Research on Blockchain Carbon Asset Management System Based on FISCO BCOS

Yuhao Zhang[1], Hong Zhou[2], Jiaqi Wu[1], Weiping Deng[3], Haibo Yi[1,*]

[1]School of Artificial Intelligence, Shenzhen Polytechnic, Shenzhen, China

[2]Shenzhen Saixi Information Technology Co., Ltd, Shenzhen, China

[3]WeBank, Shenzhen, China

*Correspnding author

Keywords: blockchain, carbon, asset management, FISCO BCOS

Abstract: Blockchain technology, with its decentralized and tamper-proof nature, has found potential applications beyond digital currencies. This paper focuses on building a carbon asset management platform based on FISCO BCOS, an enterprise-grade blockchain platform developed by the Chinese company FISCO. The steps involved in building this platform include defining the requirements, setting up the network, developing smart contracts, integrating with external systems, testing and deploying, and monitoring and maintaining the platform. By combining technical expertise and industry knowledge, this platform can effectively manage carbon assets, including tracking emissions data, managing offsets, and automating carbon accounting processes. The platform's potential impact is significant, as it could streamline the carbon asset management process, improve transparency, and help organizations meet their sustainability goals. Overall, this paper highlights the importance of leveraging blockchain technology to address pressing environmental challenges and the need for continued research in this area.

1. Introduction

To provide a comprehensive background for this research on FISCO BCOS, it is important to examine the current state of blockchain technology and its applications in various industries.

Blockchain is a decentralized, digital ledger that records transactions in a secure and tamper-proof manner. It consists of a chain of blocks, with each block containing a set of transactions [1]

Each block in the chain is linked to the previous block through a cryptographic hash function, creating an unbroken chain of data. This makes it extremely difficult for anyone to alter any of the blocks without being detected, as any changes made to one block would require changes to all subsequent blocks [2].

The technology behind blockchain was first introduced as the basis for the cryptocurrency Bitcoin, but its potential applications extend far beyond just digital currencies. Blockchain can be used for a wide range of purposes, including supply chain management, voting systems, identity verification, and more [3].

Because it is decentralized, blockchain removes the need for intermediaries such as banks or governments to verify and record transactions. Instead, it relies on a network of users who collectively validate and store the digital ledger. This makes it a highly transparent and secure way to conduct transactions and exchange information [4].

FISCO BCOS is an enterprise-grade blockchain platform developed by the Chinese company FISCO (Financial Blockchain Shenzhen Consortium). It is designed to provide businesses and organizations with a secure and flexible way to build, deploy, and manage blockchain-based applications [5].

FISCO BCOS is based on a permissioned blockchain architecture, which means that access to the network is restricted only to authorized users. This makes it particularly well-suited for use cases where privacy and confidentiality are important, such as in financial transactions or supply

  DOI: 10.25236/icmmct.2023.002

chain management [6].

One of the key features of FISCO BCOS is its modular architecture, which allows developers to customize the platform to meet their specific needs. This includes the ability to choose from a range of consensus algorithms, including PBFT (Practical Byzantine Fault Tolerance) and RAFT, as well as the option to incorporate smart contracts written in multiple programming languages [7].

FISCO BCOS also includes a number of built-in tools and services to help simplify the development and deployment process. These include an integrated development environment (IDE), a smart contract editor, and a monitoring and management dashboard [8].

Overall, FISCO BCOS is a powerful and versatile blockchain platform that offers businesses and organizations a secure and reliable way to leverage the benefits of blockchain technology [9].

Carbon asset management refers to the process of managing carbon assets, which are financial instruments that represent ownership or rights to emit a certain amount of greenhouse gases (GHGs) into the atmosphere [10].

Carbon asset management involves tracking and optimizing these assets to help organizations meet their emissions reduction goals and comply with regulatory requirements related to carbon emissions. This includes activities such as measuring, reporting, verifying, and offsetting emissions [11-13].

One of the primary tools for carbon asset management is carbon accounting, which involves quantifying an organization's carbon emissions and identifying opportunities to reduce them. This may include implementing energy efficiency measures, switching to renewable energy sources, or investing in carbon offsets [14-16].

