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Analysis on the Application of Ecological Environment Protection System Under Blockchain Technology

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Abstract. The continuous development of the Internet and the continuous changes in digital technologies such as artificial intelligence, blockchain technology, and AIGC technology mean that digital technology is the direction of future urban development. With the development and progress of society, problems such as environmental damage, lax regulatory systems, and low enthusiasm of people to protect the environment frequently occur. The quality of the global environment and social development develop in inverse proportion. As one of the key technologies for the development of future digital cities, blockchain technology has the characteristics of decentralization, openness, non-tamperability, traceability, and incentivization, which can meet the public's openness and incentives for ecological and environmental protection behaviors. change. Use the "incentive mechanism" and "distributed ledger" technologies in the blockchain to improve the public's behavioral enthusiasm for protecting the ecological environment and the standardization of resource utilization, and ensure the authenticity and real-name nature of the data obtained from participating in ecological protection activities. Fundamentally implement technology and ecological environmental protection measures to promote the construction of ecological civilization in the digital era.

Keywords. Blockchain, incentive mechanism, ecological environment, environmental protection

1. Feasibility Analysis of Applying Blockchain Technology to Ecological and Environmental Protection Systems

1.1. Blockchain and Core Technology

From a recording perspective, blockchain is a decentralized ledger that uses distributed ledger technology to record real and untampered data [1]. From a broad perspective, blockchain is a distributed, non-tamperable, decentralized technology, ensuring data security and integrity through the use of blocks and hash functions, and ensuring the

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credibility of the network through consensus algorithms. Used to build and maintain distributed ledgers and decentralized networks with extremely strong security.

The decentralization, transparency, and non-tamperability of blockchain rely on the following core technologies. First, distributed ledger technology. It is a way to record and store information. Unlike traditional centralized ledgers, it has countless nodes, and all information is repeatedly stored on multiple different nodes, rather than in a single central database. All nodes form a chain and jointly store the same complete data. If the information on one node is tampered with, other nodes will receive a reminder.The possibility of information tampering is technically avoided to a certain extent. Second, asymmetric encryption technology. Also known as public key cryptography, it is a method of encrypting and decrypting data in which a pair of different keys are used: a public key and a private key. There is a mathematical relationship between the two keys, but one key cannot be easily derived from the other [2].The public key information is open and transparent, and the private key is only owned by the other party in the transaction. Therefore, the security of data in the blockchain can be ensured. Third, smart contracts. Compared with traditional paper contracts, smart contracts can be understood as virtual contracts that exist in the digital world. The difference from traditional contracts is that they are written using computer programs. The content of the agreement has multiple conditions. When the information is entered When predetermined conditions and rules are met, the operation will be automatically performed without the intervention of a middleman [3].This is also a manifestation of decentralization and strong trust. Fourth, incentive mechanism. It is used in the consensus layer of the blockchain architecture layer. Due to the consensus mechanisms in the blockchain: Proof of Work (PoW), Proof of Stake (PoS), Mortgage of Equity (DPoS), etc. there are more or less problems such as waste of resources or long verification time when performing information consensus verification, and need to be used Incentive mechanism to encourage miners, validators and nodes to participate in the operation of the network. This incentive mechanism usually uses financial rewards as the main incentive method.

The author believes that the core technology of blockchain, with its decentralization, openness, openness, and non-tampering characteristics, is highly suitable for the construction of ecological civilization today: the enthusiasm of the masses is not high, the corporate product supply chain is not clear and transparent, carbon emissions, etc. question.

1.2. The feasibility of integrating blockchain technology into ecological and environmental protection

London-based blockchain startup Provenance is a blockchain e-commerce supply chain service platform that creates a sense of trust in the entire supply chain system by deploying blockchain systems based on Bitcoin and Ethereum. Provenance issues a digital passport to products that vouch for their authenticity and origin.

This platform uses distributed ledger technology to open supply chain information at every sales link, allowing brands to track the origin and history of product materials, ingredients and products, and provide consumers with information about physical products.

Users at every link in the supply chain need to register on Provenance. After registration, users will have a unique private key to prove the authenticity of their identity. Every user with a private key can record information on the blockchain and

can also view the information within their authority. The characteristics of the blockchain make the information recorded on the blockchain non-tamperable and irrevocable. This characteristic ensures that the product information viewed by consumers is completely true and reliable, thereby protecting the rights and interests of consumers.

This platform uses smart contracts built on the blockchain. Consumers can purchase products by signing smart contracts with manufacturers. The contract stipulates that when the price of the product is lower than an agreed price at a certain point in the future, consumers purchase a certain quantity of goods at this agreed price. Because smart contracts are legally binding and can be executed automatically, manufacturers can predict future revenue based on the quantity and price of goods agreed in the signed smart contract. Consumers will also benefit from this, not only having the opportunity to purchase goods at lower prices, but also experiencing a new experience brought by this innovative shopping method.

