directions within that information. Blockchain technology overcomes the challenges of untimely and insecure data in management safety accounting information systems, ensuring data authenticity and reliability. Its tamper-proof and traceable characteristics instill management trust in the data, enabling the analysis and mining of collected data to fully leverage the benefits of management accounting. Figure 1 illustrates the management accounting information processing workflow based on blockchain technology. This paper reconfigures the management accounting process in terms of data collection, definition, processing, analysis, application, and evaluation based on the characteristics of blockchain technology, restructuring the management accounting information process into: data layer, network layer, consensus layer, incentive layer, and application layer.

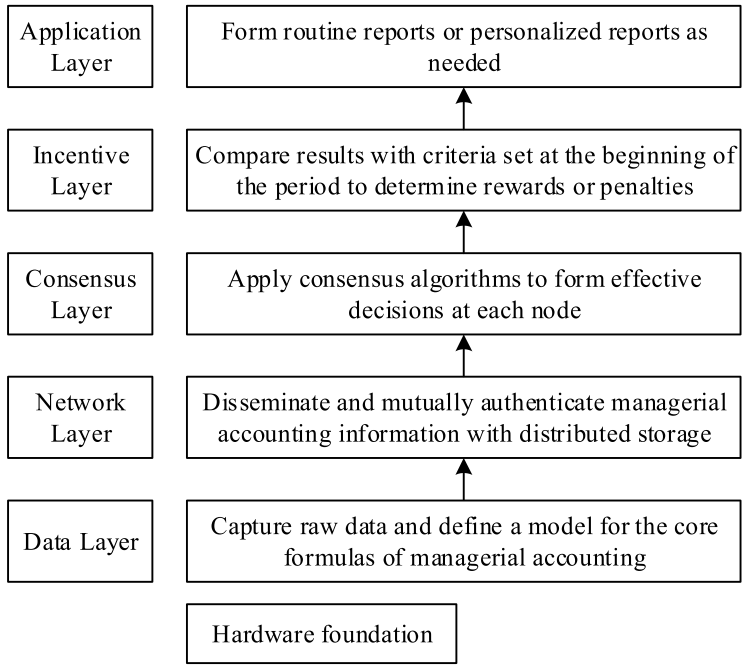

Figure 1: Processing flow of management accounting information

II. A. 1) Data Layer

Taking the data layer, network layer, and consensus layer as examples, we analyze the specific processes of a blockchain-based system. The data layer in a blockchain technology context is the most fundamental core layer, serving as the lowest level. It primarily includes raw data entered into the system from the start of a transaction, covering various aspects such as transaction volume, transaction time, product sales, product costs, and human resources. These data points must be closely interconnected through the "chain." On one hand, in accordance with blockchain requirements, it must include both "blocks" and "chains," along with basic information such as data, timestamps, hash values, random numbers, public keys, and private keys. On the other hand, definitions must be established based on the needs of management accounting. Core indicator formulas, various financial analysis methods, and analytical models from management accounting should be defined and input into the blockchain, enabling it to intelligently recognize these elements.

II. A. 2) Network Layer

The network layer is similar to distributed storage and serves as a hierarchical level for data verification. The information within the enterprise management security accounting information system based on blockchain includes both internal and external data, which are distributed and recorded through the upper-level data layer. Each department acts as both a transmitter of its own data and a verifier of other departments' data. Through verification, timestamps are generated, enabling full traceability throughout the process. For example, if sales department information has been recorded within a sub-block, the finance department can verify sales figures based on account balances, and the warehouse department can verify sales status based on outbound shipment quantities. Once the data is verified, it is stamped with a timestamp and stored on the blockchain.

Data at the network layer is distributed across multiple storage locations, with data verifying each other through timestamps to form a chain of trust. This reduces information asymmetry, eliminates the need for third-party audits, lowers costs, and improves efficiency and data quality.