Carbon offsets are another important component of carbon asset management. They allow organizations to offset their carbon emissions by investing in projects that reduce GHG emissions elsewhere, such as reforestation or renewable energy projects. By purchasing carbon offsets, organizations can effectively balance out their carbon footprint and demonstrate their commitment to sustainability [17,18].

Overall, this article examines the potential of using FISCO BCOS platform for carbon asset management. It discusses the platform's modular structure, permissioned blockchain architecture, and built-in tools. Effective carbon asset management is crucial for organizations looking to reduce their environmental impact and demonstrate commitment to sustainability. The FISCO BCOS platform has the capability to track, optimize, and offset carbon emissions, making it a valuable solution for promoting sustainable development. Furthermore, this article provides useful insights and references for professionals involved in carbon asset management while also advancing research and practice in this area. [19,20].

2. Related work

A consortium chain is a type of blockchain network that is designed to be used by a group of organizations with shared interests or goals. Unlike public blockchain networks, which are open to anyone, consortium chains are permissioned, meaning that access to the network is restricted to authorized users. [21,22]

The main technologies used in consortium chains include:

Consensus algorithms: These are used to ensure that all nodes in the network agree on the current state of the blockchain. In consortium chains, consensus algorithms are typically designed to prioritize efficiency and scalability, since they are intended for use in enterprise settings. Common consensus algorithms used in consortium chains include Practical Byzantine Fault Tolerance (PBFT) and Proof of Authority (PoA).

Smart contracts: These are self-executing programs that automatically execute the terms of an agreement when certain conditions are met. In consortium chains, smart contracts are often used to automate business processes and reduce the need for intermediaries.

Distributed ledger technology (DLT): This is the underlying technology that powers blockchain networks. DLT refers to a distributed database that is replicated across multiple nodes in a network, making it highly secure and resistant to tampering. [23]

Identity management systems: These are used to manage user identities and permissions within the network. In consortium chains, identity management systems are important for ensuring that only authorized users are able to access sensitive information and perform transactions on the network.

Interoperability protocols: These are used to enable communication between different blockchain networks. In consortium chains, interoperability is important for enabling collaboration between different organizations and facilitating cross-border transactions.

Overall, as shown in Table 1, the main technologies used in consortium chains are designed to provide a secure and efficient way for groups of organizations to collaborate and share information. By leveraging blockchain technology, consortium chains offer a high degree of transparency and immutability, making them well-suited for use in a wide range of enterprise applications.[24,25]

Table 1 Comparing the main technologies used in consortium blockchains

Technology	Public Blockchain	Consortium Blockchain
Consensus Algorithm	Proof of Work (PoW), Proof of Stake (PoS), Delegated Proof of Stake (DPoS)	Practical Byzantine Fault Tolerance (PBFT), Proof of Authority (PoA)
Smart Contracts	Complex and customizable	Limited functionality and customization
Permission	Public access, anyone can participate	Restricted access, limited to authorized users
Identity Management	Anonymous or pseudonymous	Controlled identity management, specific permissions
Interoperability	Little to no interoperability between different chains	Higher degree of interoperability between different chains

Here is a comparison of several methods of carbon asset management:

Carbon Offsets: This method involves investing in projects that reduce greenhouse gas (GHG) emissions, such as renewable energy and reforestation projects. Carbon offsets provide a way for organizations to balance out their own emissions by supporting GHG-reducing activities elsewhere. One disadvantage of this method is that the impact of the investments may not always be fully verifiable or transparent.

Cap-and-Trade: Under a cap-and-trade system, governments set a limit on the total amount of GHG emissions that are allowed within a certain jurisdiction or industry sector. Companies are then given allowances that allow them to emit a certain amount of GHGs. If a company emits less than its allowance, it can sell excess allowances to other companies. One disadvantage of cap-and-trade is that it can be difficult to set an appropriate cap that balances environmental concerns with economic growth.

Carbon Tax: A carbon tax is a fee levied on the carbon content of fossil fuels, with the goal of encouraging individuals and businesses to reduce their consumption of these fuels. The revenue generated from the tax can be used to support climate-friendly initiatives. One disadvantage of carbon taxes is that they can be politically challenging to implement, as they can be seen as a burden on businesses and consumers.