The fully public nature of the non-permissioned blockchain can also enable users to monitor target objects through devices connected to the Internet, and track the origin of goods and the intermediate transactions in a transparent manner. On the blockchain, consumers can not only view the static attribute information of the product, but also view the transit and transportation process of the product from the manufacturer to the dealer to the end consumer. Consumers can learn about the process along the way just from their smartphones. Information updated at every step.

Provenance supply chain management platform based on blockchain technology can improve the transparency of the supply chain to help prevent waste, inefficiency, fraud and unethical behavior. This can also help consumers better understand how products are manufactured and shipped so they can make more environmentally friendly choices.

1.3. Advantages of Applying Blockchain Technology to Ecological and Environmental Protection

- Build a Monitoring System for Sustainable Resources

The openness and traceability characteristics of blockchain technology can track the supply chain of products to ensure that the source and manufacturing process of products comply with environmental regulations; track the carbon emissions of enterprises and individuals, and help establish a more accurate carbon emissions market [4-5]. This will help combat environmentally damaging activities such as illegal logging and illegal trade in wildlife while promoting carbon emission reduction projects and encouraging the reduction of greenhouse gas emissions to combat climate change.

- Deepen Sustainable Resource Management Measures under The Construction of Ecological Civilization

Economic construction requires a large amount of natural resources, such as minerals, energy wood and water resources. Excessive exploitation and utilization of resources may lead to resource depletion, ecosystem damage and biodiversity loss. The management of sustainable resources is the key to building a sustainable society. Through blockchain distributed ledger technology, it can be used to record the collection and use of natural resources such as wood, water resources and minerals. This data can be generated by sensors and monitoring devices and then repeatedly,

securely stored on multiple nodes and shared publicly. Ensure sustainable management of resources, avoid deforestation and resource depletion, and reduce the risk of data fraud and pollution incidents.

- Increase Enthusiasm for Environmental Protection Activities

The incentive mechanism of the blockchain can be combined with smart contract technology to improve the trust and enthusiasm of the masses. Its technology can be used to create incentive programs to encourage individuals and organizations to take environmental actions such as recycling, water conservation and forest protection. Rewards can be distributed automatically through smart contracts. The decentralized features of the blockchain are based on a secure carbon trading platform for enterprises [6], and organizations that reduce carbon emissions can receive rewards by selling excess emission rights. This helps companies and individuals actively participate in the trading of carbon emission rights and reduce emissions from carbon exploration.

2. The Application and Construction of Blockchain Technology Integrated into Ecological and Environmental Protection Systems

2.1. Resource Management and Activity Monitoring under Distributed Ledger Technology and Asymmetric Encryption Technology

As shown in Figure 1, sensors and monitoring equipment are used to collect environmental data, such as meteorological information, water quality data, wildlife migration records, resource source and usage data, product supply chain data, etc., and then combined with blockchain to establish an environmental data recording platform.When these data enter the system, they will be blocked, and then asymmetric encryption technology will encrypt and decrypt the data through public and private keys to ensure the integrity and non-tamperability of the data [7]. Distributed ledger technology divides processed digital data into multiple different nodes for consensus, verification, and recording. Only data that passes verification can be added to the ledger and spread throughout the network for sharing.

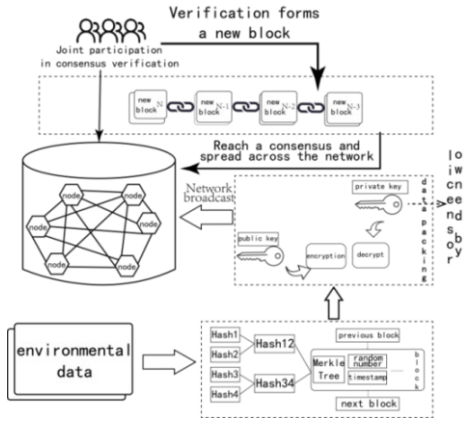

Figure 1. Application of Distributed Ledger Technology In Environmental Data Storage

2.2. Incentive Mechanism and Environmental Protection Reward and Incentive System under Smart Contracts

The public's environmental protection awareness is directly proportional to environmental protection behavior. In the procedures for ecological civilization construction, the public's initiative for environmental protection is crucial. The incentive mechanism and the environmental protection reward and incentive system under smart contracts can be implemented using blockchain technology. Built on the basis of [8]. As shown in Figure 2, first formulate a digital agreement text. The agreement content includes environmental protection activities and behaviors, the amount of the reward, the contract owner (usually a regulatory agency or organization), and the reward record. This digital protocol is disseminated throughout the network and verified, recorded, and disclosed at each node. Individuals or entities can then take environmental actions, such as cleaning up trash, saving energy, etc. When they take these actions, they need to submit information about those actions to the smart contract. The smart contract will verify whether the submitted environmental action meets the set conditions. These conditions may include specific types of pro-environmental actions, timestamps, geographical location information, etc. If the environmental protection action meets the conditions, the smart contract will automatically distribute reward tokens to the individual or entity who submitted the action.

