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Analysis of the Impact of Big Data Technology on Environmental Pollution Control Audit

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Abstract: As China strives towards the second centenary goal, increasing attention is being paid to environmental pollution and other related issues. Concurrently, with the rapid development of big data technology, many big data solutions have been applied to environmental pollution control audits, exerting a significant impact. This paper presents the current situation of environmental pollution audits, summarizing the application of big data from the perspectives of both domestic and international research. In terms of data collection and data analysis for environmental pollution audits, cloud platform technology, and visualization technology are selected based on multiple data sources. The impact in the field of environmental pollution control audits is further analyzed. It is found that the environmental pollution audit cloud platform is not yet perfect, the technical skills of audit personnel are insufficient, and some technologies are not mature. Relevant suggestions are put forward to provide a reference for the future development of big data technology and its integration with environmental pollution control audits.

Keywords: Big data technology; Environmental pollution control; Audit

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1. Introduction

Environmental pollution not only affects the balance of natural ecosystems but is also directly related to human health. In this context, auditing environmental pollution control is particularly important. China has promulgated many laws, regulations, and rules on auditing and the environment, yet specific evaluation standards are still lacking. In November 2017, the General Offices of the CPC Central Committee and the State Council issued the "Provisions on Auditing Outgoing Leading Cadres' Natural Resources and Assets (Trial)," which clarified the content and priorities of audits and marked the formal establishment of a new and regular audit system [1].

The application of big data technology in environmental pollution control audits provides new perspectives and methods. It can process and analyze large-scale environmental monitoring data, effectively identifying pollution sources and evaluating the efficacy of governance measures. Big data offers high-efficiency and high-precision tools for environmental audits, making environmental policy formulation and implementation more

scientific and accurate. Over the past few years, big data technology has been popularized in many fields, from business and government to science and research, with accounting and auditing being no exception [2]. This not only improves the transparency and credibility of environmental governance but also provides real-time data support for policymakers, helping them make more rational decisions.

Therefore, exploring the impact of big data technology on environmental pollution control audits is not only of significant theoretical value but also has extensive practical implications.

2. Literature review

With the increasing importance of environmental protection and the further development of big data technology, attention to environmental pollution and the use of big data technology in various fields have increased significantly. However, due to the immature development of big data applications, studies on their impact on environmental pollution audits remain relatively scarce. This chapter reviews domestic and international research literature on the application of big data in environmental pollution audits.

2.1. Environmental pollution audit research

Current studies on environmental pollution audits primarily focus on air and water pollution. In water pollution audits, Sarkar *et al*. and Andrews and Sturm identified that audits typically include water resource environmental protection and watershed pollution prevention and control [3,4]. Tang employed a PSR (pressure-state-response) model, combined with special audit project cases, to evaluate pollution prevention and control in the Tuojiang River Basin [5].

In air pollution audits, Li categorized performance audits based on pollution sources, ground-level maximum concentration, and pollution migration trajectories, constructing corresponding audit models [6]. Scholars like Chen and Wang developed an atmospheric environment performance audit evaluation index system based on the PSR model and applied it to air pollution control in Lanzhou City during the 12th Five-Year Plan period [7]. Additionally, Yu *et al.* used the ultra-efficiency DEA model to analyze the relationship between national audits and air pollution control efficiency, concluding that national audits can enhance pollution control efficiency [8].

Research on the impact of environmental pollution audits is limited, with most focusing on empirical analysis. Cai *et al.* measured environmental pollution using indicators such as atmospheric pollution, water pollution, solid waste pollution, and noise pollution. Their regression analysis revealed that economic responsibility audits can improve local government governance by focusing on environmental protection responsibilities [9]. He and Nian found that government environmental audits could enhance local and surrounding green development efficiency using the Tobit-Spatial Durbin model [10]. Xie *et al.* demonstrated that increased national audit investment improves the supervision and consultation functions, contributing to better disposal efficiency of industrial “three wastes” in the region [11].

2.2. Research on the application of big data in environmental pollution audits

Studies on the application of big data technology in environmental pollution audits are limited, mainly focusing on visualization technology. Mu and Nie highlighted the main features of different visualization software, proposing the use of intelligent human-computer interaction technology and automatic modeling functions for water pollution studies [12]. Chen and Gao suggested using big data tools for comprehensive analysis of air quality monitoring, financial data, enterprise electricity data, project approvals, and both structured and unstructured data in atmospheric pollution audits [13]. Gao recommended using R language visualization tools to

map audit areas, assess pollution levels, and identify audit clues and anomalies [14].

To enhance the efficiency of environmental pollution control audits, Liu proposed using big data technology for real-time supervision through cloud platforms and web crawler technology to collect and analyze audit data comprehensively [15].

By integrating big data technology with environmental pollution control audits, it is possible to process and analyze extensive environmental monitoring data more effectively, identify pollution sources, and evaluate governance measures. This approach offers high-efficiency, high-precision tools that improve the transparency and credibility of environmental governance, supporting policymakers in making informed decisions.