Blockchain-based Carbon Asset Management: This method involves tracking and verifying carbon assets using blockchain technology. By leveraging the transparency and immutability of the blockchain, this method provides a secure and accurate way to track and manage carbon assets. However, the initial investment required to build and deploy a blockchain-based carbon asset management system can be significant.

Overall, as shown in Table 2, each method of carbon asset management has its own advantages and disadvantages. Organizations looking to manage their carbon assets should carefully consider their specific goals, resources, and constraints when selecting a method to use.

Table 2 Comparing several methods of carbon asset management.

Method	Advantages	Disadvantages
Carbon Offsets	Provides a way for organizations to balance out their own emissions, supports GHG-reducing activities elsewhere	The impact of investments may not always be fully verifiable or transparent
Cap-and-Trade	Provides an incentive for companies to reduce their emissions, allows for flexibility in how emissions reductions are achieved	Can be challenging to set an appropriate cap that balances environmental concerns with economic growth
Carbon Tax	Provides a clear price signal for carbon emissions, generates revenue that can support climate-friendly initiatives	Can be politically challenging to implement, can be seen as a burden on businesses and consumers
Blockchain-based Carbon Asset Management	Provides a secure and accurate way to track and manage carbon assets, leverages the transparency and immutability of blockchain technology	Initial investment required to build and deploy a blockchain-based system can be significant

3. Blockchain System Design

The design process for blockchain-based web applications typically involves the following steps:

Define the Problem: Identify the problem that the application will solve and determine what benefits blockchain technology can provide.

Choose a Blockchain Platform: Select a blockchain platform that best suits the needs of the application. Consider factors such as scalability, performance, security, consensus mechanism, and development tools.

Table 3 Design features of a blockchain-based web application.

Feature	Description
Decentralization	The application is powered by a decentralized network of nodes rather than a centralized server. This provides greater security, immutability, and transparency.
Smart Contracts	The application uses smart contracts to define the business logic of the application. These contracts are self-executing and enforceable, allowing for secure and automated transactions.
Consensus Mechanism	The application uses a consensus mechanism to ensure that all nodes in the network agree on the current state of the blockchain. Popular consensus mechanisms include Proof of Work (PoW), Proof of Stake (PoS), and Practical Byzantine Fault Tolerance (PBFT).
Transparent Ledger	The blockchain maintains a transparent and tamper-proof ledger of all transactions and data stored on the network. All users can view this ledger, providing greater transparency and accountability.
Cryptographic Security	The application uses cryptography to secure transactions and data on the blockchain. This includes encryption, digital signatures, and hash functions.
Token Economy	The application may incorporate a token economy, where tokens are used as a currency or utility within the system. This can provide incentives for users to participate in the network and help drive adoption of the application.
Interoperability	The application may support interoperability with other blockchain networks or external systems, allowing for greater flexibility and integration in enterprise settings.

Develop Smart Contracts: Write smart contracts that define the business logic of the application. This involves determining the data structures, algorithms, and rules that govern the interactions between users and the blockchain.

Build a User Interface: Design a user interface that allows users to interact with the smart contracts and access the data stored on the blockchain. The user interface should be intuitive, responsive, and easy to use.

Integrate with External Systems: Integrate the blockchain-based web application with external systems such as databases, APIs, and other web services. This allows the application to interact with data sources outside of the blockchain network.

Test and Deploy: Thoroughly test the application to ensure that it operates as expected and is secure. Once testing is complete, deploy the application to the production environment.

Monitor and Maintain: After deployment, monitor the application to ensure that it is functioning correctly and promptly address any issues that arise. As the blockchain ecosystem evolves, consider updating the application to take advantage of new features and capabilities.

Overall, as shown in Table 3, designing a blockchain-based web application involves a combination of technical expertise, industry knowledge, and careful planning and execution. By following these steps, developers can create powerful and effective applications that leverage the benefits of blockchain technology to solve real-world problems.

4. Blockchain Carbon Asset Management System Design

A framework for carbon management typically includes the following components:[25]

Carbon Footprint Assessment: Identifying and measuring an organization's greenhouse gas emissions from all sources, including direct (e.g., fuel combustion) and indirect (e.g., purchased electricity) emissions.

