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A study on carbon finance based on information management systems

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Abstract. Against the global backdrop of addressing climate change and promoting low-carbon development, carbon finance has become a key market-based tool for driving emissions reduction. To ensure its effective operation, the application of information management systems serves as essential technical support for the advancement of carbon finance. Drawing on the SWOT analytical framework, this paper examines the application of information management systems in carbon finance from the four dimensions of strengths, weaknesses, opportunities, and threats. The findings indicate that the system's strengths lie primarily in its ability to identify and quantify risks arising in the development of carbon finance; its weaknesses stem from demanding performance requirements and high operation-and-maintenance costs. Meanwhile, the advancement of China's "dual-carbon" goals and the maturation of various emerging technologies provide significant developmental opportunities; yet the variability of carbon-market rules and the diversity of user needs pose major threats to the system's adaptability. This study enhances the understanding of the strategic role of information management systems in carbon finance and offers insights for promoting its sustainable development.

Keywords: carbon finance, information management system, SWOT analysis, China

1. Introduction

Against the contemporary global backdrop of combating climate change and advancing a green, low-carbon transition, the concept of carbon finance has emerged in response to urgent environmental and economic imperatives. Carbon finance refers to a series of financial activities and market mechanisms derived from carbon emission rights as the core underlying asset. Its essence lies in using market-based instruments to promote the reduction of greenhouse gas emissions while providing financing support for low-carbon projects. An information management system, by contrast, is an integrated framework that brings together users, technologies, and processes. Its core function is to systematically collect, store, process, and disseminate information within an organization through computer hardware, software, databases, and other technological means, thereby supporting organizational operations, management, and strategic decision-making.

In the context of addressing climate change and promoting a global transition toward low-carbon development, carbon finance plays a pivotal role by pricing carbon emissions through market mechanisms. This process internalizes environmental externalities, creates economic incentives for emission-reduction behavior, and directs capital flows away from high-carbon sectors toward green and low-carbon projects. Carbon finance markets—including carbon-emissions trading schemes, carbon derivatives, and financial activities based on carbon assets—not only provide regulated entities with flexible and low-cost compliance tools but, more importantly, generate long-term and stable carbon-price signals. These signals help stimulate research, development, and deployment of clean energy technologies, promote industrial restructuring, and foster new business models. However, the effective functioning of carbon markets relies heavily on the precise measurement and credible management of massive, complex, and dynamic data related to carbon emissions and carbon trading. This is precisely where information management systems play a crucial role. By integrating data collection, processing, analysis, and monitoring technologies, such systems provide indispensable technical foundations and transparency safeguards for carbon-asset accounting, trading, risk control, and supervision.

As the central nervous system of modern organizational operations and strategic decision-making, information management systems systematically transform raw data into valuable information through collection, processing, storage, and distribution. They significantly optimize business processes, enhance operational efficiency and accuracy, and—more importantly—provide reliable, real-time, integrated data to support managerial decision-making at all levels, thereby reducing uncertainty.

Strategically, information management systems have evolved from traditional back-office support to key drivers of business-model innovation and core-competence building. They are no longer merely operational platforms for resource allocation, but strategic infrastructure essential for coping with dynamic complexity, advancing digital transformation, and ensuring organizational sustainability. In carbon finance markets, information management systems are no longer auxiliary tools; rather, they constitute fundamental support enabling the smooth functioning of carbon-finance mechanisms. The deep integration of the two can collectively foster the healthy development of carbon-finance markets and contribute to the achievement of China's "dual-carbon" goals.

This paper focuses on carbon-finance research grounded in information management systems and employs the SWOT analytical method as its primary framework.

2. Literature review

The studies most relevant to this paper focus primarily on research connecting finance and information management. Haoliang Fu and colleagues [1] designed a blockchain-based cloud-service framework for carbon-finance markets, aiming to address issues such as low trust in carbon-market transactions and insufficient resource sharing. Mengfei Zhou and Ke Xu [2] conducted research on financial information management systems, providing their perspectives and understanding of related concepts and approaches.