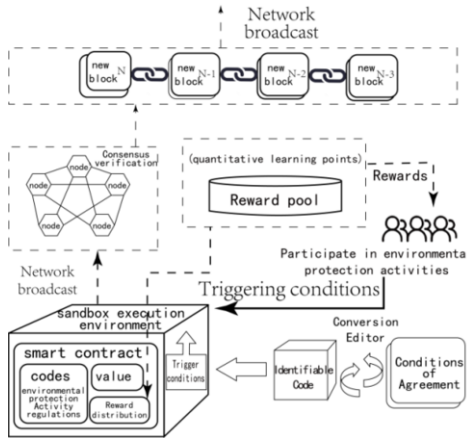

Figure 2. The Operating Model of Smart Contract Technology Applied to Environmental Protection Incentives

```
pragma solidity ^0.8.0;
contract EnvironmentalRewards {
    address public owner;
    uint public rewardAmount;
    mapping(address => uint) public rewards;
```

```
    event RewardClaimed(address indexed user, uint rewardAmount);
    constructor(uint _rewardAmount) {
        owner = msg.sender;
        rewardAmount = _rewardAmount;
    }
    modifier onlyOwner() {
        require(msg.sender == owner, "Only owner can execute this.");
        _;
    }
    function claimReward() external {
        require(rewards[msg.sender] == 0, "You have already claimed your reward.");
        rewards[msg.sender] = rewardAmount;
        emit RewardClaimed(msg.sender, rewardAmount);
    }
    function withdrawReward() external onlyOwner {
        require(address(this).balance >= address(this).balance, "Contract balance is
insufficient.");
        payable(msg.sender).transfer(address(this).balance);
    }
}
```

The above code is a simple smart contract example, which is used to record and distribute environmental rewards. This smart contract has the following main functions: 1.constructor: The constructor sets the reward amount and contract owner when the contract is deployed. 2.claimReward: allows participants to claim rewards, and one person can only claim them once. 3.withdrawReward: Allows the contract owner to withdraw reward funds. Environmental protection rewards and incentive systems under incentive mechanisms and smart contracts can be built on the basis of blockchain technology and automatically execute reward strategies based on smart contracts to encourage individuals, organizations and enterprises to take environmental protection actions, such as waste classification, water and energy saving savings while ensuring transparent, fair and verifiable reward distribution.

2.3. Pollution Source Emission and Trading Platform Based on Consensus Mechanism, Distributed Ledger Technology, and Digital Signature Technology

Pollutant emissions have always been a key issue in ecological environment damage, but the processes of industrialization and urbanization are usually accompanied by large amounts of pollution emissions. Green, low-carbon, high-quality development requires reducing carbon emissions. As shown in Figure 3, a pollution source emissions

trading market is created. Distributed ledger technology records pollutant emission data and transaction data to ensure the source and integrity of the data. Then companies or individuals put excess pollution source emission data into the market for other participants to purchase. Both parties to the transaction set conditions that satisfy the trading and distribution of automated pollutant emission rights. When the pollution source emission data enters the platform, the consensus mechanism of the blockchain verifies the data, and then the data is encrypted to form a public key and a private key (digital signature). Ensure that authorized parties agree on the consistency of transactions and data. After the conditions during the transaction meet the preset conditions of the smart contract, automatic transactions will be carried out and rewards will be issued.

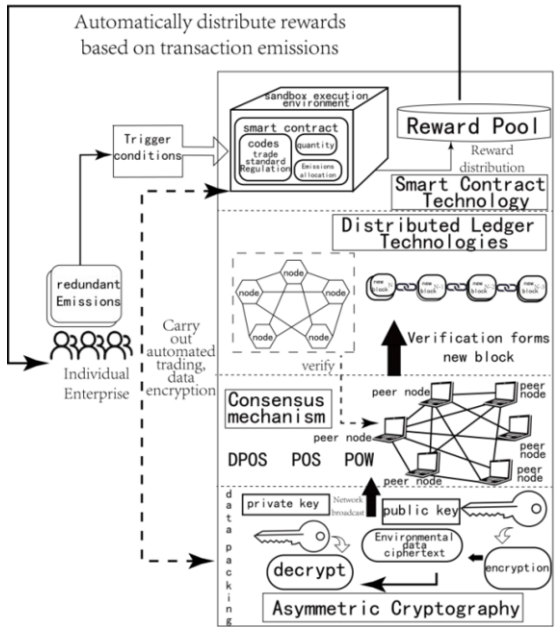

Figure 3. Operation Model of Pollution Source Emission and Trading Platform under Blockchain Technology