Target Setting: Establishing clear and measurable goals or targets for reducing greenhouse gas emissions, often using science-based criteria and/or in line with national or international climate goals.

Strategy Development: Developing a comprehensive plan or strategy that outlines actions to reduce emissions across the organization, including energy efficiency improvements, renewable energy procurement, supply chain engagement, and other measures.

Implementation: Putting the strategies into action through various initiatives, such as energy-efficient equipment upgrades, transportation optimization, and low-carbon procurement policies.

Monitoring and Reporting: Tracking progress towards meeting emissions reduction targets and regularly reporting results to stakeholders, internally and externally.

Continuous Improvement: Reviewing and updating the carbon management framework regularly to improve effectiveness, enhance performance, and incorporate new findings and best practices.

The implementation steps of carbon resource management typically include:

Establishing a Carbon Management Team: This involves assembling a team responsible for developing and implementing the framework, including representatives from different areas of the organization.

Conducting a Carbon Footprint Assessment: This involves identifying and measuring all greenhouse gas emissions associated with the organization's operations, such as energy use, transportation, procurement, and disposal.

Setting Emissions Reduction Targets: Based on the results of the carbon footprint assessment, organizations can set realistic targets for reducing their greenhouse gas emissions over time.

Developing a Carbon Management Plan: This plan outlines specific actions to be taken to achieve the emissions reduction targets, along with timelines, responsibilities, and resources required.

Implementing the Plan: This involves carrying out the various initiatives identified in the plan, which may include energy efficiency improvements, renewable energy procurement, supply chain engagement, and other measures.

Monitoring and Reporting Progress: To ensure the effectiveness of the plan, progress towards meeting the emissions reduction targets should be monitored regularly, and results should be reported to stakeholders.

Continuously Improving: It is important to review and update the carbon management framework regularly to improve effectiveness, enhance performance, and incorporate new findings and best practices.

5. Result

We present Table 4 summarizing the main functions of carbon management:

Table 4 Design features of a blockchain-based web application.

Function	Description
Measuring and Reporting GHG Emissions	Identify and quantify all sources of greenhouse gas emissions associated with an organization's operations, products, and services.
Setting Emissions Reduction Targets	Establish targets for reducing greenhouse gas emissions over time, often in line with science-based criteria or national and international climate goals.
Developing a Carbon Management Strategy	Outline specific actions to be taken to achieve emissions reduction targets, such as energy efficiency improvements, renewable energy procurement, supply chain engagement, and other measures.
Implementing the Carbon Management Plan	Carry out the various initiatives identified in the plan, which may include energy efficiency improvements, renewable energy procurement, supply chain engagement, and other measures.
Monitoring and Reporting Progress	Regularly monitor progress towards meeting emissions reduction targets and report results to stakeholders, both internally and externally.
Continuous Improvement	Review and update the carbon management framework regularly to ensure its effectiveness, enhance performance, and incorporate new findings and best practices.

6. Conclusion

This paper proposes a method for managing carbon assets based on blockchain. Firstly, a high-security level blockchain system is built based on FISCO BCOS to provide secure traceability and certification. Secondly, a visualization middleware is built based on WeBase to manage carbon assets, achieving visualized management and monitoring. Finally, a series of smart contracts are developed based on Solidity and deployed on the blockchain to achieve automatic triggering and intelligent business operations. The blockchain-based carbon asset management system proposed in this article can be used by energy-consuming businesses for internal carbon asset management, achieving sustainable energy development.

Acknowledgments

We acknowledge the funding support from 2022 Guangdong Provincial Ordinary University Characteristic Innovation Projects (No. 2022KTSCX308).

References

[1] Kuleto V, Bucea-Manea-Oni R, Bucea-Manea-Oni R et al. The Potential of Blockchain Technology in Higher Education as Perceived by Students in Serbia, Romania, and Portugal. Sustainability, 2022, 14.

[2] Tanwar S, Parmar A, Kumari A et al. Blockchain Adoption to Secure the Food Industry: Opportunities and Challenges. Sustainability, 2022, 14.