3. Analysis of the impact of big data technology on environmental pollution control audit

3.1. Collecting environmental pollution audit data on a cloud platform based on multiple data source synthesis

A cloud platform based on multi-data source synthesis refers to establishing a network data aggregation platform. This platform utilizes environmental pollution indicators released by various authorities to collect and store big data in the cloud. Currently, many regions have established natural resource audit data platforms that access substantial business data from departments managing land, atmosphere, minerals, water resources, agriculture, and other environmental resources. The platform's data comes from local resource and environment management departments' monitoring and recording activities. It directly collects structured data, uses text mining technology, and links the records and published texts of relevant departments [16].

This ensures the data source's integrity, and integrating blockchain technology can further secure the platform's data [17]. The platform shares environmental index data with the public, allowing them to query information. During environmental pollution audits, auditors can browse and search for relevant environmental index data on the platform. The platform often integrates with local electronic maps, enabling auditors to click on map areas to accurately locate and retrieve relevant indicators. Auditors can use web crawler technology to collect comprehensive data required for audits.

Compared to traditional audits, this method saves time by avoiding field data collection, allows access to data anytime and anywhere, and ensures data authenticity, providing a strong basis for audit opinions. When both auditors and auditees use the cloud platform, they may either use the same or different cloud platform suppliers [18].

3.2. Intelligent data analysis on environmental pollution audits based on visualization technology

Big data analysis results are often abstract. Visualization software can transform audit data into graphics and images, which auditors can then analyze using their audit knowledge. This high-throughput characteristic allows auditors to systematically understand and analyze the connotations and characteristics of the audited data through visual graphics and images [19]. Visualization technology makes audit conclusions more intuitive and easier for stakeholders to understand and accept.

On one hand, visualizing environmental pollution data allows for a more intuitive comparison of pollution conditions both horizontally and vertically, facilitating a comprehensive evaluation of the audited subject's pollution control performance within a specific audit period. This makes the audit results more practical.

On the other hand, the application of visualization technology can improve the audit resource database and environmental pollution audit assessment methods. Effective long-term governance of environmental pollution

requires integrating the massive environmental data collected in each audit into a database. Digitizing the audit process saves time on low-value-added tasks and allows for analyzing all data rather than relying on sampling methods [20]. The extensive application of visualization technology will increase the demand for database quantity and quality, prompting improvements in the database and the exploration of more effective evaluation methods.

4. Big data technology's impact on environmental pollution control audit: problems and conclusion suggestions

4.1. Open issues

4.1.1. Environmental pollution audit cloud platform is not yet robust

Currently, many regions have relatively simple and scattered environmental pollution audit information systems, lacking integration and coordination. Data standards and formats vary across different systems, with significant data missing. This fragmentation hinders data aggregation and platform unification. Different departments and institutions often operate independently, making data sharing difficult [21]. Additionally, most environmental pollution information platforms are not government-controlled, raising concerns about data accuracy, as institutions or enterprises may present embellished data. The overall data quality needs improvement, and weak data authenticity significantly affects audit quality.

4.1.2. Auditors' technical weaknesses

Auditors' initial training is often theoretical and closely aligned with traditional audit methods [22]. There is a shortage of professionals skilled in using visualization technology, which requires proficiency in computer and data processing techniques. Currently, computers cannot completely replace manual operations, imposing higher quality requirements on auditors.

4.1.3. Immature technologies

While visualization technology can integrate large amounts of data, the accuracy and authenticity of audit results can be affected. The visual analysis process requires substantial data support, often from diverse sources, which can be challenging to export and process. Some audit results depend on data provided by the auditee, complicating the audit. Due to the particularities of audit objects, data sources are more diversified, potentially introducing uncertain or unquantifiable factors, which make the analysis susceptible to subjective influence.

4.2. Conclusion and suggestions

4.2.1. Improve government-led environmental pollution audit standards and regulations

Audit operations differ across institutions, necessitating unified standards from relevant departments. These standards should enhance operational guidance and integrate big data with audit work. Additionally, key environmental resource data, linked to national security, require improved laws and regulations, such as clarifying database access rights to standardize big data technology applications in audits and safeguard national security.

4.2.2. Enhance auditor quality and strengthen big data technical training

Applying big data technology in environmental pollution audits requires high auditor quality. Continuous learning and improvement enable auditors to use big data technology more effectively, focusing on audit core points and adapting the technology to audit needs.

4.2.3. Establish a shared platform database with enhanced security

Creating a shared platform and database can significantly aid data analysis. However, its security risks must not be overlooked. Strengthening data security and managing identity authentication are crucial. Data authenticity greatly impacts visual analysis results, and any tampering with the main database can have amplified adverse effects due to its sharing function.

Disclosure statement

The authors declare no conflict of interest.

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