Journal of Global Information Management
Volume 30 • Issue 11

Analysis of Safe Storage of Network Information Data and Financial Risks Under Blockchain Combined With Edge Computing

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ABSTRACT

To discuss the control of financial risks (FRs) under blockchain (BC) and improve network information security (NIS) and data security, edge computing (EC) combined with BC is proposed to control the risks of the big data (BD) financial system. Firstly, the BC-based financial system is introduced, and the characteristics of BC such as decentralization, tamper-resistant, and smart contract are analyzed. Secondly, the development status of NIS and the characteristics of marginal computing are explained, and the control model of NIS is established. Then, EC is used to encrypt the identity authentication system to ensure data security, and the BC-based FR evaluation model is established. Finally, a questionnaire is designed regarding the NIS model, and the results are analyzed. A simulation experiment is conducted regarding the index evaluation of the BC-based FR evaluation model. The experimental results indicate that network personnel control, environment, and technology have positive effects on NIS, and the impact factors are 0.26, 0.24, and 0.33, respectively.

KEYWORDS

Blockchain, Data Security, Edge Computing, Financial Risk, Network Information Security

INTRODUCTION

In the current era of network information, data, which contains massive important information, has become the main source for people to obtain information. Moreover, data transmission and storage are very convenient, which can help people achieve fast, effective and accurate information transmission (Mobashar et al., 2021). Furthermore, the data age will also produce many security problems. In the Internet age, data are being produced all the time, and the storage, encryption and transmission of data may be subject to malicious attacks (Liu and Ye, 2021; Liu et al., 2022; Lv et al., 2022). In addition, databases, edge devices, and cloud storage have great security risks and are vulnerable to attacks such as hackers and Trojans. Once the data is damaged and polluted, it will cause serious information loss (Mukherjee et al., 2021; Sun et al., 2022; Sheng et al., 2022). To ensure the network information security (NIS), effective security measures must be taken to store data. Encrypting data

DOI: 10.4018/JGIM.312580 *Corresponding Author

according to its security level is a very effective method (Indrakumari et al., 2021; Wang et al., 2022; Yang et al., 2022).

In addition, the identities of visitors and administrators of the data storage system must be identified. Different permissions should be given to different visitors, so that low-level managers can't modify and encrypt data, thereby preventing data leakage and pollution and strengthening the protection of private data (He et al., 2021; Jan et al., 2021; Cao et al., 2021; Sun et al., 2021; Liu et al., 2020). In recent years, the concept of blockchain (BC) has been gradually accepted. Data storage system based on BC has a good advantage in dealing with single point of failure. However, how to build a secure and efficient network storage system based on this advantage is the main problem to be solved at present (Huang et al., 2021a; Yang et al., 2021; Yan et al., 2021; Li et al., 2022). The access of Internet of Things (IoT) adoptions on edge nodes can ensure the bidirectional identity security of the system and data sources collected by IoT, and improve the security of network storage.

The NIS and financial risks (FRs) are analyzed regarding the BC. The NIS model is established from three aspects, i.e., network control personnel, environment, and technology which affect data security, and a questionnaire is designed to propose hypotheses. At the same time, the evaluation index system of FR is established, and the risk evaluation of financial system under BC is carried out by using edge calculation and dynamic theory. The resource allocation and operation efficiency of the financial industry are optimized to ensure the sustainable development and long-term stability of the financial industry. The innovation lies in the use of edge computing (EC) to encrypt the network identity authentication system, and from the perspective of dynamics, FRs are correctly evaluated by establishing first-level evaluation indexes and calculating weight values. After BC is introduced into traditional network information system, NIS storage mode is enhanced, and FR assessment model is established, which plays a positive role in accelerating the progression of BC in the era of data, and has reference significance for the research of FR control. The research innovation point is combining BC with EC, so as to improve the performance of the system and effectively address the issue of financial security.

The structure of the article mainly includes four parts. Firstly, the latest research in the relevant research field is summarized, the existing problems in the current research are analyzed, and the research method of this work is explained. Secondly, the research theory and method involved in the research are explained, the method of solving the problem in this work is explained, and the experimental path of the research is designed. Then, combined with the collected information and data, the method designed in this work is tested to verify the effectiveness of the design method in dealing with the corresponding problems. Finally, the research conclusions are summarized, and the limitations of current work and future work prospects are analyzed.

RECENT RELATED WORK

Relevant researchers have carried out extensive work on the adoption of BC and EC. Firdaus and Rhee (2021) explored the use of EC to address the increasing system complexity and data storage issues in intelligent transportation systems. BC and smart contracts were applied to create a trustworthy environment for secure data storage and sharing. It was proven that it can defend against system failures with or without symptoms to achieve consensus among consensus participants. Moreover, the use of incentive mechanism can promote the continuous operation of the system. Zhang et al. (2021a) studied the joint adoption between BC and multi-access EC. BC is an information storage, dissemination, and management mechanism that enables the reliable transfer of data. Multi-access EC can realize high frequency interaction and real-time transmission of data. Therefore, it is of great significance to combine the two technologies to analyze the multi-access EC network of BC. Then, problems related to resource integration architecture and resource management were summarized, and the adoption prospect of this technology was explored. Hu et al. (2021) explored the adoption of BC and EC to organic agricultural supply chain (SC). The immutability of BC and the paradigm

of EC were utilized, and the trust framework was constructed to reduce the cost and enhance the operational efficiency of organic agricultural SC. Through the classification of stakeholders, a novel consensus mechanism was adopted to manage information flow, which can significantly improve performance and reduce costs.

