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Construction and evaluation of cross-border payment system based on block chain

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Abstract

With the deepening of economic globalization and the increasing volume of international trade, the shortcomings of traditional cross-border payments have been gradually exposed. In recent years, blockchain technology has become a rapidly emerging concept in the financial sector, with the characteristics of no trust system, traceability of transactions, data non-tamperability, and so on, so it has a unique advantage in the field of cross-border payment of commodities. Based on the research of Chinese and foreign scholars, this paper summarizes the problems existing in cross-border payment of traditional commodities, analyzes the practicality of introducing blockchain to solve the problem of cross-border payment pain point from the theoretical level, and writes blockchain platform for cross-border payment system and deploys currency conversion smart contracts as an example. By using AHP hierarchical analysis method to evaluate the effectiveness of the system, it provides reference suggestions for the future development of cross-border payment system.

Keywords

Cross-border payments; blockchain; smart contracts; performance evaluation.

1. Introduction

In the period of economic globalization, commodity trade has transcended national boundaries, and import and export trade has gradually flourished. Cross-border payments play an important role in a cross-border trade. Traditional cross-border trade payments are made through SWIFT (International Interbank International Cooperation Organization). This method of payment is time-consuming, expensive, expensive to pay, inefficient remittances, etc. Remittance flows go through multiple transit agencies, resulting in severe delays, opaque transactions and high rates of error.

Blockchain is a completely new technology that builds a de-centrized bridge for credit and is a distributed ledger that can be shared but not tampered with easily. The biggest feature of this approach is the ability to do point-to-point transaction bookkeeping, it is added to the database with open and transparent, not easy to tamper with the characteristics, thus ensuring the security of transaction information, without the need for any central institutions can reach a credit consensus. Blockchain technology has been used in finance, energy, credit, trade and other fields.

The emergence of blockchain has brought new hope to solve the defects of traditional cross-border payment system, and its characteristics of centering, non-tampering and privacy protection make up for the defects of traditional cross-border payment system. In this paper, the cross-border trade of commodities-coffee is used as an example to optimize cross-border payment systems using blockchain smart contract technology. The combination of blockchain

and cross-border payments saves a large number of intermediaries and establishes a point-to-point network between multinational financial institutions, enabling importers and exporters to conduct point-to-point transactions directly, reducing the operating costs of SWIFT networks, reducing the loss of capital flows, simplifying business processes and improving the efficiency of remittance processing.

2. Literature

2.1. Research on cross-border payments for traditional commodities

Many researchers have found that because traditional cross-border payments involve a large number of subjects and complex procedures, the pain points of the entire process are more prominent. This paper summarizes the problems of traditional cross-border payment systems studied in the relevant literature into the following three points, namely: uncertainty of information, long time-consuming payment procedures and outstanding cost problems.

2.1.1. Information security aspects.

Peng Bo [1] argues that traditional cross-border payments are a centralized payment. The sender needs to submit his or her identity and account information to the bank or payment institution, and the customer's information is at risk of being compromised if there is a problem with the transaction process. After this information is submitted, it is manually collected and tested repeatedly, which is inefficient and error-prone. Wang Qingying [2] in the study of e-commerce cross-border payment also found that cross-border payment system than the domestic payment system is much more complex, higher risk, it is easy for cyber hackers to steal customer information, passwords and transaction information, resulting in certain economic losses. And traditional cross-border payment systems don't track the business in real time, even if they know that the transaction process is risky and require real-time monitoring.

2.1.2. Time-consuming aspects of the payment process

At present, SWIFT network system is a traditional cross-border payment method often used by people, payers need to use the system for the exchange of messages for financial transactions, while the system will provide financial institutions with uniform rules of message services and interface services. Yao Lin [3] believes that the existing payment system is very complex, the funds need to go through commercial banks, the People's Bank of China and other agencies. If cross-border payments are involved, the process will be more complex. The systems between various agencies and intermediaries are not connected, and the cost of direct settlement is too high. Settlement payments for a cross-border transaction take an average of 3-5 days and go through multiple intermediaries, wasting a lot of time.

2.1.3. Cost composition

Yan Hong [4] found that traditional cross-border payments account for less than 20 per cent of global payments, but the fees involved account for 40 per cent of the total global transaction costs.

One of the reasons for this is the instability of the exchange rate, including differences in the charging mechanism between the multiple financial institutions involved in the payment process, which make it impossible to accurately calculate and charge the specific cost of the intermediary. Due to the complexity of cross-border payment process, involving more data information and transfer channels, a higher level of technical and business process support is required, but the cost of bank supervision and compliance is relatively large.