II. A. 3) Consensus Layer

In corporate decision-making, if power is relatively centralized, consensus can be reached quickly, but there is a high risk of authoritarianism. However, if power is decentralized, reaching consensus becomes difficult, but once achieved, the relationship becomes stable. The application of blockchain technology in managing secure accounting information systems can utilize various algorithms to quickly reach consensus. Since blockchain technology is decentralized, although decision-making is more dispersed, the technology enables nodes to quickly reach a highly effective consensus on the data within the block.

Currently, there are over a dozen consensus algorithm mechanisms in blockchain technology. The data layer, network layer, and consensus layer form the foundational infrastructure of blockchain technology and are indispensable; the absence of any one of these layers renders the system ineligible to be classified as blockchain.

II. B. Combining Blockchain with Relational Database Management Systems (RDBMS)

II. B. 1) Digital Signature Scheme

In the proposed system, tamper-proof and verifiable features are supported by introducing consortium blockchain interaction into the relational tables of the RDBMS. Let U be the set of users, where each user $u \in U$ holds a unique key pair $(K_{pub}(u), K_{pri}(u))$, where $K_{pub}(u)$ is the public key and $K_{pri}(u)$ is the private key, generated using a 4908-bit asymmetric encryption (RSA) algorithm, ensuring that even if U contains millions of users, there will be no key conflicts.

Given any data x, the encoding function δ is represented as:

$$\delta : (x, K_{pri}(u)) \mapsto x' \tag{1}$$

In equation (1), x' is the lossless encoded ciphertext of x. The public key can be used to decrypt x' using the encryption function:

$$\delta(x', K_{pub}(u)) = x \tag{2}$$

Use a digital signature scheme to prove that user u owns data x. First, use a fixed hash function h to calculate the hash value of x. Then, calculate the ciphertext of $h(x)$:

$$sig(x) = \delta(h(x), K_{pri}(u)) \tag{3}$$

Finally, publish the data in the form of data, signature, and public key $< x, sig(x), K_{pub}(u) >$, which does not include the user's private key.

To verify the authenticity of the ownership of the published data, first decode the signature:

$$y = \delta(sig(x), Key_{pub}(u)) \tag{4}$$

Then, use h to verify whether the hash value of the decoded signature y is equal to $h(x)$ to complete the identity verification of the data publisher.

II. B. 2) Interaction between relational tables and blockchain

An additional attribute has been added to each relation table R in the relational database D to store the transaction timestamp, new table signature, previous table signature, and user public key. Additionally, an extra bit flag is used, which is a Boolean attribute (1/0), indicating whether the transaction is a delete operation. Let $attr(R)$ denote the attributes of each table R in D, where the attribute id is the row identifier (row_id). Popular RDBMS systems such as MySQL and PostgreSQL have built-in row identifier generation attributes. By adding the extra attribute to table R, we obtain the new table:

$$R' = (t, sig, sig', K_{pub}, 1/0) \tag{5}$$

In Equation (5), sig and sig' correspond to the signatures of $R(t)$ before the transaction and $R(t-1)$ after the transaction, respectively.

During the transaction update process, when user $u \in U$ wants to commit transaction ΔD, for each table R involved in the transaction, let ΔR denote the row data that is added, modified, or deleted. For each tuple $x \in \Delta R$, insert additional information into the table:

$$R' = < x, i, sig, sig', Key_{pub}(u), 1/0 > \tag{6}$$

In equation (6), i is the current transaction timestamp, $Key_{pub}(u)$ is the public key of the transaction submitter, and 1/0 is a Boolean value indicating whether x was deleted in the transaction.

Each ΔR has a unique timestamp t and signature sig_t. Thus, transaction verification is performed as follows:

$$\delta(sig_t, Key_{pub}(u)) = h(\Delta R + sig_{t-1}) \tag{7}$$

Validate all tables R' in the database and ensure that any data tampering is detected by the validation function.

