Can the issue of invoice reimbursement in China be solved completely through the integration of blockchain and IoT technology?

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ABSTRACT

In order to achieve the automatic and non-inductive reimbursement of invoices and eliminate the various inconveniences as well as risks caused by artificial reimbursement, this paper creatively combines blockchain technology with electronic invoices. This system realizes interactive flows of paperless invoice for each node from consumption, reimbursement to tax payment through the blockchain network system. Based on the Internet of things technology, the off-chain data can be automatically processed and connected to the on-chain seamlessly. Meanwhile, using a dual-chain structure ensures the subsequent identification and business separation. Through the combination of theory and technical framework, the non-inductive invoice reimbursement system is constructed to reduce the overall reimbursement costs and promoting the improvement of the taxation system in China.

CCS CONCEPTS

•Software and its engineering~Software creation and management~Designing software~Software design engineering•Computing methodologies~Distributed computing methodologies~Distributed programming languages

Keywords

Blockchain, No reimbursement, Invoice, The Internet of Things, Taxation system.

1. INTRODUCTION

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1.1 Background and significance of research

Invoices are the most important original materials in accounting as well as the objects which accountants deal with every day. In August 1986, the Ministry of Finance issued 《the Interim Measures for the Administration of National Invoices》. Since then, the invoice has a unified national name and concept.

However, lots of manpower, material and financial resources are wasted when using paper invoices. To eliminate the disadvantages of paper invoices, China's first electronic invoice was put into use in 2013. On December 1st, 2015, the electronic invoice system was implemented nationwide, which started the stage of using electronic and paper invoices together. However, e-invoicing doesn't completely get rid of the disadvantages of paper invoices with infinite repeat printing.

Blockchain is a new application model of distributed data storage, consensus mechanism, encryption algorithms and other technologies [5]. Blockchain electronic invoices are the innovative collision between blockchain technology and electronic invoices. Therefore, it breaks through the requirements of traditional invoices for clients and tax control appliances. There are no more restrictions on volume and amount of invoice. Additionally, it avoids the risks of falsely making out invoice, false invoices, reimbursing multiple times on one invoice, false reimbursing and deducting, etc. more effectively, which returns invoices to the origin of commercial activity vouchers. The first blockchain electronic invoice was launched on a trial basis in Shenzhen in August 2018. There are 1,190 registered invoicing companies including China Merchants Bank, Tencent and UnionPay. As of May 5th, 2019, 2.25 million blockchain invoices had been issued by on-chain enterprises, with a total price tax of 1.89 billion yuan. At present, the average daily invoices have reached 30,000. Since blockchain electronic invoice system has been launched, it realizes "zero negative feedback"[1]. The combination of Blockchain technology and electronic invoices can completely solve the problems which caused by paper invoices. In addition, it improves electronic invoices and create a new development for invoice reimbursement.

1.2 Domestic and foreign literature review

As the critical revenue source of public finance, tax is the most important means to realize the public function of the state. As shown in Figure 1, this paper uses the United States and China as comparative illustrations.

The United States has a relatively perfect tax system. Its tax authority is highly decentralized with no compulsory affiliation between central and local political economic institutions. Independent levels of government power can implement local tax policies and reduce tax collection and management costs [2]. However, in China, central tax authority controls local and local belongs to central, which forms a tax system with a highly connected relationship.

The United States also has an extremely sound tax collection and administration system. Firstly, the universal implementation of tax declaration in the United States. Secondary, social specialization of tax audits. Thirdly, formulating strict and comprehensive laws to achieve taxation by law [2]. While in China, problems cannot be reported in accordance with normal procedures due to operational errors and they have to be resolved by the local tax bureau. Additionally, although China has formulated relevant laws to ensure taxation, there still exist problems that law enforcement officers are lax in law enforcement, taking bribes in secret. What's worse, there are even improper interference of local governments in tax enforcement. Thirdly, the relevant laws and regulations are not perfect, which leads to the criminals have chances.

The majority of taxpayers in the United States are individuals. Personal income tax is the main federal government revenue, while the main taxpayers in China are enterprises or organizations. Value-added tax and consumption tax are two main tax categories which are considered.