Another body of literature relevant to this study consists of works that examine carbon finance specifically. Yeping He and co-authors [3], analyzing the sources of various carbon risks and carbon-finance risks, proposed policy recommendations for China's carbon-risk and carbon-finance-risk governance. Dengbao Yao and Yu Jin [4] constructed a pressure index for China's carbon-finance market, designed to comprehensively depict the market's risk conditions and assist market participants in prospectively assessing potential risk levels. You Zhang and Lu Zhang [5] conducted in-depth studies on the patterns, pathways, and impacts of carbon finance on industrial-structure adjustment, emphasizing its critical role in accelerating industrial upgrading. Ronghua Ju and Jiahao Liu [6] explored mechanisms and pathways for developing China's carbon finance and offered recommendations. Weinan Zhang and Jihu Cai [7], after elaborating on the connotations and mechanisms of carbon finance, summarized the current development status and issues in China, and proposed corresponding policy suggestions.

A final group of relevant studies concerns research on information management systems. Haixia Xu [8], drawing on systems theory and management theory, analyzed the advantages and value of optimizing and integrating computer-application technologies with information management systems. Xiaoxiang Wu [9] provided a detailed design scheme for information management systems based on big-data technologies, offering theoretical and practical guidance for further development. Kangying Liu [10], based on utility theory and estimated risk-preference functions, studied methods for estimating risks in financial information management systems in a big-data context.

3. SWOT analysis

3.1. Strengths

Identifying and quantifying development risks in carbon finance. The application of information management systems offers several advantages. First, such systems can help enterprises assess the potential impacts of climate change—especially extreme weather events—on their assets and supply chains, thereby quantifying the physical risks associated with carbon-finance development. Second, they can measure transition risks brought about by carbon-price volatility, technological change, and policy tightening, enabling timely adjustments to carbon-finance strategies. Third, they can support market-value assessments and risk-exposure analysis of carbon assets held by enterprises, thus quantifying the market risks that may arise during the development of carbon finance. In sum, by integrating information management systems, carbon finance gains the capability to identify and quantify developmental risks, forming a key advantage for promoting its own sustainable development.

At the core of this advantage is an information management system that establishes an end-to-end framework for data integration and intelligent analytics. By breaking down silos between internal datasets on energy use, production, and finance and external inputs such as climate models, policy developments, and market data, the system enables the seamless flow and deep fusion of risk-related information. Building on this foundation, embedded analytical models translate abstract, qualitative risk drivers into concrete, quantifiable metrics, including probability estimates and potential loss calculations. This process not only enhances the precision and foresight of risk management; more importantly, it provides a robust value anchor and pricing basis for rational carbon-asset valuation and the innovation of carbon-finance products. In turn, risk management shifts from a cost center to a key locus of value creation, fundamentally strengthening the resilience and pricing efficiency of the carbon-finance system.

3.2. Weaknesses

High demands for real-time data processing and system stability. To achieve accurate carbon-asset management and effective risk control, information management systems must be able to process massive volumes of high-frequency energy-consumption and emission data in real time or near real time. This places exceptionally high requirements on computational power, storage capacity, and overall system architecture. Moreover, during complex calculations, system failures or data errors—whether caused by natural factors or human mistakes—could lead to trading disruptions, asset loss, or other significant financial risks. These challenges demonstrate that system performance and stability pose major weaknesses when applying information management systems to carbon finance.

High initial investment and costly maintenance. In the early stages of system development, substantial financial inputs are required for research and development, hardware procurement, and integration with external systems. In the mid- to late stages, specialized technical teams are needed for daily operation and maintenance, security updates, and functional upgrades, as well as to ensure ongoing compliance with evolving policies and market rules. Thus, the high economic cost is an unavoidable disadvantage in the application of information management systems in carbon finance.

The stringent requirements for real-time responsiveness and operational stability stem from the dual character of carbon finance, which is both environmental and financial. The continuity of environmental data monitoring and the immediacy of trade execution demand exceptional reliability throughout a complex data-processing pipeline. Even slight delays or minor errors can be magnified by financial leverage, setting off cascading crises of market confidence. The high costs over the development cycle further underscore the upfront, infrastructure-like nature of such systems. Their development and maintenance are not merely technical tasks, but strategic investments that require sustained commitment.