II. B. 3) Delegated Byzantine Fault Tolerance (DBFT) Algorithm

Query operations are a key functionality for implementing blockchain technology. To support efficient data queries within the system, the DBFT algorithm is applied in the proposed system. DBFT is a data structure tightly integrated with blockchain, capable of dynamic updates as blocks are generated. DBFT enables real-time duplicate detection with minimal computational overhead. Figure 2 illustrates the DBFT structure. DBFT is a binary tree structure, where each node contains a bit vector V, a timestamp t, and a node depth d. Expired nodes are removed and stored in the linked list on the left.

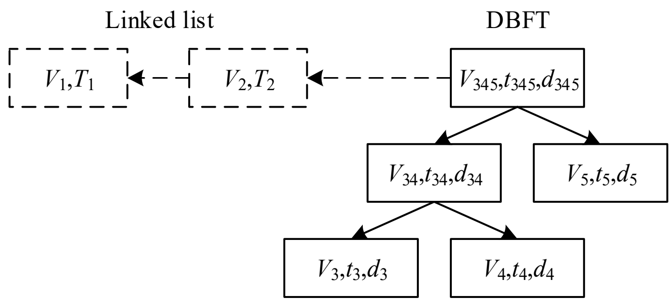

Figure 2: DBFT structure

Let node p is a leaf node corresponding to the blockchain block B_p. Assume that B_p contains l AIS data fragments. For the AIS data m_j in B_p, where $j \in \{1,2,\ldots,l\}$, id_j denotes the row identifier of the transaction in the relational database, and t_j denotes the transaction timestamp. Each AIS data has a unique row identifier and timestamp. Therefore, concatenate id_j and t_j to form the primary key P_{key} of the AIS data:

$$P_{key} = concat\left(id_j, t_j\right) \tag{8}$$

$h(\cdot)$ is an unbiased hash function. Using the Bloom filter method, the primary keys of AIS data are treated as input elements of the Bloom filter, and V_p is the bit vector of block B_p. Each piece of AIS data in B_p is added to the filter. Then, the bit vector V_p can be calculated as:

$$V_p = \begin{cases} 1, & if\ h(id_j \| t_j) = index \\ 0, & if\ h(id_j \| t_j) \neq index \end{cases} \tag{9}$$

In equation (9), $i \in [1,2,\ldots,k]$ and $j \in [1,2,\ldots,l]$. Use the latest timestamp in B_p as the timestamp t_p of node p, where $t_p = \max(t_j)$. Set the depth of leaf nodes to 1.0, so $d_p = 1.0$. Use an unbiased hash function to determine the position of each data primary key in the bit vector. The purpose of the Bloom filter is to quickly determine whether an element exists in a set while saving space. In this context, the Bloom filter is used in the bit vector V_p of a node to mark the data keys contained in block B_p.

For a non-leaf node q, perform a bitwise XOR operation on the two child nodes V_{2q} and V_{2q+1} to calculate its bit vector V_q, timestamp t_q, and depth d_q:

$$V_p = \begin{cases} V_q = V_{2q} \mid V_{2q+1} \\ t_q = \max\{t_{2q}, t_{2q+1}\} \\ d_q = \min\{d_{2q}, d_{2q+1}\} + 1 \end{cases} \tag{10}$$

DBFT provides insert, search, and delete operations, with the smallest unit of operation being a block. When a new block is generated, the corresponding leaf node is inserted into DBFT.

(1) Insert: Always insert the new leaf node into the shallowest node in DBFT. First, check if the current root node is a leaf node. If it is, the current root node is treated as the left child node, the new node as the right child node, and they are merged. If it is not a leaf node, it selects an appropriate child node based on the depth of the left and right child nodes as the new root node and recursively performs the insertion operation. The entire operation ensures the balance and correctness of DBFT.

(2) Search: First, check whether the primary key P_{key} satisfies the bit vector of the current root node. If it does not satisfy, it means that the primary key is not on the current branch, and the result is returned as false. If it satisfies, continue to check whether the current root node is a leaf node. If it is a leaf node, it means the matching primary key has been found, and the result is returned as true. If it is not a leaf node, the search operation is recursively called, with the left and right child nodes as the new root nodes, until a leaf node is found or it is determined that none was found. This ensures the accuracy and efficiency of the search operation.