There is an extremely important relationship between the issuance of invoices and taxation. Invoices are valued as the basis of inspection and revenue coming from valid documents such as invoices is the basis of taxation when the tax authority confirms corporate incomes or expenses. In order to solve the problems happening in present taxation in China, the first step is to improve the existing invoice system.

Comparison of Chinese and American taxation systems

	United States	China
Taxation system	Tax authority is highly decentralized; There are three levels of tax collection and management system; Reduce tax collection and management costs.	Highly centralized authority; Highly close relationship; Nepotism prevails.
Tax collection and management system	Tax declaration; Social specialization of tax audit; Achieve taxation by law.	Online tax filing; Achieve taxation by law, which is not perfect
Taxpayer	The main taxpayers in the United are primarily individuals. Personal income tax is the main federal government revenue	The main taxpayers in China are enterprises or organizations, Value-added tax and consumption tax are two main tax categories which are considered.

Figure 1. Comparison between Chinese and American taxation systems

2. SITUATION ANALYSIS OF INVOICE APPLICATION

2.1 Related processes of common invoices and present pain points

At present, most enterprises still implement the reimbursement requirement through the combination of electronic invoices and paper invoices.

As shown in figure 2, in general, enterprises need accountants to bring various paper certificates and identity cards to the tax bureau to register and then receive a specific number of paper invoices. Issuing invoices requires professional tools such as tax control software and tax control disks. It also needs to be extremely careful when operating. The tax identity, remarks and other information on the paper invoices should be carefully checked to ensure complete accuracy. Then put the blank paper invoice into the printer, making sure the password fields are not skewed and the handwritings are clear. This set of procedures requires a high concentration of accountants. While these steps are too complicated if any step goes wrong, a paper invoice will be invalidated.

Figure 2. Traditional process of issuing invoices of enterprises

When it comes to reimbursement for enterprises' internal employees, to start with, paper invoices are supposed to be provided on specific dates with standardized expense reimbursement forms. Then the invoices are submitted to department head for review and signature. Later, the invoices are passed to the person in charge of the Finance Department for review and signature. After then, the invoices are sent to the unit manager or company general manager for approval, continuing to give final approval to directors. Finally, the invoices are returned to the Finance Department, where cashiers review the appropriation and fill in the relevant bills. The flow chart is shown in Figure 3 below.

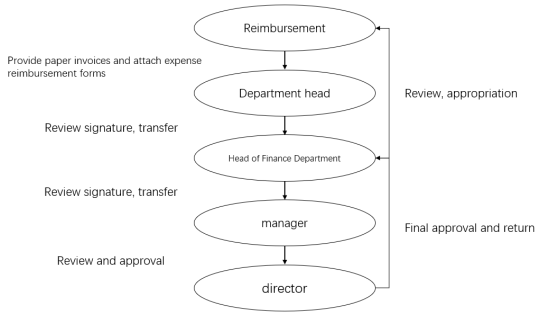

Figure 3. Reimbursement flow chart

In summary, issuing invoices and reimbursement take a lot of time. Meanwhile, there exist problems that complicated processes, difficulty to keep vouchers, and hard to remedy. All problems mentioned above are difficult points in the practical application of traditional paper invoices.

2.2 Development Status and Pain Points of Electronic Invoices

Electronic invoices are receipts or payment vouchers in the form of data message, which are the new form of invoices that follows the paper invoices. With the rapid development of technology, electronic invoices have become the main force used in taxation business. Take China as an example, invoicing companies have grown rapidly from less than 50,000 in 2016 to nearly 300,000 nowadays. The invoicing volume has also soared from less than 500 million copies in 2017 to nearly 2 billion in 2018 [3]. On November 26th , 2015, the State Administration of Taxation issued 《The Announcement on Issues Concerning the Implementation of Electronic General Value Added Tax Invoices Issued through the Electronic Value Added Tax Invoice System》 [4], which standardized and unified the electronic invoice. At present, electronic invoices are widely used in various fields. For example, there exist options for issuing electronic invoices in software such as Didi Taxi, which is convenient for users to download and print invoices for financial reimbursement.