A storage system is a big data (BD) infrastructure. To better serve upper-layer adoptions, the storage system must meet data security requirements to the maximum extent. However, traditional storage systems rely on the central server for encryption, backup, and audit operations. The centralized functions of the central server can't ensure the storage security of BD. In the present stage, the control of FRs still needs to be improved. Therefore, the NIS model is established from three aspects: network controller, environment, and technology that affect data security, and the NIS and FRs are discussed.

RESEARCH ON NIS AND FR UNDER BC AND EC

The Adoption of BC in the Financial Field

BC is a specific encryption mathematical algorithm. Each transaction information is encrypted and recorded in the data area (including six two-characters, five two-English lowercase letters, and ten Arabic numerals). The data structure is connected in a chain structure. The BC records and updates data blocks in a distributed multi-point manner and determines the security of the data blocks with a specific password. Technically, a BC connects data blocks into a chain with a hash function to store and verify data and utilizes a distributed node consensus algorithm to generate and update data. The modeling will be broadcasted in a comprehensive system to guarantee transmission security. It is a novel type of distributed database, which makes it difficult to tamper with encrypted accounts (Piao et al., 2021; Meng et al., 2022; Sui et al., 2020; Lei et al., 2021). Regarding the operating mechanism of BC in the upper region, the technical specifications of BC are as follows.

Decentralization and consensus mechanism are explained as follows. Decentralization is the most notable feature of BC. There is no powerful central node in the BC to set rules, unify accounts, and maintain accounts. Accounting rules are public (Deb and Roy, 2021; Ma et al., 2021; Zheng et al., 2021a).

It can't be tampered with and it is easy to check. The BC employs a hash function to encrypt data. Each data block contains the data of the last block, the current transaction, and transaction time. Therefore, for a new block, if the function value of the last block is verified equal to the value of all accounts before verification, the BC formed in this way is relatively easy to verify (Yin, 2021; Zheng et al., 2021b).

Smart contract belongs to the field of traditional contract, and smart contract is a self-executing program. It can be triggered by the triggered program, and the relationship between the contracts will be executed automatically without human intervention. Intelligence is an important feature of regional chain technology (Huang et al., 2021b; Yu et al., 2021; Kong et al., 2021; Zhao et al., 2021).

As the underlying technology of Bitcoin, the BC has set off an upsurge of investment in financial science and has been welcomed and sought after by the global society. BC is considered a revolutionary nuclear technology with the most advanced revolutionary nuclear technology after the Internet. In all fields, there is a flourishing adoption field of BC. Supply chain finance is a multi-participant and relatively closed environment, with controllable and data support, combining the characteristics of BC itself (He, 2021). BC ensures the authenticity of the transaction background, the determination of the debt-debt relationship, the authenticity of financing needs, and the traditional SC finance such as logistics, capital flow, etc. In addition, the adoption of BC to SC finance is closely integrated. Coordinated development solves many problems encountered in SC finance, reduces bank risk control costs, and addresses insufficient credit for small and medium-sized enterprises in the SC. Then, high-quality core enterprises idle bank credit lines to these enterprises, which realizes the circulation of trust in the entire chain. BC is introduced into the SC financial business. It is possible to avoid or control the related risks in the operation of traditional SC financial business through

multi-party collaboration and accelerate the development of the financial market. BC itself facilitates the penetration of supervision and the operation of asset securitization directly through the end of the asset. Then, it can realize the separation of main credit rating and project rating, invest funds in target assets, and solve related issues such as own development funds (Ye et al.; 2021; Zhang et al., 2020; Zhang et al., 2021b; Zhang et al., 2022; Djuitaningsih & Arifiyantoro, 2020).