(3) Deletion: First, check whether the timestamp of the current root node meets the deletion condition. If it does, delete the

root node and its child nodes. Then, check whether the current root node is a leaf node. If it is a leaf node, the deletion operation is complete. If it is not a leaf node, recursively call the deletion operation, using the left and right child nodes as the new root nodes, to ensure that the deletion operation traverses the entire DBFT. This maintains the stability and effectiveness of the DBFT.

II. C. Financial Shared Information System Architecture Based on Blockchain

II. C. 1) Architectural Design Philosophy and Objectives

The objective of constructing a financial shared information system based on blockchain technology is to optimize the financial shared information system through blockchain technology, enhance the transparency and auditability of financial reporting, and thereby address issues such as information security risks, time-consuming business approvals, and suboptimal localized business outcomes, while maintaining the system's original capabilities to improve operational efficiency, reduce costs, and enhance efficiency. This approach also aims to enhance the efficiency and compliance of the original system architecture.

Therefore, during the design and construction process, it is essential to adhere to the principles of taking financial shared services as the foundation, aligning with corporate strategy, focusing on creating value as the core objective, and implementing blockchain and related technologies as the core technical framework. Starting from the current challenges and bottlenecks faced by financial shared services, it is necessary to conduct in-depth analysis to identify the underlying causes of these issues. From there, solutions should be explored through technical optimization, architectural optimization, and organizational restructuring. The process should be approached from the perspective of data flow, focusing on the following stages: data input—data storage—data processing—data retrieval— —data transmission—data output. By leveraging blockchain technology's distributed storage, asymmetric encryption, P2P networks, and consensus algorithms, we can truly resolve the challenges identified in financial shared services practice.

II. C. 2) Proof of Work (PoW)

Take the Proof of Work (PoW) algorithm used in corporate finance as an example. Each block's storage content includes a section recording a variable random number (N). The system sets a computational difficulty value (e.g., Bitcoin's difficulty rule requires the first N bits of the hash value to be 0, with higher N values indicating greater difficulty). When a node receives data broadcast across the network, it actively packages the data to attempt to complete a new block and earn incentives based on the incentive mechanism. The node records the received data in the storage content and uses a hash function to calculate the hash value of the storage content. If the resulting hash value does not meet the computational difficulty requirement, the node's block packaging attempt is invalid, and it must adjust the random number and perform the hash operation again until the computational difficulty condition is met. Once the computational conditions are met, the node broadcasts the block to the entire network. Other nodes in the network then validate its validity. Upon successful validation, they extend their own blockchain storage, meaning the entire network acknowledges this block.

The PoW consensus algorithm is considered capable of addressing trust consensus issues in complex system environments and is currently widely adopted as a consensus mechanism in practical financial security applications. In systems using PoW as the consensus mechanism, each node must expend computational power to obtain the opportunity to generate a new block. As the number of nodes increases, the computational power required to generate each block also increases. From an economic perspective, PoW achieves its goal of preventing attacks by increasing the cost of an attack through the expenditure of resources, thereby sacrificing some efficiency of the blockchain to ensure its security and stability.

III. Application and Analysis of a Secure Accounting Information System Based on Blockchain Technology

III. A. Analysis of the necessity of constructing a secure accounting information system based on blockchain technology

III. A. 1) Descriptive statistics of various sub-projects that constrain the current development of accounting informatization

To ensure the practical applicability of this study, a questionnaire survey was conducted to statistically analyze various sub-projects constraining the development of accounting informatization. The study examined the effectiveness of applying blockchain technology to specific stages, thereby validating the necessity of this research. Using a scoring system (1.00–5.00 points), 220 financial accountants from various enterprises were invited to participate in the survey, and descriptive statistics were conducted on the various sub-projects. Table 1 presents the descriptive statistical results of the various sub-projects that constrain the development of accounting informatization. Among the 12 sub-projects that constrain the development of accounting informatization, the average score exceeded 4.50 points, indicating that all 12 surveyed projects pose certain obstacles to the development of accounting informatization, including issues such as the inability to guarantee the authenticity of transaction information. Among these, the sub-project with the highest level of constraint is "Inability to fully verify the authenticity of original accounting information (A5)," with an average score of 4.94. This indicates that determining the authenticity of original accounting information is a key focus for ensuring the effectiveness of financial statement audits.