However, even though the birth of electronic invoices is a progress across the ages, it still has several serious problems. Firstly, electronic invoices can be printed indefinitely. Consumers can print e-invoices through clients or machines but printed e-invoices can only be prevented to be reused by specific codes. Secondly, it is difficult to check the authenticity of electronic invoices, which are saved in the form of files when changing the relevant information through the technologies such as photoshop. Thirdly, when there are bugs in the tax system, it is more difficult to check the information. In conclusion, while electronic invoices bring convenience to life, they also waste a lot of labor costs and time costs currently.

3 OVERVIEW AND MECHANISM OF BLOCKCHAIN

3.1 Definition and Application of Blockchain

The concept of blockchain first appeared in 《Bitcoin: A Peer-to Peer Electronic Cash System》, written by Satoshi Nakamoto, where describes blockchain is a data structure used to record the history of bitcoin transaction accounts.

Blockchain system is defined as a system with features including decentralization, time series data, collective maintenance, programmable, security and trustworthiness. The system's database is a distributed network database. Understanding from an accountant's perspective, blockchain is equivalent to a ledger

chained in chronologically. Unlike ordinary ledgers, blockchain ledgers can only add transaction records and cannot delete transaction records. All information is permanently in the data once it is recorded. It is because of these characteristics that makes the combination of blockchain and electronic invoices become reality, and solve the problems caused by paper invoices and electronic invoices to accounting and make the flow of invoices transparent, to ensure the fairness and openness of accounting and taxation work.

3.2 Blockchain characteristics

The characteristics of the blockchain can be seen as Figure 4 below:

1.Decentralized / Intermediate Trust. The system itself guarantees its authenticity and does not require the intervention of external trust endorsement subjects.

2.Stability, reliability, and sustainability. It is a distributed network architecture, and there is no single point of failure. Therefore, it has stronger stability, reliability and sustainability in the dimension of technical architecture.

3. Encryption mechanism and consensus mechanism. There is no need for the third party to enter. The entire transaction is completed through a technical intermediary.

4. The on-chain data can only be increased and cannot be modified. After written into the blockchain, the data cannot be modified or deleted. Only another record can be added to indicate the transactions are invalid, which determines the openness and transparency of transactions.

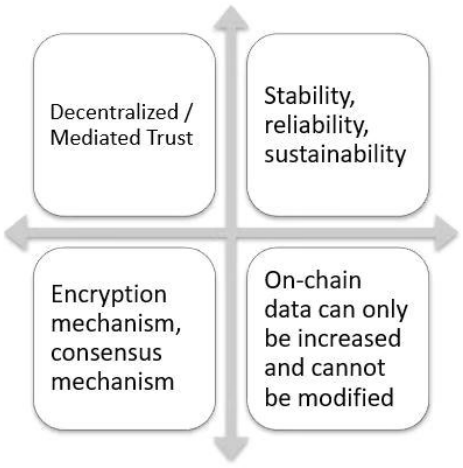

Figure 4. The features of blockchain

4. OPTIMIZATION OF INVOICE PAIN POINTS BASED ON BLOCK TECHNOLOGY

4.1 Realizing open and transparent billing process through blockchain technology

Electronic invoices replace traditional paper invoices, laying the foundation for smart contracts in blockchain technology. Since these two types of invoices are currently monitored in China by " retrospective after opening ", the relevant information of the invoices still cannot be effectively monitored and illegal acts are to be continue despite repeated prohibition. The blockchain electronic invoice technology uses a series of individuals or institutions related to transactions and invoices, such as the issuer, the drawee, the third party agency, customs, industry and commerce, banks, and third-party supply chains as the nodes [6], realizing the comparison of invoice flow, capital flow and business flow.