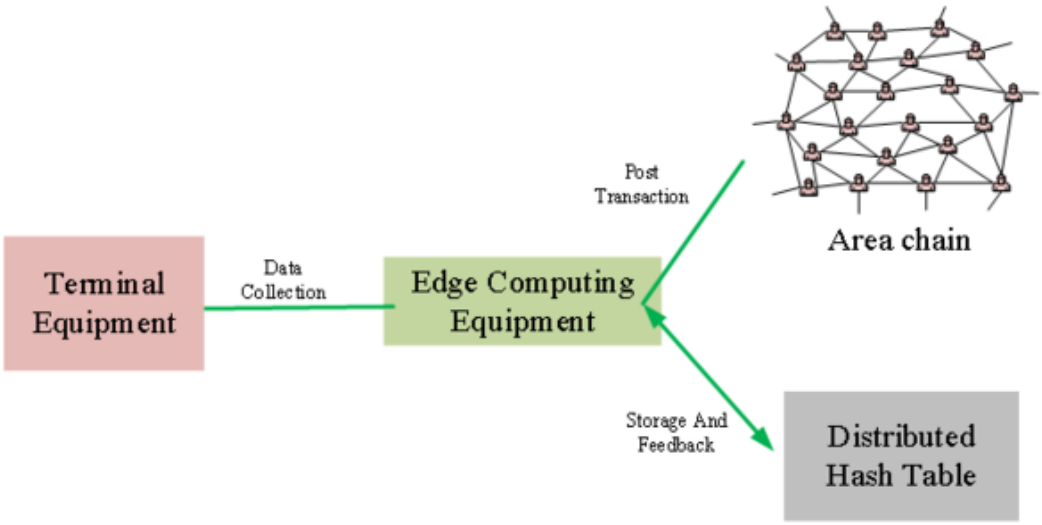
Application of EC in FR

BC and computer technology are both hot research fields in the information age. Although both ultimately lie in the communication between two hosts, computer networks mainly focus on information communication between hosts, and extend the adoption layer, transmission layer, network layer, physical layer, and data link layer models (Dey and Shekhawat, 2021). BC can not only realize information exchange between hosts while satisfying the above five-layer model, but also achieve credit flow through relevant algorithms. The key technology involves NIS technology, among which the secure storage of data is one of the most successful fields (Kadadha et al., 2021). China's economic development is shifting from high-speed growth to medium-speed and high-quality growth now. In the process of transformation, the most important thing is to support the real economy and control the virtual economy. For the progression of the financial industry, reasonable reform is also needed to help the financial industry reduce the virtual component.

The feasibility of introducing BC into the financial industry is that the advantages of decentralization can be brought into play (Boubeta et al., 2021), and reasonable control can be carried out in combination with the characteristics of FRs to ensure the sustainable prosperity of the financial industry. With the help of EC capabilities, the unique advantages of BC can be deployed and promoted. BC platforms and adoptions can be deployed on EC platforms to provide BC services to users. At the resource level, BC can share EC node resources with business adoptions to save cloud resource overhead. BC nodes and adoptions are rapidly deployed on edge nodes/edge clouds in the form of software, which has the advantage of high deployment efficiency. EC has obvious advantages as follows when compared with traditional cloud computing.

1. **Low delay and high real-time:** The edge device is far away from the central server and located at the boundary of the whole data system, so it is close to the data source. Data can be processed at the first time when received, which is then transmitted to the central server. The advantage is that it can lighten the pressure on the central server, speed up the time of data transmission, and enhance the efficiency of the central server (Du, 2022).
2. **Reduce power consumption:** The preprocessing of data by edge devices can share some functions of central server, greatly lighten the operating pressure of central server and cloud database, and decrease the power consumption of network broadband.
3. **Reduce the risk of centralized data storage and increase the system fault tolerance rate:** As there is no need to upload data to the cloud server for centralized processing, part of the storage space can be released to improve the system running speed. To deal with complex problems, more space can be vacated to avoid system locking phenomenon, improve fault tolerance rate, and achieve data storage security. In addition, because edge devices are far from the central server, data is stored locally, which greatly reduces the risk of data leakage. The protocol model under BC and edge calculation is illustrated in Figure 1.

Figure 1. Protocol model based on region chain technology and EC



NIS Control Mechanism Model in the Context of BD

In the context of BD, NIS faces serious security issues. The establishment of a NIS control mechanism is important for clarifying the internal mechanism of NIS in the context of BD. Practical guidance must be provided for NIS work (Huang et al., 2021c). The analysis of NIS control elements is as follows:

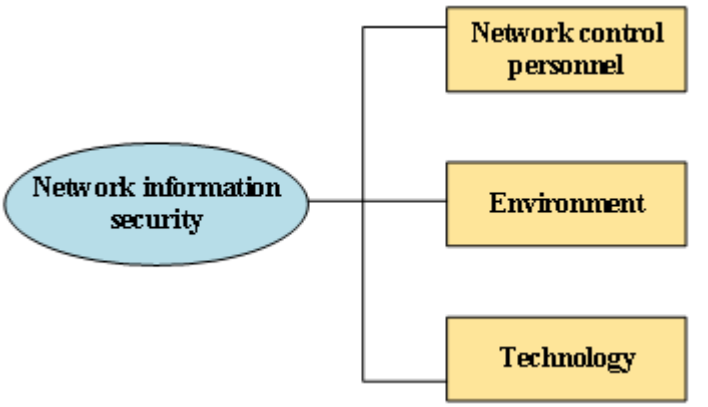
1. **Staff layer:** Since the network information behavior of network users is the root of NIS problems in the NIS control mechanism, and to protect NIS is to protect the legitimate rights and interests of network users, system security management personnel are the core in the NIS control mechanism. The personnel layer is decomposed into network users, network managers, network information service providers, and hackers and attackers who threaten NIS. Personnel in the NIS control mechanism are classified into network controllers and network security managers (Wang and Li, 2021; Thapa et al., 2020; Ibrahim et al., 2018).
2. **Environmental layer-environmental support:** The environmental layer constructs a secure network environment in various ways and plays an environmental support role in the mechanism in the NIS control mechanism. Network facilities are the cornerstone of the Internet environment, and the normal operation and maintenance of network facilities is the basic guarantee for NIS. In the context of BD, the rapid development of IT technologies such as the IoT and cloud computing has challenged the carrying capacity and computing power of existing network facilities (Liu, 2021).
3. **Technical layer-technical support:** The technical layer uses various security technologies to construct a protection layer for NIS in the NIS control mechanism, which plays a role of technical support in the mechanism. The main function of security protection is to protect user privacy and data security and prevent information leakage, which is a very important link in the network security system (Li et al., 2021).