Li Liang [5] found that cross-border payments are the main economic business of commercial banks, and many domestic commercial banks set high fees for cross-border payments. And the use of SWIFT network settlement costs are also very expensive, these payment costs include the intermediary bank remittance fees, various overheads, SWIFT network channel fees and so

on. In the event of a trading delay, funds must also be prepared to cover the delayed losses. The Blockchain White Paper [6] reported that intermediate party fees have remained high due to the large number of payment processes involved. A single transaction from exporter to importer costs up to $25-35. The cost composition of cross-border payments is shown in Figure 1:

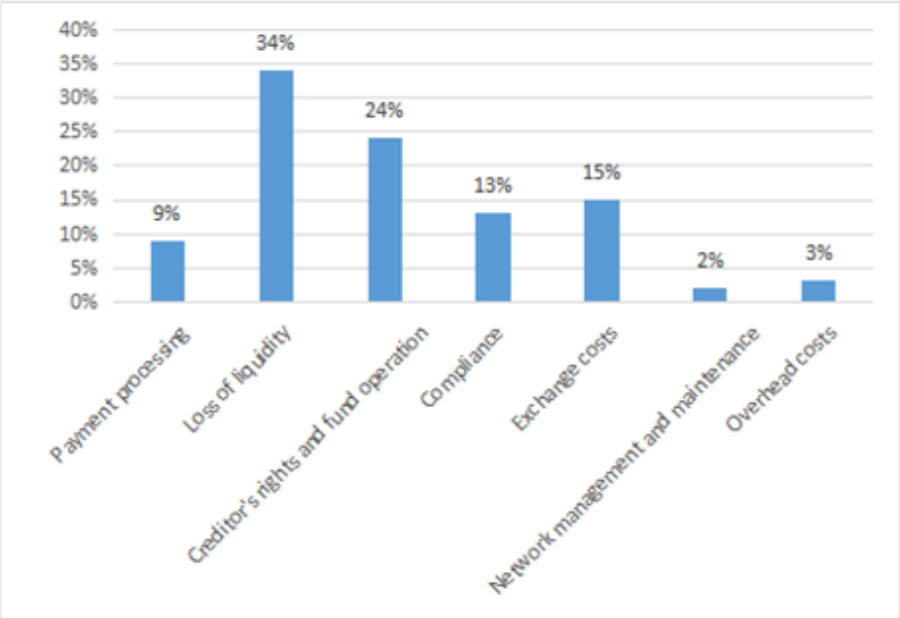

Figure 1 The cost composition of cross-border payments.

2.2. Research on the application of blockchain in cross-border payment systems.

With the deepening of blockchain research in the field of finance, people have gradually discovered the importance of blockchain. In April 2018, Cargil, a Malaysian agricultural giant, will import a shipment of soybeans from Argentina. In this cross-border trade, HSBC and ING completed the cross-border transaction payment using the blockchain R3 Corda platform. The speed of payment for this transaction is unmatched in the past, only 24 hours to complete the payment process, generally in peacetime need 5-10 days. The feasibility of blockchain technology for cross-border payments of commodities was announced.

Li Yimeng [7] analyzed the development status of cross-border trade payment system in the Belt and Road region, combined blockchain technology with traditional cross-border trade payment system, and analyzed from the technical level that blockchain can solve the shortcomings in the traditional cross-border payment field. Li Yan [8] believes that there are advantages, disadvantages, opportunities and challenges in applying blockchain to cross-border payments, and he analyzes them through the SWOT model and proposes strategies. Song Yu-penang, Wang Chao-tang [9] believes that the combination of blockchain technology and cross-border payment clearing can solve problems including high cross-border remittance fees and slow payment speed. Many literatures show that the combination of blockchain and commodity cross-border payment system is feasible and can be used to compensate for the shortcomings of traditional cross-border payment, while providing new ideas for optimizing the system.

2.3. Overview.

Through the study of relevant literature, we can find that there are many problems in cross-border payment of traditional commodities, including risk, efficiency and cost, which are the focus of many scholars. Blockchain as the focus of attention in the financial field at present,

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many scholars combine it with cross-border payment system, use blockchain technology advantages to solve the pain point of the payment process, provide new ideas for the innovation and optimization of cross-border payment methods, and promote the development of China's international trade.

3. The application of blockchain in cross-border payment systems for commodity trade.

3.1. Basic ideas

3.1.1. Address information security issues.

Blockchain ID card can be combined with bank KYC, blockchain ID card based on consensus mechanism, need cross-border trade participants multi-party verification, to ensure that identity can not be tampered with, removed, forged. Therefore, in the KYC process, banks can effectively control the authenticity of customer information materials. Based on these features of blockchain identity technology, the KYC process of banks can be more efficient and meet regulatory requirements more quickly. At the same time, blockchain smart contracts can track cross-border payments and prevent transaction forgery and fraud.