Issuing false invoices is the act of falsifying the relevant information of a transaction or directly fabricating a transaction. "fake transaction real invoice" is a typical phenomenon, which the flow of funds and transactions are not unified. However, the conditions required to verify invoices are constrained as well as the time difference at the website, both of which main to the exceptionally excessive cost of verifying every bill. Furthermore, a large geographical span caused by the distance between two parties or even the cross-border transaction, a large time span caused by the flexibility of the time interval and limitations of space and time also make it difficult to verify invoices. However, these problems can be solved easily through blockchain technology.

As shown in Figure 5, Firstly, we can use a decentralized distributed ledger model to record, store, and update data. In theory, only by attacking a certain proportion of nodes simultaneously can the whole network be controlled. To a certain extent, it can ensure high confidentiality of data. Secondary, every transaction movement is automatically timestamped when it's far written into the blockchain database. In this way, even if the transaction is returned, the transaction record will not be deleted. Additionally only one more record can be added to indicate that the transaction is cancelled. In this way, the complete, comprehensive and immutable transaction information is achieved. Thirdly, collective maintenance enables this transaction record to be updated in real time on any node and all parties to the tax collection can view the updated data. Traceability also guarantees that all information can be known thoroughly. Through checking the updated information about the location and time, the tax authority can obtain the information more efficiently and thus solving the problem of asymmetry of the information collected by both parties, promoting the transition of the tax payment process in a more efficient and easy way, and realizing the "pre-opening review" of invoices. Finally, the smart contract mechanism can automatically deduct the tax payable in the taxpayer account and thus reducing the cost of issuing invoices [7]. Through the operations above, the entire process of transactions, invoicing, and tax payment can all realize transparent and open.

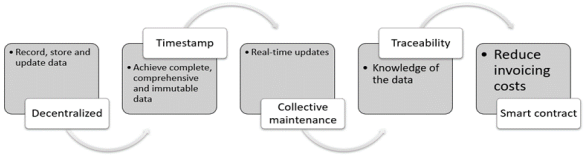

Figure 5. The open and transparent process of issuing invoices realized by blockchain technology

4.2 Using blockchain technology to solve the issues of personal reimbursement and paying tax

From the discussion above，even though one person uses the electronic invoice to report tax, he or she still need the accountant to use the tax control plate in accordance with the rigorous operational procedures for tax declaration. Additionally, when meeting the situation such as the crash of tax control disk or official software, it is still necessary for he or she to communicate with business personnel or explain the situation to the relevant tax bureau for manual tax declaration. Due to the information asymmetry between tax professionals and tax preparer, communication also becomes extremely difficult. In fact, the more people are involved in, the more complicated the process is, the more effort are taken, the more unpredictable the risk is. Therefore, the basic purpose of establishing the non-inductive invoice reimbursement system is to reduce manpower input, reduce non-technical risks, and realize the "one-stop" service from consumption to reimbursement to tax declaration.

Firstly, giving that most of China's personal income tax needs to be withheld through company wages in advance, reimbursement also needs to be submitted through the company's reimbursement process to submit invoices, therefore, a simple blockchain system can be established by merchants, individuals, companies and tax bureaus, so that the reimbursement process can follow a consumer-insensitive link.

Secondary, input the information data of each node into the blockchain. The high confidentiality of the blockchain can prevent personal information and company information from being maliciously stolen. When consumers make purchases at merchants, they need to choose a payment method that can identify them such as payment after chain up, Alipay, WeChat payment code and other real - name payment software or bank cards. For some people who are inconvenient or do not know how to use electronic devices, the usage of the recently emerging face payment method, the usage of the machine for facial recognition can deduct directly in the electronic wallet.

As shown in Figure 6, taking having a meal in a restaurant as an example, the customer can pay with Quick Mark code through payment software or swipe bank card to pay for the meal. After the payment is successful, there will form the record about the meal's location, time and related in time. When the technology of facial payment develops more mature and can be more widely used in various places, the face can be scanned and recognized with the machine in the hotel and compared with the information in the blockchain and thus money can be deducted from e-wallet automatically. Consumption in a shopping mall is in a similar way. Therefore, the application and the development of blockchain will greatly facilitate payment methods.