Table 1: Descriptive statistics of various sub-projects

Specific projects	Sample size	Minimum value	Maximum value	Mean value	Standard deviation
Reliability of transaction information cannot be guaranteed(A1)	220	1.00	5.00	4.61	0.403
Transaction information cannot be fixed(A2)	220	1.00	5.00	4.52	0.429
Motive for fraud cannot be detected in time(A3)	220	1.00	5.00	4.80	0.461
Low cost of counterfeiting(A4)	220	1.00	5.00	4.73	0.455
Impossible to review the authenticity of the original accounting information with 100% certainty(A5)	220	1.00	5.00	4.94	0.428
Unable to trace transaction information(A6)	220	1.00	5.00	4.74	0.425
Review cost too high and the monitoring period too short(A7)	220	1.00	5.00	4.63	0.417
Review of transaction information cannot be comprehensive(A8)	220	1.00	5.00	4.71	0.426
Data centers are vulnerable to attacks and can be paralyzed(A9)	220	1.00	5.00	4.68	0.420
Data centers are vulnerable to the theft of internal information(A10)	220	1.00	5.00	4.75	0.445
Initial system construction cost too high(A11)	220	1.00	5.00	4.51	0.417
Cost of post-system maintenance too high(A12)	220	1.00	5.00	4.57	0.482

III. A. 2) Descriptive statistics on the application of blockchain technology

Further descriptive statistics were conducted on the results of the survey regarding the application of blockchain technology. Table 2 summarizes the descriptive statistical results of the application of blockchain technology. In the application of blockchain technology in financial reporting data audits, the mean score for each application phase exceeded 4.80 points, indicating that each phase is critical for a secure accounting information system. The phase of generating original transaction information had the highest score at 4.92 points, followed by the accounting information processing phase with a mean score of 4.88 points. In fact, these two stages are the most critical stages in the generation of corporate accounting financial reporting information. Therefore, it is necessary to utilize blockchain technology at the source to solidify transaction information, ensuring that the generation of transaction information is authentic, thereby ensuring that subsequent processed data is reliable and trustworthy. In accounting information systems without full artificial intelligence, there is a risk of forgery or fabrication in the processing of corresponding financial accounting data, which further highlights the importance of this study's use of blockchain technology and related algorithms to solidify transaction information.

Table 2: Descriptive statistics of the application of blockchain technology

Specific projects	Sample size	Minimum value	Maximum value	Mean value	Standard deviation
Original transaction information generation process	220	1.00	5.00	4.92	0.421
Accounting information processing process	220	1.00	5.00	4.88	0.405
Ledger generation process	220	1.00	5.00	4.83	0.482
Report generation process	220	1.00	5.00	4.85	0.463
Financial information analysis process	220	1.00	5.00	4.82	0.457

III. A. 3) Analysis of the conditions for implementing a secure accounting information system based on blockchain technology

Based on the above analysis, it can be concluded that the construction of a secure accounting information system using blockchain technology is both necessary and important to a significant extent. However, given the unique characteristics of blockchain development in China, leveraging it to enhance corporate financial security, improve the transparency and auditability of financial reports, still requires the full integration of other conditions.

Table 3 presents a descriptive statistical analysis of the implementation conditions for a blockchain-based secure accounting information system. The mean scores for all four conditions exceed 4.60 points, indicating that each of these conditions is indispensable when constructing a blockchain-based secure accounting information system. This study is based on the assumption of an interconnected environment. Therefore, the condition of "Internet+" and the rapid development of the Internet of Things, operating in a fully interconnected environment, is the most critical, with an average score of 4.85. Additionally, the maturity of related technologies, reduction in integration costs, and support from relevant legal systems are also necessary conditions to enable a blockchain-based secure accounting information system to achieve a high level of application and provide technical support for corporate financial security.