3.1.2. Address the long time-consuming issue of traditional payment processes.

Blockchain smart contracts can be combined with the payment process, enabling some parts of the cross-border payment business to be automated according to coded smart contracts after certain conditions have been met, increasing the efficiency of cross-border payments. Ripple payment systems are a typical example of the combination of blockchain technology and cross-border payments.

The Ripple system utilizes a blockchain consensus mechanism, and market players are played by financial institutions in the system. In a cross-border trade, payment information between the transfer and the incoming bank is passed to the node server, and a consensus is reached that the cross-border business can be completed after a unanimous vote. There is no need for reconciliation and confirmation of information between banks via SWIFT, thus saving significant time. Typically, it takes about 1 to 3 days to confirm a transaction over the SWIFT network, while the Ripple system takes only a few seconds. Comparing the Ripple system to SWIFT, you will find that SWIFT reduces the cost between incoming and foreign travel, as shown in Figure 2:

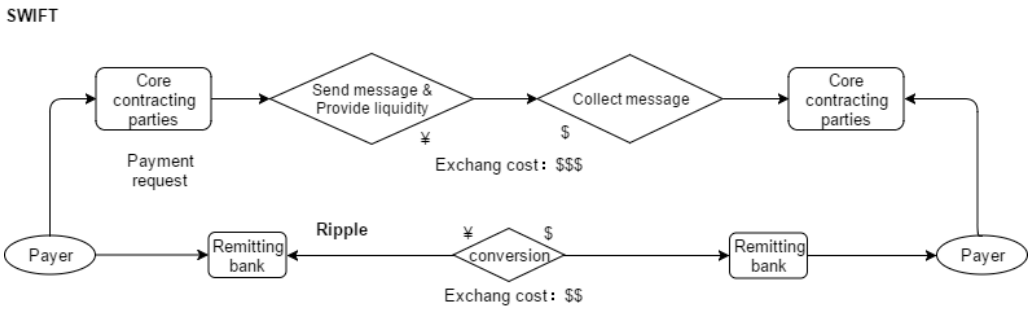

Figure 2 Ripple and SWIFT process cost comparison

3.1.3. Address the high cost of traditional payment.

The addition of blockchain greatly simplifies the cross-border payment process and reduces the cost of payment. According to McKinsey's calculations, the cost savings could be as high as 40%. The Ripple system measures that traditional cross-border payment systems cost an average of $5.56 per transaction, and blockchain cross-border payment systems can reduce them to $2.21, a reduction of almost 60 per cent. The savings are mainly incurred during bank

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transfers. In 2016, SWIFT networks calculated the number of paid messages that had been completed, and researchers found that paying transactions over the Ripple network could save about $10 billion. The situation is shown in Figure 3 below:

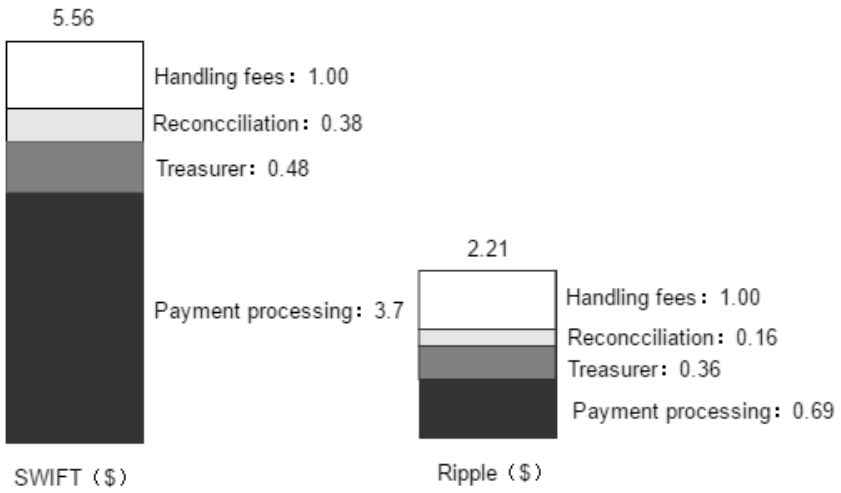

Figure 3 The cost savings of the Ripple system compared to SWIFT

3.2. Design the system

This article will use a specific commodity - coffee cross-border trade payment as a case study of system design, and based on Ripple payment system to design coffee cross-border trade payment system, as shown in Figure 4:

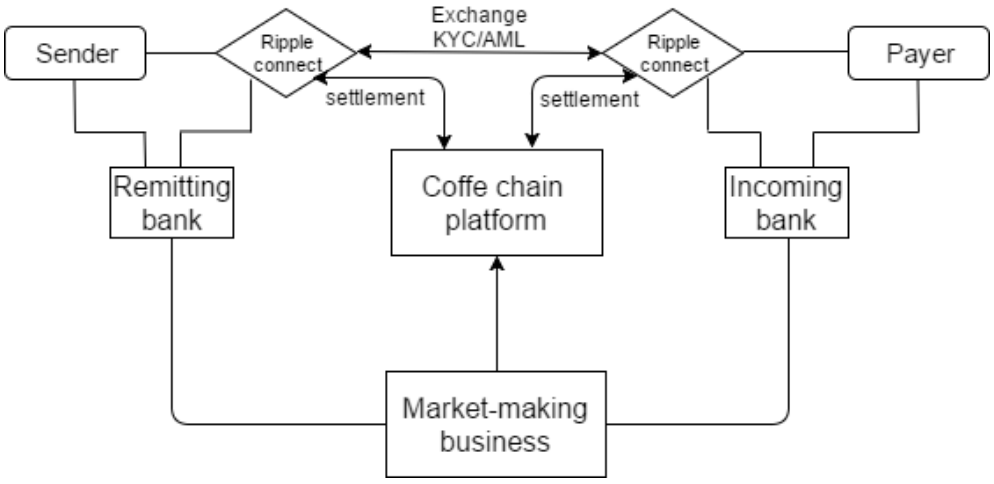

Figure 4 Cross-border payment system for coffee trade

The entire payment system can be divided into the initiating and accepting parts of the transaction. In the cross-border settlement of coffee trade, the initiating end of the transaction consists of several modules, such as Ripple connection, verification machine, distributed ledger and foreign exchange quote connector. KYC/AML information, customer identification information and payment information for the transaction are exchanged through a channel connected by ripple networks. The verification machine confirms the identity of both parties to the transaction before it is initiated. The distributed ledger holds operational information on the transfer of funds in the transaction. In the course of trading, market traders for both sides of the trade to provide foreign exchange liquidity, foreign exchange quoters can provide marketers with the best foreign exchange quotations. Remittance travel through the coffee chain platform, the payer's legal tender A into the same value of coffee currency, and then the coffee chain platform will transfer the coffee currency in the transfer account into the transfer

bank account, and finally converted to the transfer party's legal tender B. The specific operating procedures of the coffee chain platform are as shown in Figure 5:

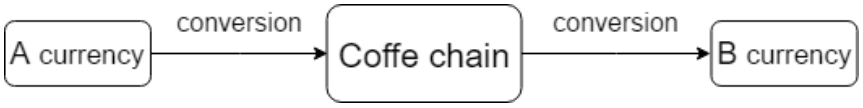

Figure 5 Coffee blockchain platform currency conversion

But the biggest difference between the coffee cross-border trade payment system and the Ripple system is that the Cable Coin model will be used in the coffee chain platform to reduce the loss of funds due to exchange rate fluctuations on both sides of the transaction. The digital currency commonly used in Ripple is XRP, and the price of Ripple is not stable or even volatile. Because of the short-term sharp fluctuations in the price of Ripple currency, resulting in capital losses on both sides of the transaction.

3.3. Deploy smart contracts on the coffee chain platform

3.3.1. Introduction to smart contracts

Smart contracts are a piece of code in Taifang that can be deployed as an embedded programd contract on any blockchain system. In this paper, smart contracts are deployed on the blockchain platform of the coffee trade cross-border payment system, and when cross-border payments occur, certain conditions in the contract are triggered, and the code in the smart contract is executed autonomously. All executed procedures are recorded in the blockchain. Therefore, cross-border payment data can be traced retroactively and no one is allowed to tamper maliciously. The structure of smart contracts in the blockchain is shown in Figure 6.

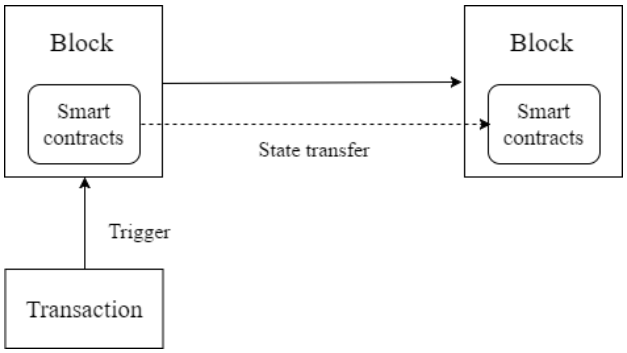

Figure 6 Smart contract structure for blockchain.

3.3.2. The code for the smart contract

One of the biggest features of coffee cross-border payment systems based on blockchain technology is the currency conversion of coffee blockchain platforms. This article will use the Solitidy language to write smart contracts and invoke them in the remix environment, which will implement two functions: (1) to create a specified number of tokens (in the coffee trade cross-border payment system is coffee currency) when the remittance travel initiates the payment contract, and the owner of the coffee coin is the transfer account that initiated the contract. (2) Transfer a specified amount of coffee coins from cross-border transactions to a designated remittance bank account. Information about each transaction is stored on the coffee chain platform, making it easy for participants in cross-border transactions to track and trace it later. The functional flow and code of the smart contract are As shown in Figures 7 and 8.