After completing the payment deduction in the e-wallet, because of blockchain's real-time synchronization technology and non-tampering, the consumption information is written into the blockchain data with consumption price, location and time are automatically synchronized to each node and cannot be tampered with. When the system finds data updates, it is up to the individual to decide whether this data needs to be reimbursed. If reimbursement is required, then this application will be sent from the personal side to the company side. The company also does not need to re-compare with the data on the nodes. It only needs to approve whether it is a reasonable expenditure. At this point, the personal reimbursement process completes [8].

Through the system established by blockchain technology, the deduction of personal income tax can be separated from the company and self-assessment of taxes can be realized. The discussion above indicates that China's personal income tax payment is relatively backward. The way to earn income has changed a lot. Most people are not limited to just one single contract-signing job, various non-contractual jobs such as scattered labor and home tutoring are also the critical ways to earn incomes. A moderately prosperous society will be achieved in China by 2020. With the personal income of residents having been increased gradually and in the context of national economic development, tax payment methods are supposed to be improved with the times.

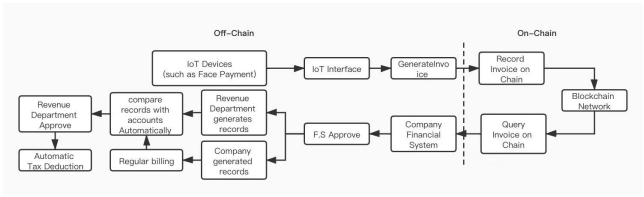

Figure 6. Non-inductive reporting and tax deductions link based on blockchain

After the establishment of tax deductions link based on blockchain, individual fees and incomes associated with other nodes can be written into the data block in detail. According to the time node specified by the company for the reimbursement of employees, individuals can choose to reimburse the items in the consumption list. Based on the relevant regulations of the company, the system will increase the repayment balance and confirm whether the tax result of the reimbursement item is correct. If it is wrong, it will be returned and the reimbursement process will be resumed. When someone deliberately falsifies reimbursement data or tries to tamper with information, the blockchain reimbursement system will be able to track and compare relevant information. If it is determined to have been tampered with for illegal purposes, the system will automatically synchronize to the taxpayer's credit record, further limiting reimbursement invoice limits, etc. At the same time, because the credit history is linked to other credit systems in the society if the company maliciously forges reimbursement data to deduct tax, the system can also disclose the untrusted information of the company and synchronize it to other credit information systems through the blockchain. law enforcement agencies can use the data recorded by the blockchain as direct evidence to require them to make up for taxes or carry out

related administrative and criminal penalties. Therefore, to a certain extent, can reduce the incidence of corporate tax evasion and crime.

Based on the discussion above, the manual link and process processing time of the personal reimbursement and the company's tax deductive actions will be significantly reduced. On the basis of a non-sense invoice reimbursement system, it is more dependent on the blockchain, an automated business chain for technical processing. It achieves the reduction of the operational risk, facilitate personal reimbursement and corporate tax deductions. At the same time, it creatively realized the functions of liquidation supervision in the taxation department and backup accountability after the fact.

4.3 Using blockchain technology to achieve a single reimbursement for blockchain invoices

Therefore, according to the discussion above, we can summarize the overall unindicative reimbursement link diagram of Figure 7 below. For individuals, it is completely possible to achieve completing the clearing and reimbursement processes at the time of consumption without the contact with reimbursement invoices.

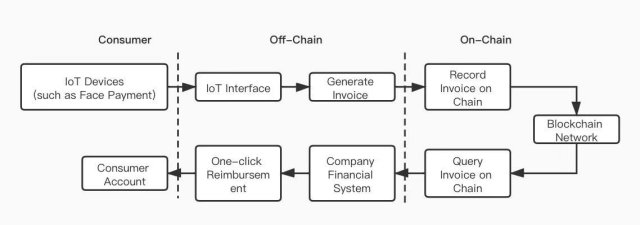

Figure 7. Non-inductive invoice reimbursement link based on blockchain

5. SYSTEM ARCHITECTURE

Blockchain nodes provide three service modules-push service, query service and write service, which is shown in Figure 8 below:

•Push service means that after the invoices are issued, the invoices are directly pushed to the company, which filled by consumers and entered into the company's financial system. After confirmed by the company's financial system, the reimbursement information will be uploaded through the write service.