Establishment of NIS Control Evaluation Model

The NIS control evaluation index system is a complex, relevant and highly integrated system, involving hardware and software, with both external and internal influences. Various factors influence and restrict each other, so the evaluation index can reflect the entire content of information security from

all sides (Luo et al., 2021) The NIS control mechanism under BD takes the three elements of "network controller", "environment" and "technology" as the basis. Therefore, before the construction of the evaluation system, a NIS control evaluation model is constructed to verify the degree of influence of these three elements on NIS, which is illustrated in Figure 2.

Figure 2. NIS evaluation model structure



Three hypotheses are proposed for the evaluation model as follows:

H1: Network controllers have a positive influence on NIS.
H2: The environment has a positive impact on NIS.
H3: Technology has a positive impact on NIS.

To verify the hypotheses, a questionnaire is fabricated for empirical research, which takes the form of Likert's seven-level scale, and relevant questions about the three variables of "network controller", "environment", and "technology" are asked in the research model. The questionnaires are issued in relevant departments of NIS work. A total of 300 questionnaires are distributed and 294 questionnaires are returned. After invalid questionnaires are excluded, 285 valid questionnaires are obtained, and the recovery rate is 95%.

Financial Risk Evaluation Model Based on BC

As an emerging technology, BC is introduced into the financial system to solve many financial problems via its own characteristics. However, the adoption of BC often poses huge risks. The evaluation of FRs under the BC is a very complex and major problem. As there are many evaluation indexes in the financial system, and the indexes at each level influence and restrict each other, it is necessary to evaluate each index by a combination of qualitative analysis and quantitative statistics to achieve a scientific and reasonable evaluation. Qualitative analysis refers to evaluating the vagueness of the index, and quantitative refers to calculating the relative weight of the index. Then, dynamic analysis is carried out according to the weights, and the influence of all levels of indexes is determined (León and Ñíguez, 2021)

The "edge" in EC is a relative concept, which mainly refers to any resource in the network except the cloud. Regarding the basic functions such as data collection, terminal equipment can perform predictive analysis and intelligent processing (Ding et al., 2021), which has accelerated network marginalization. The existing EC architecture mainly includes three levels: terminal equipment, edge

server, and cloud. With the support of technologies such as network virtualization, collaborative perception, and concurrency control, a variety of adoption services can be provided to the terminal side in time (Yang, 2021).

Identity authentication is a prerequisite to ensure the safe operation of the EC environment. Since the EC environment is essentially a distributed network, identity authentication usually involves multiple trust domains. Therefore, the related research on identity authentication includes single domain authentication, multi-domain authentication, and handover authentication (Selvaraj et al., 2021).

Identity authentication and registration phase of edge devices are explained as follows:

1. The edge device generates a random number R_e and at the same time generates a public key and private key pair PK_e / SK_e, where the public key is public and the private key is kept secret.
2. The BC generates a random number R_c and at the same time generates a public key and private key pair PK_c / SK_c, where the public key is public and the private key is kept secret.
3. The edge device uses the public key of the BC PK_c to encrypt the random number R_e and generates a cipher text Z_e, with a timestamp T_{Se}, and then sends it to the BC. The cipher text generation equation is as follows:

$$Z_e = En_{PK_c}\left(R_e\right), T_{Se} \tag{1}$$

4. The BC uses the public key of the edge device PK_e to encrypt the random number R_c and generates a cipher text Z_c, with a timestamp T_{Sc}, and then sends it to the BC. The cipher text generation equation is as follows:

$$Z_c = En_{PK_e}\left(R_c\right), T_{Sc} \tag{2}$$

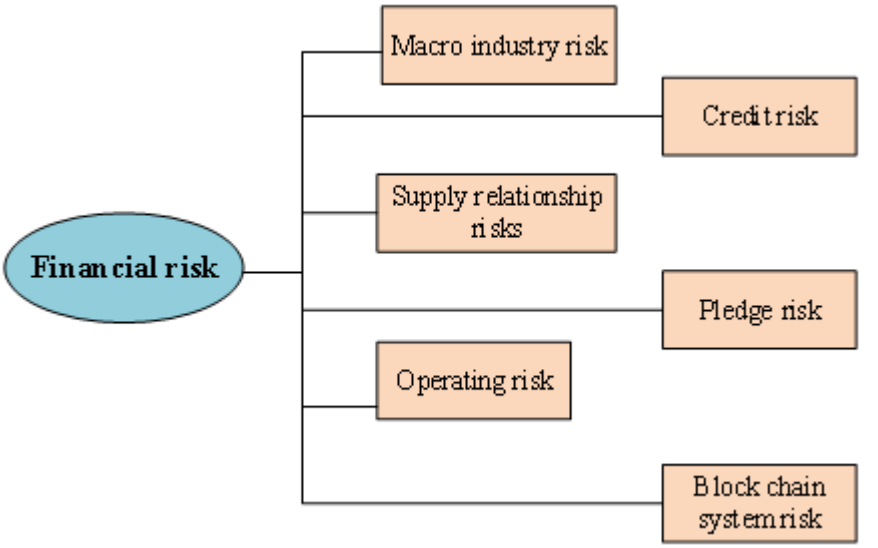
5. The edge device uses its own private key SK_e to decrypt the ciphertext Z_e and obtain the random number Z_c. The BC uses its own private key SK_c to decrypt the ciphertext Z_c and obtain the random number Z_e.
6. The edge device and the BC both receive each other's random numbers at the same time, and then use the XOR operation to combine the two random numbers into one random number (Sun and Lei, 2021):

$$N_{ec} = R_e \oplus R_c \tag{3}$$

The BC saves this random number. When subsequent edge devices need to access the BC for transactions, there is a need to show the random number to verify their identity. This encryption method ensures the security of the data (Gross et al., 2021).