These blockchain technologies and concepts jointly build a pollution source emission reduction and trading system, improving the efficiency and credibility of the carbon market through transparency, security and automation [9]. Distributed ledger technology and consensus mechanisms can be used to track the carbon emissions of businesses and individuals. Each emission is recorded on the blockchain, and smart contracts can automatically calculate and verify pollution source emission rights. Carbon emission rights can be traded on the blockchain, which helps companies and countries better track, record and trade pollution source emission rights, encourage the reduction of carbon emissions, and promote the development of sustainable energy and technology.

3. Potential ethical impacts and solutions of blockchain technology empowering ecological and environmental protection

3.1. Privacy protection and security issues brought about by the traceability of sustainable resources

Blockchain technology can improve the transparency and traceability of sustainable resource use data, but it may also sacrifice personal privacy rights. Public blockchain records may expose sensitive information about individuals or organizations. However, the absolutely open and traceable characteristics of the blockchain also encourage the public to consciously supervise each other and standardize behavior. Therefore, based on this privacy security issue, the author believes that a privacy protection mechanism can be added. Use anonymization technology or access control measures to ensure that only authorized personnel can access specific information, balancing the relationship between transparency and privacy protection.

3.2. Rights and governance issues in the blockchain system built under smart contract technology

The governance structure of blockchain systems needs to be more democratic and open to avoid excessive concentration of power in the hands of a few nodes or organizations. The author believes that the decentralized system characteristics brought by blockchain technology ensure the participation and balanced interests of all parties through an open consensus mechanism and democratic decision-making process. In terms of community governance, a decision-making mechanism based on community participation can be established to ensure that the voices of all participants are heard and respected. Community participation and democratic decision-making mechanisms can balance the interests of all parties and ensure fairness and rationality in decision-making. This can be achieved through a multi-party consensus mechanism, an open decision-making process and a transparent governance model.

3.3. The application of blockchain technology is accompanied by digital divide and social inclusion

The complexity and expertise of blockchain technology may create a digital divide, a gap in technology that prevents certain groups of people from fully understanding or participating in it. In order to improve social inclusion, the author believes that it is necessary to invest in education and training projects to lower the threshold for using blockchain technology so that more people can understand and participate in the application of blockchain technology. Simplifying the user interface, providing easy-to-understand training, and community advocacy can help various groups better integrate with this technology.

3.4. Accuracy and credibility of environmental supervision data under blockchain technology

Although blockchain is considered a highly secure and tamper-proof technology, the accuracy and trustworthiness of data entry are still affected by human factors.

Incomplete, incorrect data entry or malicious attacks can affect system reliability [10-11]. Therefore, the author believes that an effective data verification and review mechanism should be established to ensure that only verified data can enter the blockchain system and improve the credibility and integrity of the data; in terms of real-time supervision, establish regulatory agencies or technical means to monitor in real time Data entry to promptly detect and resolve errors or malicious behavior.

3.5. Energy consumption and sustainability associated with distributed ledger technology

Blockchain technology requires a lot of computing power and energy support, especially for consensus mechanisms such as Proof of Work. This results in a huge demand for electricity resources, which can have a negative impact on the environment. Therefore, it is crucial to develop more energy-efficient consensus mechanisms or use more energy-based sustainable blockchain technology. For example, explore consensus mechanisms based on Proof of Stake that reduce energy consumption or other more energy-efficient mechanisms. At the same time, promote the use of renewable energy supply to support the operation of blockchain technology and reduce its dependence on traditional energy sources, such as solar or wind energy, to reduce blockchain technology's dependence on non-renewable energy.

4. Conclusion

As blockchain technology continues to mature and develop, the application fields of blockchain technology continue to expand. Integrating into the field of ecological protection can provide innovative solutions for the ecological environment protection system. Through blockchain, we can establish credible environmental data records, ensure environmental standards are adhered to, encourage green production and consumption, track carbon emissions and support the development of renewable energy. However, the integration of blockchain and ecological protection also faces some challenges, including issues such as performance scalability, energy consumption, standardization, privacy protection, and laws and regulations [12]. Therefore, in future research, the in-depth development of blockchain technology in the fields of environmental monitoring, resource management, carbon emission markets, and sustainable development also requires further research to ensure the effective application of blockchain in environmental protection.

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