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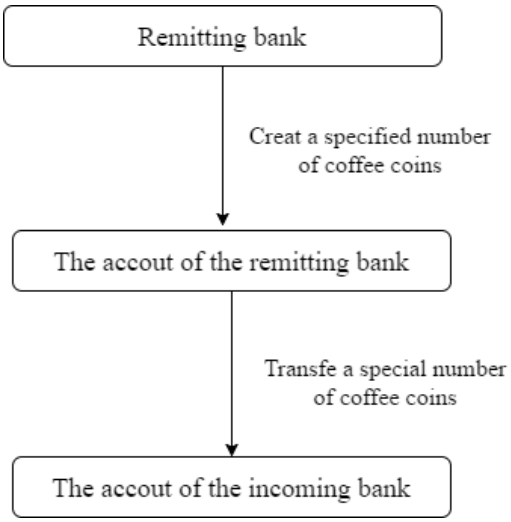

Figure 7 Functional flowcharts for smart contracts

```
pragma solidity ^0.6.1;

contract MyToken {
    mapping (address => uint256) public balanceOf;

    constructor (uint256 initialSupply) public {
        balanceOf[msg.sender] = initialSupply;
    }

    /* Send coins */
    function transfer(address _to, uint256 _value) public {
        require(balanceOf[msg.sender] >= _value);
        require(balanceOf[_to] + _value >= balanceOf[_to]);
        balanceOf[msg.sender] -= _value;
        balanceOf[_to] += _value;
    }
}
```

Figure 8 Code for smart contracts.

3.3.3. Call the smart contract

The environment in which smart contracts are deployed is JavaScript VM, and an Ethereum account is created on the coffee chain platform as an account for remittance travel, as shown in Figure 9. By depositing the coffee coins required for the transaction into your account, you can send the transaction and deploy the contract. A trading interface is formed after a successful contract deployment, as shown in Figure 10. There are two functions that can be implemented in the trading interface: querying the balance of the foreign exchange travel account and the number of coffee coins transferred.

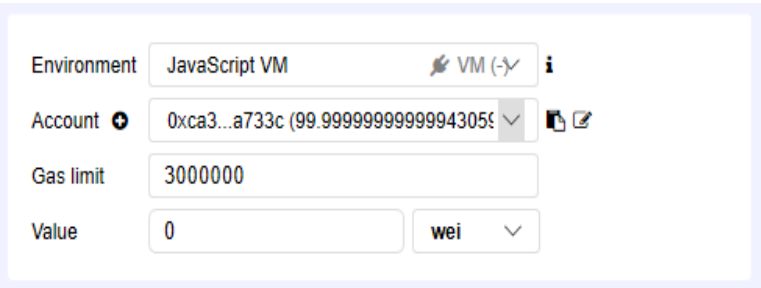

Figure 9 Information on the account of the hui travel

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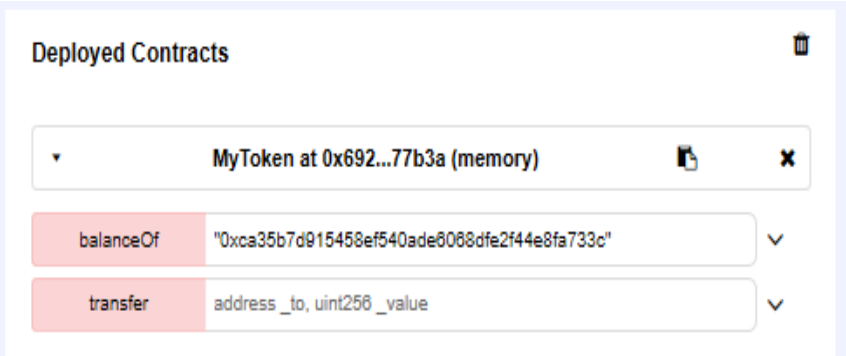

Figure 10 Trading interface for smart contracts.

3.3.4. The instance action

This paper assumes that a Chinese coffee importer wants to import a batch of coffee beans from Brazil. The Bank of Remittance (in Brazil) needs to transfer a sum of 100,000 coffee coins equivalent to the total value of the coffee beans to the Bank of China, figure 11 shows the transfer operation of the foreign exchange trip. If the remitting bank successfully transfers the coffee coin, you can see the account balance stored in the coffee chain platform, as shown in figure 12. You can see from the figure that there are now 100,000 coffee coins in the Ethereum account. In the coffee chain platform, each deposit or transfer transaction has a specific hash value, and once the transaction data is changed, the hash value changes, thus preventing the transaction data from being maliciously tampered with.