Financial risks are mainly evaluated regarding macro and industry risks, credit risks, SC relationship risks, pledge risks, operational risks, and BC system risks (Ülgen et al., 2021). The specific structure is illustrated in Figure 3.

Figure 3. The impact structure of FRs



It is assumed that the total risk of the system is *E*, these six main factors are set as the first-level index E_i, the second-level index is E_{in}, and the third-level index is E_{in}. The impact of secondary impact indexes on primary indexes is determined by quantitative processing (Tendilla et al., 2021). Each secondary index can form a judgment matrix based on the fuzzy judgment of mutual importance. According to the matrix, the importance of the index is calculated to complete the evaluation. It is supposed that the order of the judgment matrix of E_i is *m*, and E_{cd} is the ratio of the importance of the third-level index to the second-level index (Tsurugizawa and Yoshimaru, 2021). The expression equation is as follows:

$$c = \left(b_{cd}\right)_{mm} = \begin{bmatrix} b_{11} & b_{12} & \cdots & b_{1m} \\ b_{21} & b_{22} & \cdots & b_{2m} \\ \vdots & \vdots & \cdots & \vdots \\ b_{m1} & b_{m2} & \cdots & b_{mm} \end{bmatrix} \tag{4}$$

Then, the relative weight of the secondary indexes is calculated, and the weight corresponding to each secondary index is set as W_{inm}. The product of each row element of the matrix is as follows:

$$M_C = \prod_{d=1}^{M} b_{cd} \tag{5}$$

$$\overline{W_{inc}} = \sqrt[m]{M_c} \tag{6}$$

The normalization process is as follows:

$$W_{inc} = \frac{\overline{W_{inc}}}{\sum_{k=1}^{m} \overline{W_{inc}}} \tag{7}$$

According to the relevant information and the opinions of financial practitioners, the relative importance of each index is sorted out, and the weight of the index is calculated regarding the importance.

To test the feasibility of the simulation system, the simulation is implemented. The weight of risk point and the value of risk comment come from the review of relevant reference documents. The theoretical research of the predecessors is referred to, which is analyzed to get the initial value of the system risk evaluation.

EXPERIMENTAL RESULTS AND ANALYSIS

Analysis of NIS Questionnaire Outcome

To test the rationality of the NIS system evaluation model, a credibility analysis of the questionnaire is implemented. After the collected questionnaire data are sorted out, invalid questionnaires and questions with factor loads less than 0.6 are eliminated. Then, the confirmatory analysis is implemented to process the questionnaire survey data, and the results are illustrated in Figures 4-6.

Figure 4. Model parameter estimation of questions in questionnaire

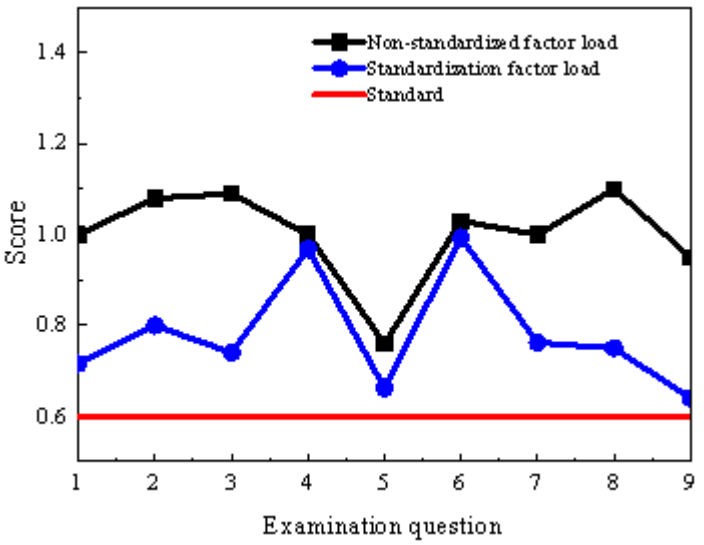


Figure 5. The standard error (S.E.) and consistency (C.R.) test of the questionnaire

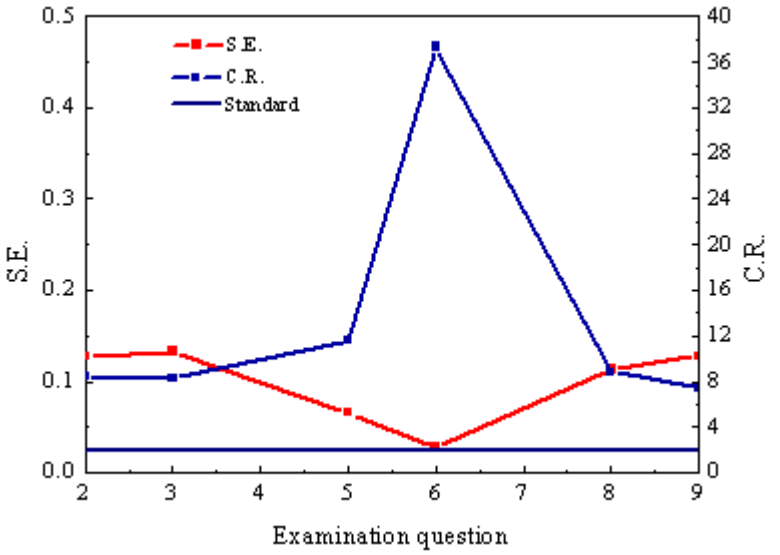
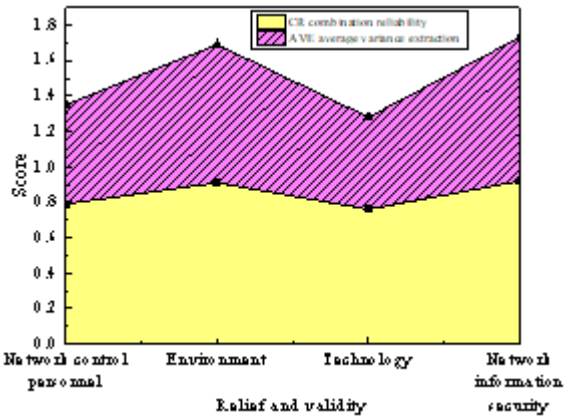