[3] Xu M, Ma S, Wang G. Differential Game Model of Information Sharing among Supply Chain Finance Based on Blockchain Technology. Sustainability, 2022, 14.

[4] Khalfan M, Azizi N, Haass O, et al. Blockchain Technology: Potential Applications for Public Sector E-Procurement and Project Management. Sustainability, 2022, 14.

[5] Rana N P, Dwivedi Y K, Hughes D L. Analysis of challenges for blockchain adoption within the Indian public sector: an interpretive structural modelling approach. Information technology & people, 2022(2):35.

[6] Azmi N A, Sweis G, Sweis R, et al. Exploring Implementation of Blockchain for the Supply Chain Resilience and Sustainability of the Construction Industry in Saudi Arabia. Sustainability, 2022, 14.

[7] Lin J H, Li X, Lin P. Could we rely on credit swap hedging as a substitute for insurer blockchain technology involvement? International Review of Economics & Finance, 2022, 80.

[8] Choi E, Choi Y, Park N. Blockchain-Centered Educational Program Embodies and Advances 2030 Sustainable Development Goals. Sustainability, 2022, 14.

[9] Son-Turan S. Fostering Equality in Education: The Blockchain Business Model for Higher Education (BBM-HE). Sustainability, 2022, 14.

[10] Zhang H, Xiong H, Xu J. Dynamic Simulation Research on the Effect of Governance Mechanism on Value Co-Creation of Blockchain Industry Ecosystem. Sustainability, 2022, 14.

[11] V Carrières, Lemieux A A, Margni M, et al. Measuring the Value of Blockchain Traceability in Supporting LCA for Textile Products. Sustainability, 2022, 14.

[12] Ltifi M, Mesfar S. Does the corporate social responsibility of the service based on Blockchain technology affect the real behaviour of the consumer? Journal of Air Transport Management, 2022, 104.

[13] Chen J, Chen S, Liu Q, et al. Applying Blockchain Technology to Reshape the Service Models of Supply Chain Finance for Smes in China. The Singapore Economic Review, 2021.

[14] Hu H, Wang Y. Research on Convergence Media Consensus Mechanism Based on Blockchain. Sustainability, 2022, 14.

[15] Naclerio A G, Giovanni P D. Blockchain, logistics and omnichannel for last mile and performance. The international journal of logistics management, 2022(33-2).

[16] Tamar M. Benedetta Cappiello and Gherardo Carullo (eds.), Blockchain, Law and Governance. Chinese Journal of International Law, 2021.

[17] Joshi S, Sharma M, Das R P, et al. Assessing Effectiveness of Humanitarian Activities against COVID-19 Disruption: The Role of Blockchain-Enabled Digital Humanitarian Network (BT-DHN). Sustainability, 2022, 14.

[18] Cappa F. Collecting money through blockchain technologies: first insights on the determinants of the return on Initial Coin Offerings. Information Technology for Development, 2021, 27(3).

[19] Kshetri N. Blockchain and sustainable supply chain management in developing countries. International Journal of Information Management, 2021, 60(1):102376.

[20] Polemis M L, Tsionas M G. The environmental consequences of blockchain technology: A Bayesian quantile cointegration analysis for Bitcoin. International Journal of Finance & Economics, 2021(2).

[21] Wustmans M, Haubold T, Bruens B. Bridging Trends and Patents: Combining Different Data Sources for the Evaluation of Innovation Fields in Blockchain Technology. IEEE Transactions on Engineering Management, 2021, PP(99):1-13.

[22] Park N. Development of Blockchain Learning Game-Themed Education Program Targeting Elementary Students Based on ASSURE Model. Sustainability, 2022, 14.

[23] Envelope A, Iak A, Rm B et al. Public service operational efficiency and blockchain – A case study of Companies House, UK. Government Information Quarterly, 2022.

[24] Chiu J. Blockchain Technologies, Applications and Cryptocurrencies: Current Practice and Future Trends. Journal of Economic Literature, 2022(1):60.

[25] Cerchione R, Centobelli P, Riccio E et al. Blockchain's coming to hospital to digitalize healthcare services: Designing a distributed electronic health record ecosystem. Technovation, 2022(1):102480.