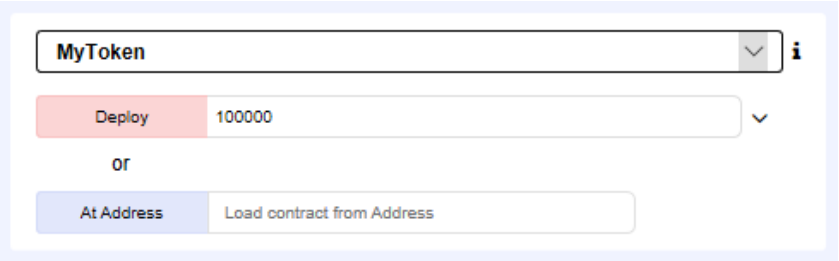

Figure 11 The remitting bank deposited coffee coins in the Ethereum account

Figure 12 Stores transaction information.

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The remitting bank now needs to transfer 100,000 coffee coins into the account of the incoming bank, as shown in figure 13. At this point, when you look at the remittance account, you will find that the 100,000 coffee coins in the account have been emptied and the transferred account is the Ethereum account of the incoming bank. Figure 14 shows the transaction information.

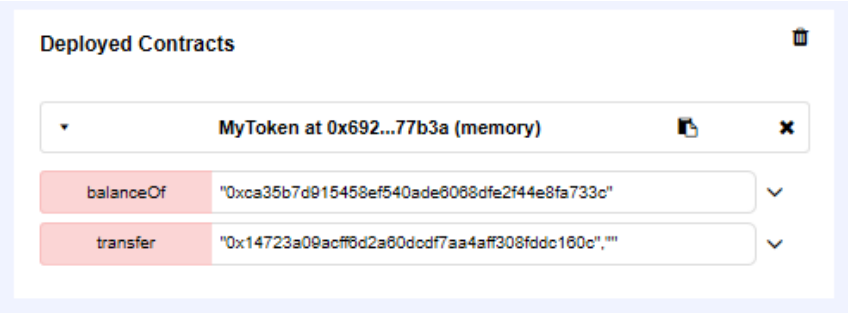

Figure 13 The remitting bank transferred the coffee coins to the account of incoming bank

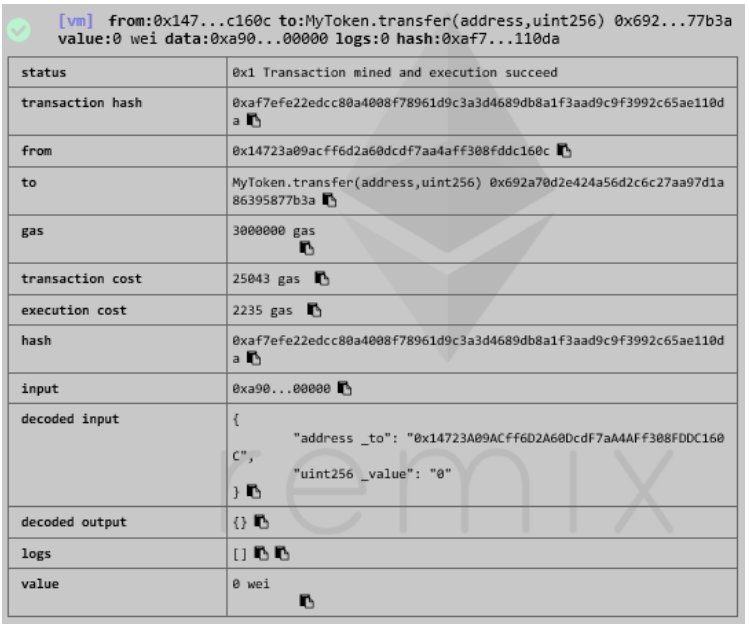

Figure 14 Information on transfer transactions

From the above experimental results, it can be seen that token smart contracts quickly and successfully complete the process of converting payment currency, which greatly saves payment time, improves payment efficiency, reduces the losses caused by exchange rate instability, and improves the cost of traditional cross-border payment systems. The process of each transaction is recorded in the blockchain system, which does not allow any party to maliciously modify the data, enhances the security of payments, facilitates the query and traceability of transaction participants, and enhances the information security of blockchain cross-border payments.

4. Evaluation of the effectiveness of the blockchain-based coffee cross-border trade payment system

4.1. Introduction to the method of effect analysis.

VensimPLE software: Use this software to create a causal cycle chart of each indicator, through the process of modeling, you can understand the causal relationship between the indicators and positive and negative correlation.

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Hierarchical analysis: The decision-making problem analyzed by hierarchical analysis method should focus on what aspects of system construction should be focused on introducing blockchain into the coffee cross-border trade payment system. The indicators of the decision-making problem are then broken down into interrelated ordered levels. The weighting of each indicator is given by the AHP software.