Figure 6. Reliability and validity of the questionnaire



From Figure 6, C.R. is the critical ratio. When the absolute value of C.R. is superior to 1.96, the *P* reaches the significance level of 0.05, marked as "*". When it is superior to 2.58, the *P* reaches the significance level of 0.01, marked as "**". When it is superior to 3.89, the *P* reaches the significance level of 0.001, marked as "***". In the analysis process, items with a standard load below 0.6 are considered as insufficient validity and deleted. The remaining three items in each dimension are the observation variables.

The standard error (S.E.) of all observed variables in the model under the model's unstandardized estimation greater than zero means no collinearity problem for each observed variable. The absolute values of the critical ratios are all greater than 1.96, and all the *P*s reach the 0.001 level, proving that the significance of the correlation between each observed variable and the dimension to which it belongs meets the standard. SMC is the multivariate correlation square of the observed variable,

which indicates the degree to which the observed variable is explained by its latent variable, that is, the reliability of the observed variable. All SMCs in Table 1 are greater than 0.36, which proves that the reliability of the model meets the standard. CR is the combined reliability, and the combined reliability is greater than 0.7, which proves that the observation variables of the same dimension have good credibility, indicating that the internal quality of the model is ideal. AVE is the average variance extraction amount, which is a convergence validity index. The larger the AVE, the more effectively the observed variable can reflect the potential characteristics of the common factor dimension. Generally, the AVE is required to be greater than 0.5, and the AVE of each dimension in Figure 6 meets the standard. Table 1 shows that the results of the confirmatory analysis meet the requirements of reliability and validity, proving that the quality of the questionnaire data is good, and the next data processing can be carried out.

Hypothesis Test Result

The structural equation output report of the NIS model questionnaire contains the model's fitness index, as illustrated in Table 1.

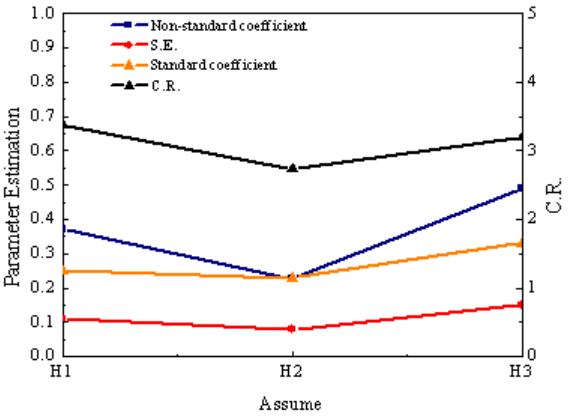
Table 1. Appropriate indexes

Model fit index	Chi-square	Degree of freedom	Chi-square/degree of freedom	RMSEA	GFI	AGFI
Statistics	101.74	48	2.12	0.074	0.925	0.873
Optimal standard value	-	-	<3	<0.08	>0.09	>0.09
Fitting condition	-	-	Good	Good	Good	Acceptable

In Table 1, the lower the chi-square (χ^2), the better the fit between the model's causal path diagram and the actual data. The lower the ratio of chi-square to degrees of freedom, the better the covariance matrix of the hypothetical model fits the observed data, and the general requirement is less than 3. GFI is the fitness index. The higher the GFI, the fitter the model is. GFI is usually required to be greater than 0.9. AGFI is the adjusted fitness index, and its requirements are the same as GFI. RMSEA is the mean square and square root of the asymptotic residuals, which is between 0.05 and 0.08 in this model, which indicates that the model is well adapted. According to the results of the fitness index, the good fit of the structural equation model shows that the model construction is reasonable and the results are acceptable and convincing.

The research hypothesis is estimated according to the fitness index, and the results are illustrated in Figure 7.

Figure 7. Research hypothesis estimation results



From Figure 7, all relevant parameters of the research hypothesis meet the significance standard, so all the research hypotheses are valid.