Table 3: Descriptive statistics of the system implementation conditions

Specific projects	Sample size	Minimum value	Maximum value	Mean value	Standard deviation
With the rapid development of "Internet +" and the Internet of Things, we are in an environment of comprehensive interconnection	220	1.00	5.00	4.85	0.421
Blockchain technology supporting this system is gradually maturing and has a realistic foundation for realization	220	1.00	5.00	4.62	0.405
Implementation of innovative technologies can be well integrated with traditional technologies, minimizing the integration costs	220	1.00	5.00	4.64	0.482
Regulatory authorities need to recognize this concept and require the implementation of relevant systems and laws	220	1.00	5.00	4.80	0.463

III. B. Practical Application of a Secure Accounting Information System Based on Blockchain Technology

III. B. 1) Comparison of Accounting Information Error Rates and Processing Efficiency

Based on the importance of constructing and analyzing a blockchain-based secure accounting information system, the system was deployed in T Company's self-built data center, covering the core business systems of 50 subsidiaries and 150 key supplier nodes across the entire network. The system was used to process transaction throughput and other data. A comparison was made between the accounting information processing effects of the constructed system and those of the traditional system to verify the effectiveness of the blockchain-based secure accounting information system in enhancing corporate financial security. Different financial nodes within the enterprise were selected for system testing, with 7 nodes chosen for comparison. Under conditions of consistent transmission speed and content, the error rates and information processing efficiency of the traditional system and the blockchain-based secure accounting information system were observed.

Figure 3 compares the accounting information error rates and processing efficiency of the traditional system and the blockchain-based secure accounting information system. The traditional accounting information system has a high error rate, with all seven nodes exceeding 45%, and the highest reaching 50.28%. In contrast, the error rate of the system in this paper is relatively low, with the highest reaching only 11.62%, indicating that the blockchain-based secure accounting information system has a higher accuracy rate in accounting information processing. Compared to traditional accounting information systems, the processing efficiency of the blockchain-based secure accounting information system is generally higher, with all systems achieving over 91%, and the highest reaching 93.74%. In contrast, the processing efficiency of traditional accounting information systems is lower, averaging around 80%, with the highest at 82.26%. This indicates that the blockchain-based secure accounting information system has relatively higher processing efficiency, making financial report data more transparent, enhancing auditability, and effectively mitigating financial risks.