Through the combination of the two methods, the relationship between the influence of each secondary indicator on the first-level indicator and the positive-negative correlation between the weight coefficients of each indicator and the indicators can be positive, positive or negative, and negative.

4.2. Build an indicator system and a causal cycle chart.

The construction of the indicator system can set two levels of indicators, including efficiency of cross-border payment and eecurity of cross-border paymen..Judging from the characteristics of blockchain technology itself, a first-level indicator can be set to the distributed level of the coffee chain platform. Each first-level index has four second-level index associated with it, as shown in figures 15.

According to the set index system and the characteristics of blockchain technology itself and the development of real cross-border trade payments, the corresponding secondary indicator causal cycle chart is produced using Vensim PLE software, as shown in figure16.

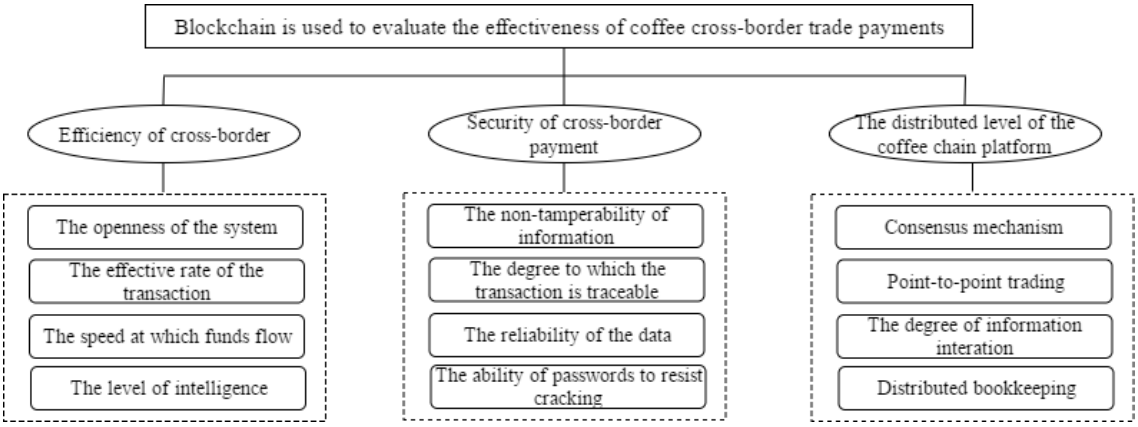

Figure 15 Cross-border payment system evaluation index system

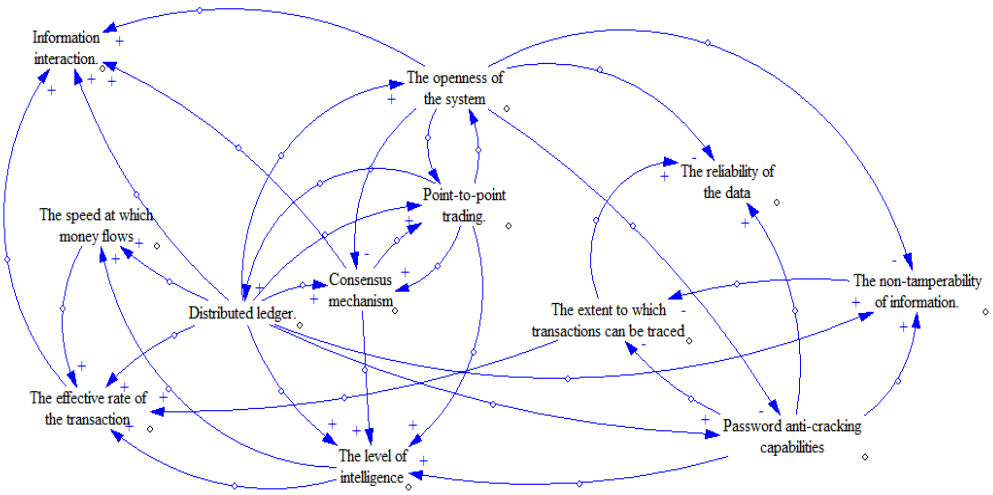

Figure 16 causal cycle diagram

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4.3. Evaluation analysis

4.3.1. The indicator weights and indicator equations are derived and analyzed

The weight of each indicator is determined by the AHP method, table 1 is the weight of the first-level index, and table 2 is the weight of the second-level index. And all indicators meet the consistency test, which is CR 0.1, as shown in Table 3.