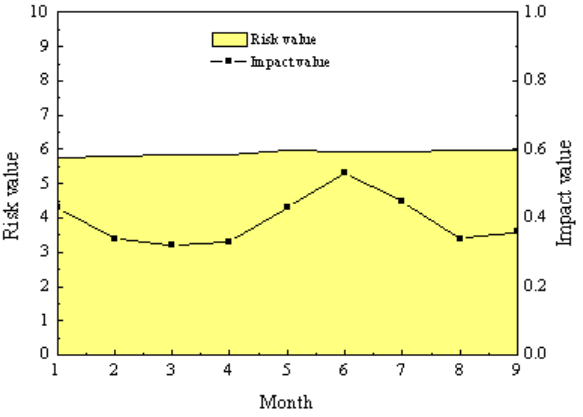
H1: Network controller has a positive influence on NIS, and the influence coefficient is 0.25.
H2: Environment has a positive influence on NIS, and the influence coefficient is 0.23.
H3: Technology has a positive impact on NIS, and the influence coefficient is 0.33.

Thus, all the three influencing factors of technology, personnel, and environment have a certain positive effect on NIS in the established NIS control model. The network security model is scientific, and the influence coefficient can be used as the evaluation standard of the model. Finally, the NIS is ensured by controlling these three aspects.

Financial Risk Evaluation Analysis Based on BC

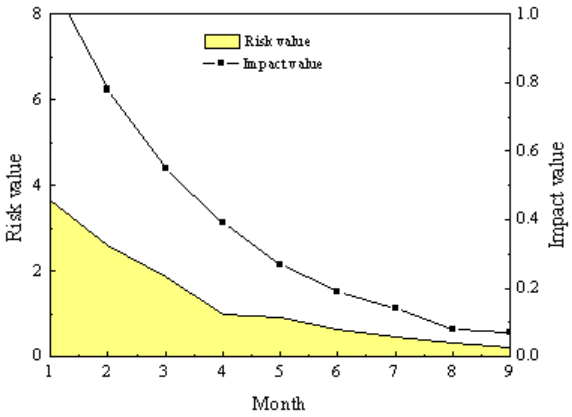
The simulation experiment is conducted according to the evaluation index and weight of the BC FR. According to the experimental results, the change trend of the macro industry risk level over time is illustrated in Figure 8.

Figure 8. Changes in macro-industry risk levels



From Figure 8, the transformation of macro industry risks is not obvious, showing a flat trend on the whole. From January to September, the risk level and impact value change very little. The main reason may be that the macro economy keeps steady growth and there is no great fluctuation in the short term, so the FR shows little fluctuation.

Figure 9. The changing trend of credit risk

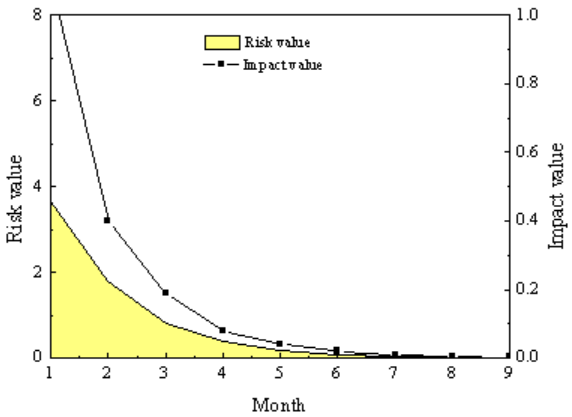


The variation trend of credit risk level over time is illustrated in Figure 9.

From Figure 9, the credit risk has a rapid downward trend over time, the initial risk is relatively high, and the impact value is also high. With the passage of time, the financial system under the BC has gradually stabilized, and cooperation in the financial market has begun to accumulate a certain amount of credit. At the same time, the credit value is transmitted under the BC system, forming a virtuous circle, which will ultimately greatly reduce the credit risk and keep it at a very low level. The unique decentralized and intelligent algorithms of BC can help reduce credit risks of the financial system.

The trend of SC relationship risk level over time is illustrated in Figure 10.

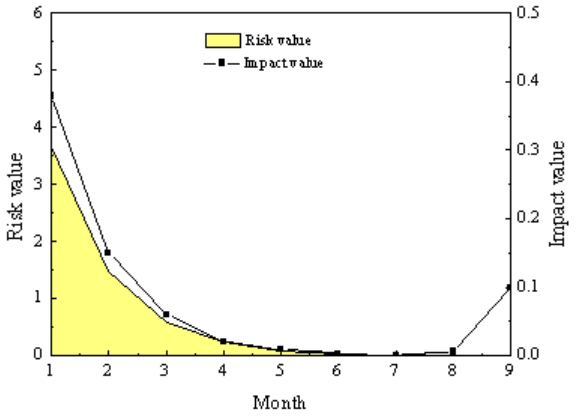
Figure 10. Changes in SC relationship risk levels



From Figure 10, the SC relationship risk, like the credit risk, will gradually decrease over time, and the impact value will also decrease. It is mainly due to the establishment of cooperative relations. The SC will form a fixed supply and marketing model and quantity based on stable cooperative relations and credit value. The losses caused by short supply and oversupply will also gradually decrease, and will eventually be in a controllable range, thus reducing the risk of the SC.

The trend of the pledge risk level over time is illustrated in Figure 11.