3.3. Opportunities

China's "dual-carbon" goals elevated to a national strategy. In 2020, China announced its "dual-carbon" goals at the United Nations and subsequently incorporated them into national strategy. This provides an enormous user base for the application of information management systems in carbon finance. At the same time, the government is promoting greater standardization and transparency in monitoring, reporting, and verification practices, reducing the difficulty of system development and data integration and helping to advance carbon-finance information systems. The alignment between these systems and China's top-level strategic design represents a significant historical opportunity.

The development of emerging technologies such as big data, artificial intelligence, and blockchain. According to data from China's National Data Administration, by September 2025, the total volume of high-quality datasets nationwide exceeded 500 PB; over 35,000 primary smart factories and more than 230 advanced smart factories had been established across China; and in Guangxi, 34 "blockchain+" application cases had been implemented. Integrating these emerging technologies into carbon-finance information management systems can greatly enhance operational efficiency, improve calculation accuracy, and lower usage barriers, representing a technological opportunity to advance carbon-finance development from basic automation to intelligent, data-driven processes.

The alignment of national strategy with shifts in technological paradigms has created an unprecedented window for developing carbon finance information management systems. China's carbon peaking and carbon neutrality goals (the "dual-carbon" targets), established as a long-term state policy, provide stable policy expectations for related R&D and market deployment, drawing sustained flows of capital and talent into the field. The advance of standardization tackles the problem of data silos at its foundation, removing structural barriers to building unified and efficient information management systems. Meanwhile, the convergent application of emerging technologies signals a profound transformation of the information management paradigm in carbon finance. The opportunity therefore lies not only in addressing current pain points, but also in unlocking new possibilities that will steer the carbon finance market toward a more efficient, intelligent, and trustworthy future.

3.4. Threats

Core carbon-market rules may change as national strategies evolve. As carbon-finance markets remain in an early stage of development, national strategies and policies may change unpredictably in response to market and societal needs. Such changes may require frequent revisions to system logic, or even the elimination and redevelopment of existing functions. Therefore, after integrating information management systems into carbon finance, rapid adaptation to shifts in market rules and national strategic adjustments becomes a significant challenge.

Diverse and heterogeneous user groups. Carbon-finance information management systems are emerging, globally oriented tools. For non-professionals, their interfaces and workflows are often complex, impose high learning costs, and provide limited support for in-depth customization. From a global perspective, designing a unified system capable of supporting multiple carbon

markets with different standards poses substantial challenges and limits broader international adoption. Hence, user diversity and heterogeneity are major obstacles that carbon-finance information management systems must overcome.

These threats collectively underscore the environmental uncertainty and demand complexity confronting the system. The volatility of policy and regulatory rules imposes stringent requirements on architecture and development: a rigid system will be unable to accommodate dynamically evolving market ground rules and will quickly lose value. This calls for a design shift from maximizing fixed functionality to maximizing adaptability to change. At the same time, the heterogeneity of the user base poses a dual challenge to universality and usability, requiring a design that can flexibly align with the distinct workflows and risk preferences of different market participants. In a globalized context, a deeper challenge lies in reconciling institutional differences across jurisdictions. This problem extends beyond technology and constrains carbon finance information management systems that seek to serve global markets.

4. Conclusion

This paper outlines and analyzes the strengths, weaknesses, opportunities, and threats associated with applying information management systems in the field of carbon finance. Such systems offer the clear advantage of identifying and quantifying development-related risks. However, they also face significant drawbacks, including heavy data-processing demands, insufficient system stability, and high operational costs. At the same time, strong national policy support and the rapid advancement of emerging technologies present valuable opportunities for further development. Nevertheless, the sector must also contend with major threats, such as frequent adjustments to carbon-market rules and national strategies, as well as the difficulty of accommodating increasingly diverse user groups.

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