Table 1 first-level indicator weights

Level 1 indicators	Weight
Efficiency of cross-border payment Y_1	0.1638
Security of cross-border payment Y_2	0.5390
The distributed level of the coffee chain platform Y_3	0.2973

Table 2 Secondary Indicator Weights and Comprehensive Weights

Secondary indicators	Peer weight	Comprehensive weights
The openness of the system X_1	0.4715	0.0772
The effective rate of the transaction X_2	0.2550	0.0418
The speed at which funds flow X_3	0.1653	0.0271
The level of intelligence X_4	0.1083	0.0177
The non-tamperability of information X_5	0.3838	0.2069
The degree to which the transaction is traceable X_6	0.1257	0.0678
The reliability of the data X_7	0.2999	0.1616
The ability of passwords to resist cracking X_8	0.1906	0.1027
Consensus mechanism X_9	0.2150	0.0639
Point-to-point trading X_{10}	0.2654	0.0789
The degree of information interaction X_{11}	0.1104	0.0328
Distributed bookkeeping X_{12}	0.4092	0.1216

Table 3 consistency test

Level 1 indicators	CR	Secondary indicators	CR
Efficiency of cross-border payment Y_1	0.0079	The openness of the system X_1	0.0172
		The effective rate of the transaction X_2	
		The speed at which funds flow X_3	
		The level of intelligence X_4	
Security of cross-border payment Y_2		The non-tamperability of information X_5	0.0536
		The degree to which the transaction is traceable X_6	
		The reliability of the data X_7	
		The ability of passwords to resist cracking X_8	
The distributed level of the coffee chain platform Y_3		Consensus mechanism X_9	0.0540
		Point-to-point trading X_{10}	
		The degree of information interaction X_{11}	
		Distributed bookkeeping X_{12}	

By analyzing the causal cycle chart and the weights between the indicators, the effect function equations of the three first-level indicators are integrated:

$$Y_1 = 0.0772X_1 + 0.0418X_2 + 0.0271X_3 + 0.0177X_4 \tag{1}$$

$$Y_2 = 0.2069X_5 - 0.0678X_6 + 0.1616X_7 + 0.1072X_8 \tag{2}$$

$$Y_3 = 0.0639X_9 + 0.0789X_{10} + 0.0328X_{11} + 0.1216X_{12} \tag{3}$$

It can be seen from the effect function equation of the first-level indicator that after the blockchain is introduced into the coffee cross-border trade payment system, The efficiency of cross-border paymen, security of cross-border payment and the distributed level of the coffee chain platform are increased by 0.1638, 0.4034 and 0.2972 units, so the total effect function can be constructed. Wherein the explanatory variable Y is the total effect of introducing blockchain into the coffee cross-border trade payment system, and the function equation is:

$$Y = 0.1638Y_1 + 0.4034Y_2 + 0.2872Y_3 \tag{4}$$

Bringing the weights of Y_1,Y_2 and Y_3 into the (4) type can be approximated to get Y=0.8544, which means that the introduction of blockchain into the coffee cross-border trade payment system has a positive effect. These theories confirm the feasibility of blockchain payments in cross-border trade in commodities.

4.4. Conclusion.

Through hierarchical analysis, we can see that the proportion of cross-border payment security is as high as 54%, that is to say, the security of the blockchain into the coffee cross-border trade payment system is very important, and the effect of the secondary indicators on the first-level indicator is basically positive, so ensuring the security of cross-border coffee trade payment is the key to the blockchain technology.

Blockchain technology itself has a very strong protection mechanism, what we need to do is to pay attention to the traceability of transactions, information non-tamperability, data reliability and anti-jamming capabilities, improve the integration of blockchain core technology and cross-border payments. At the same time, the government needs to formulate corresponding laws and regulations to protect the entire cross-border trade payment.

5. Summary and outlook

The birth of blockchain is a technological revolution, and many industries are looking for applications that combine exploration and blockchain. For the financial industry, blockchain has the potential to play a huge role in the financial field of many specific applications, cross-border payment field is a focus of analysis and research.

This paper focuses on the application of blockchain technology to cross-border payments in the financial sector. Starting from the traditional payment point of cross-border trade in commodities, from theoretical analysis to practical application. Smart contracts were written and deployed on cross-border payment systems to demonstrate the feasibility of combining blockchain with cross-border payments. The effect evaluation of blockchain cross-border payment system was carried out by Vensim PLE software and AHP method.

But there are many ways to pay across borders, such as letters of credit and collection methods, and different payment methods and blockchain combinations are different. The cross-border payment methods analyzed in this article are similar to wire transfers and do not include all

payment methods, so this is not comprehensive. And this paper does not delve into how the underlying technology of blockchain is used in cross-border payment systems.

At present, the application of blockchain has not stabilized, the real use of blockchain technology to achieve cross-border trade payment business of commodities also need to solve many problems, such as legal policy protection, domestic and foreign importers and exporters consensus. Researchers will continue to explore solutions to these problems in future studies.

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