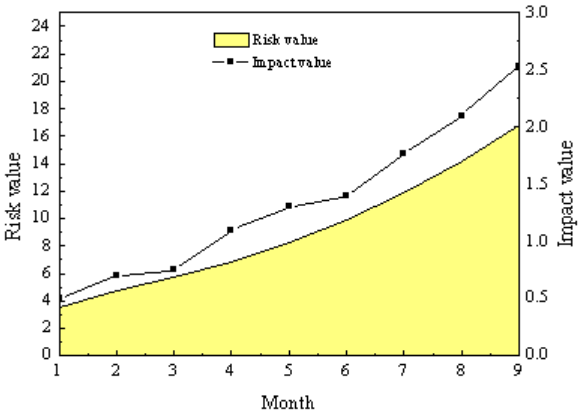
Figure 11. Changes in pledge risk level



From Figure 11, the pledge risk of the BC decreases over time. Due to the decentralization advantage of BC, the central layer is skipped in financial transactions, and the source information, production batches, and processing techniques of commodities can be traced and inquired, which ensures the quality of the pledge and greatly reduces the risk.

The trend of operational risk level over time is illustrated in Figure 12.

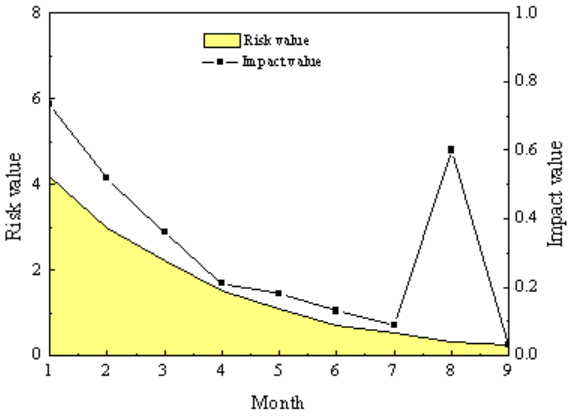
Figure 12. The changing trend of operational risk level



From Figure 12, the operational risk increases with time, and the impact value also increases. The possible reason is that the development and maturity of BC has made the financial system enter a stage of large-scale BC boom. More and more operators have begun to get involved in the BC, which has expanded the entire ecosystem. As the number of operations increases, errors will increase, resulting in a greatly increased operational risk.

The trend of the risk level of the BC system over time is illustrated in Figure 13.

Figure 13. Changes in the risk of the BC system

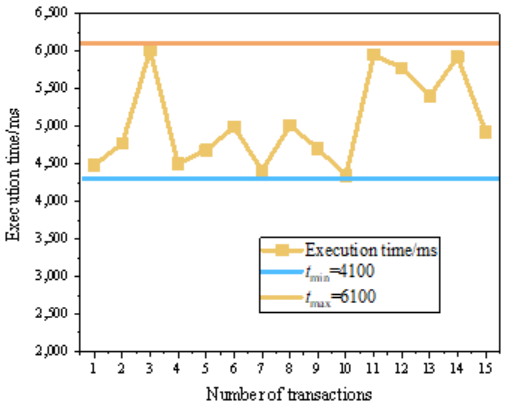


From Figure 13, the change of the BC system risk decreases with the passage of time. It is mainly due to the gradual maturity of the development of the BC, and the inclusiveness and practicality of the financial system have been greatly enhanced. In addition, its algorithms and mechanisms are constantly improving and optimizing, which gradually reduces the risk of the BC system.

Model Performance Test

To verify the execution time of data processing based on EC and region chain technology model, the transaction execution time is tested, and the test results are illustrated in Figure 14.

Figure 14. The execution time of EC combined with BC



From Figure 14, the execution time of a single BC transaction fluctuates from 4,300 to 6,100ms, and after multiple BC transactions, the overall consumption time of the protocol model shows a downward trend. The designed model based on EC and BC can ensure the security of data privacy during data transmission, with the characteristics of anti-tampering and traceability, thereby improving the security of system and network information.

DISCUSSION

With the gradual maturity of BC and BD technology, their adoptions in NIS and FR assessment will be more in-depth. At the same time, data security and FR control will continue to receive extensive attention. To improve the accuracy of FR assessment under the BC and ensure the security of financial data, a NIS control evaluation model is established via BC. Hypotheses are put forward from three aspects: network operators, environment, and technology. According to the results of the questionnaire, the three elements of network controller, environment, and technology all have a positive impact on the NIS system, and the impact factors are 0.26, 0.24, and 0.33 respectively. The IoT based on EC combined with BC can well meet the requirements for data security and consistency in FRs. Compared with similar research, this research can better deal with related problems and improve the NIS (Stephens et al., 2021). In the data interaction process of edge nodes, the real-time synchronization of data can be ensured in the synchronization of data across nodes, and the data computing requirements can be responded in time through EC to meet the requirements of data interaction timeliness in NIS.

CONCLUSION

Regarding the NIS, a FR evaluation model based on edge calculation is established from the perspective of dynamics. Secure data in the financial industry is guaranteed through authentication key encryption of edge devices and BC. Then, FRs are evaluated regarding the macro industry risk, credit risk, SC relationship risk, pledge risk, operational risk, and BC system risk. The importance of the primary and secondary evaluation indicators is used to calculate the weight. Finally, the risk and impact value are evaluated on the simulation system, and the control measures of BC FR are determined according to the risk change trend of each indicator. Disadvantages of this work is that the evaluation indicators of FR are classified as level 1 and level 2 to simplify the research steps, while in the actual situation, level 3 indicators are more sensitive to risk changes, so the evaluation set of level 3 indicators can be added in the subsequent research. However, there are still some deficiencies, and the selected indexes need to be optimized when the model is evaluated. In addition, the designed model needs to be further verified, so as to improve the effectiveness of the model to solve problems. Therefore, the research in this aspect will be strengthened in the follow-up work.

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