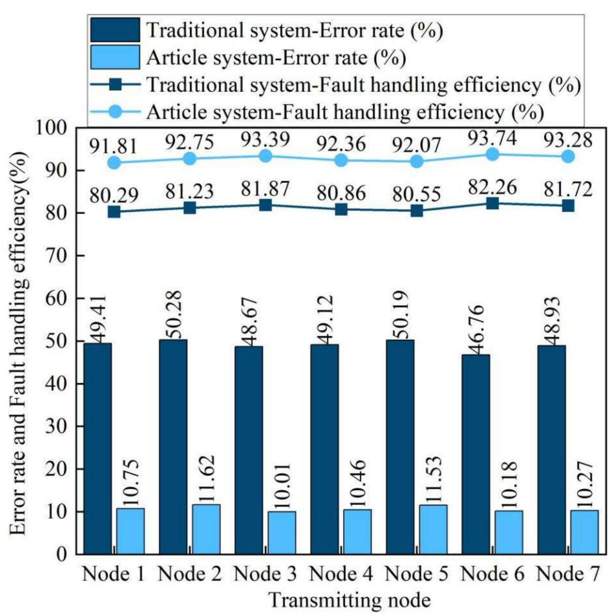

Figure 3: Comparison of Information Error Rate and Processing Efficiency

III. B. 2) Comparison of Business Indicator Category Processing Efficiency

Table 4 shows the comparison results of the accounting information performance metrics of the two systems. The blockchain-based secure accounting information system performed exceptionally well in T Company's production environment. During peak business hours, the single-node processing capacity reached 1,072 TPS, a 279% increase over the original system, meeting the high-concurrency requirements of the company's supply chain. Supply chain transaction confirmation time was significantly reduced from 7.31 seconds to 0.38 seconds, greatly improving business response speed. Block generation time was stable at 1.02-second intervals, with block size dynamically adjusted between 0.38MB and 1.02MB based on business load. System resource scheduling was reasonable, with CPU utilization peaking at no more than 62% and memory usage stable below 56%. Data synchronization latency between nodes across the network is below 100 ms, ensuring real-time sharing of supply chain data. The average response time for smart contracts processing complex supply chain operations is controlled within 98 ms. Broadband utilization exceeds 86%. Compared to traditional systems, the blockchain-based secure accounting information system achieves optimization of 35% to 466% across various business processes.

Table 4: Comparison of accounting information performance indicators

Performance indicator category	Performance parameters	Traditional system	Article system	Improvement effect
Transaction processing capability	Single-node TPS	283	1072	↑ 279%
	Total Network Transaction Per Second	978	5535	↑ 466%
Response time	Transaction confirmation	7.31	0.38	↓ 95%
	Block generation	15.28	1.02	↓ 93%
System resources	Peak CPU usage rate	95%	62%	↑ 35%
	Memory occupancy rate	91%	56%	↑ 38%
Network performance	Data synchronization delay	582ms	98ms	↓ 83%
	Broadband utilization rate	48%	86%	↑ 79%

Table 5 compares the accounting information efficiency improvement indicators after applying traditional systems and blockchain systems, respectively. Comparing the key indicators of the two systems, after applying a blockchain-based secure accounting information system, Company T achieved a qualitative leap in business efficiency. The automation processing rate increased by 109%, and the average processing time was reduced by 96%. The monthly closing cycle was reduced by 91%, and the system error rate decreased by 86%. Manual and audit workloads were reduced by 64% and 81%, respectively. System maintenance costs and audit costs were reduced by 60% and 61%, respectively. The blockchain-based secure accounting information system provides higher transparency for internal accounting information management within the company, facilitating management consensus among relevant parties, while also enhancing data processing efficiency. As a result, Company T has effectively improved business efficiency and reduced financial risks by adopting this system.

Table 5: Comparison of two system efficiency improvement indicators

Business Indicator Categories	Efficiency indicators	Traditional system	Article system	Improvement effect
Document processing Business efficiency	Automation processing rate	43%	90%	↑ 109%
	Average processing time	17min	0.6min	↓ 96%
Labor costs Operating costs	Monthly settlement cycle	5.8d	0.5d	↓ 91%
	System error rate	0.7%	0.1%	↓ 86%
Document processing Business efficiency	Manual workload	98%	35%	↓ 64%
	Audit workload	96%	18%	↓ 81%
Labor costs	System maintenance cost	99%	40%	↓ 60%
	Audit cost	96%	37%	↓ 61%

IV. Conclusion

This paper introduces blockchain technology into a secure accounting information system to comprehensively enhance the efficiency of corporate financial reporting processing and reduce the risk of financial crises. The average score for “the inability to fully verify the authenticity of original accounting information” reached 4.94 points, which is a key constraint on the current development of accounting informatization. After optimizing the secure accounting information system with blockchain technology, the maximum accounting information error rate was no more than 11.62%, significantly lower than the 50.28% of traditional systems. Additionally, the efficiency of accounting information processing reaches a maximum of 93.74%, surpassing the highest processing speed of 82.26% in traditional systems. Among the eight performance parameters across four performance indicators, the improvement achieved by the blockchain-based secure accounting information system ranges from 35% to 466%. Similarly, among the eight efficiency indicators across four business indicators, the optimization effect ranges from 60% to 109%.

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