•Query service provides on-chain invoice inquiry for individuals and companies.

•Write service includes two aspects, one aspect is to connect IoT (Internet of Things) devices and nodes, providing "insensitive invoice upload". For example, after consumption in a restaurant, the invoice is automatically generated and chained in the background. The other aspect is that after the existing invoices are reimbursed by the company's financial system, the status will be updated to having been reimbursed and thus eliminate the possibility of repeated reimbursement.

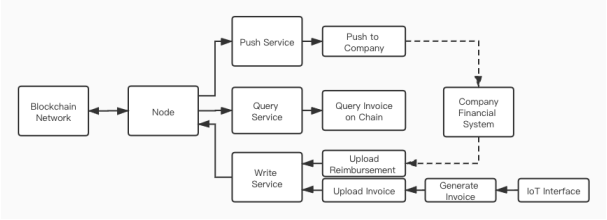

Figure 8. The structure of non-inductive invoice reimbursement system

6. CONCLUSION AND OUTLOOK

There are various restrictions on ordinary invoices and thus blockchain technology is a revolutionary change to ordinary invoices and even the entire tax system. However, blockchain electronic invoices are not 100% perfect, the non-inductive invoice reimbursement system cannot be established within two or three years.

Firstly, blockchain technology is not fully mature. Currently, blockchain technology is still in its early stages. The blockchain electronic invoice has just been launched into the market and it has only been a little over a year. How to achieve the popularity of blockchain electronic invoices under the background that the national electronic invoices have not been fully promoted is remains a question. Moreover, the non-sense invoice reimbursement system is still a theoretical setting, how to set many tax bureaus, merchants, companies and individuals as nodes, and how to chain various software and bus cards yet had not a clear plan. If it is chained nationwide, a large amount of data needs to be stored. The data processing speed also must be fast, otherwise delay problems may occur. On the other hand, blockchain technology cannot guarantee absolute security, the global Bitcoin ransomware incident on May 12, 2017 and the 2018 Iranian hacker extorted the US $ 6 million bitcoin incident at the United States Concord Hospital are difficult to track down the true murders due to the confidentiality of the blockchain. Therefore, if blockchain technology is used to commit crimes, the consequences will be disastrous. Because of this, how far does blockchain technology need to go before it can be applied to taxation needs further discussion [9].

Secondary, relevant laws should be improved. The combination of blockchain technology with electronic invoices and the tax system means the old laws cannot be continually used. Furthermore, combining related technologies to improve relevant laws also lays the foundation for the development of the non-sense invoice reimbursement system.

Thirdly, there remains the risk of facial payment technology. Although Alipay has launched the face payment function for a few years, meanwhile, in recent years, all kinds of supermarkets have also set up trials for face-to-face payments, some people also have doubts about this technology. A lot of information is circulating on the market today. Therefore, if facial information is stolen by criminals, it is likely that a large number of vicious incidents involving bank cards used by criminals will occur. News has emerged that 170,000 pieces of face information have been sold

online after the development of facial payment technology. Therefore, it is necessary to improve the sensitivity of face recognition, improve the security of face brushing payment and formulate relevant laws to protect people's rights in order to make "face brushing payment" be widely accepted by the public.

Finally, public awareness of paying taxes is supposed to be strengthened. Some people do not realize the importance of paying taxes until they are in high school or even college. The collection of personal income tax in China is generally paid through the company. However, the income earned by some sideline businesses such as tutoring is not included in the scope of collection of personal income tax. Because the sideline wages are obtained through private transfers or direct cash rather than in the form of company or business wages and the system cannot track the specific situation of the sideline, this part of income can only be paid relying on individuals' tax awareness. Therefore, the government should popularize tax law knowledge and enhance tax awareness. Not only relying on the individual's own moral constraints, the government and relevant department organizations should also carry out related activities to publicize and cultivate public awareness of paying taxes, especially in the taxpayers' childhood.

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