Scalable Computing: Practice and Experience, ISSN 1895-1767, http://www.scpe.org
© 2025 SCPE. Volume 26, Issues 2, pp. 757–765, DOI 10.12694/scpe.v26i2.4074

THE INCOME ALLOCATION MECHANISM OF TRUSTED "DUAL CONTRIBUTION" DATA ASSETS BASED ON BLOCKCHAIN TECHNOLOGY

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Abstract. In order to solve the problem of researching the distribution of returns on trustworthy "dual contribution" data assets, the authors propose a research on the distribution mechanism of returns on trustworthy "dual contribution" data assets based on blockchain technology. Integrate and apply various levels in the blockchain system. In this model, a node authorization control mechanism is added in the network layer, which can be customized in the consensus layer, and the data query efficiency can be improved through the optimization of the structure and the establishment of the index, so that the data can be managed intelligently in the intelligent contract layer, and encrypts information with customizable encryption algorithms at the transaction layer. In simpler terms, the new data asset management model utilizing blockchain technology has made on-chain data queries 2.25 times faster compared to conventional models. The benefit distribution mechanism model of blockchain is more conducive to internal cooperation than the traditional model.

Key words: Data resources, Blockchain, Benefit distribution

1. Introduction. As technology keeps evolving, we're witnessing the dawn of the financial technology era. Innovations like big data, cloud computing, blockchain, and artificial intelligence are increasingly finding their way into different corners of the economy, reshaping traditional models including supply chain finance [1]. Despite the advancements in supply chain finance, small and medium-sized enterprises (SMEs) continue to grapple with the challenge of accessing affordable financing. This is primarily due to their limited resources, modest scale, and lack of established credit history. However, blockchain technology offers a promising solution. With its decentralized nature and features like encrypted, transparent, and tamper-proof data, blockchain presents a viable avenue for addressing SMEs' financing woes [2].

Reasonable distribution of benefits in research and development alliances is of great significance for maintaining their sustainability and stability [3-4]. When distributing benefits, it is necessary to first clarify the distribution principles and influencing factors to make the distribution plan more reasonable. From the perspective of profit distribution, the prerequisite for maintaining supply chain partnerships is that the total profits obtained by each company through establishing supply chain partnerships are greater than the total profits obtained by each company when they do not cooperate. Secondly, individual enterprises will gain more profits in long-term cooperation. If the distribution of benefits in the alliance does not reach a level of fairness and justice, members are likely to be dissatisfied for this reason, leading to the leakage of intelligence and resources within the alliance, which will have a huge impact on the alliance [5]. The contribution of a company to the supply chain also affects its competitiveness in the market. If members of the company can leverage their advantages, improve their business models, regulate their behavior, and enhance their competitiveness, they can enhance their advantages and improve their overall efficiency. Therefore, investing more members can earn more profits [6]. The chaos of multiple entities in the supply chain is quite common. It is integrated into the blockchain technology support supply chain supervision function, plays a leading role, conducts in-depth monitoring on the centralized allocation, procurement, operation, financing, and provides a strong guarantee for the promotion of blockchain technology in the supply chain [7]. Although blockchain investment requires an increase in alliance operating costs, it can enhance the competitiveness and sustainable development ability

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of the alliance. If alliance members actively introduce blockchain technology to bear the corresponding costs, they should receive more benefit distribution [8].

2. Literature Review. In the System of National Accounts (SNA), the application scope of the present value of future income method is relatively narrow, and its priority is ranked after the market price method and cost method [9]. This is because the future income flow of assets is highly uncertain, which may lead to unstable asset valuation results, and the valuation process is more complex than the cost method. When valuing data assets, asset returns can be stripped from the operating earnings of institutional units, eliminating the uncertainty of future asset revenue streams; When estimating asset returns, methods such as layered measurement and moving average can be used to reduce the instability of future revenue streams for data assets. In addition, in practice, the fluctuation of asset returns is a normal phenomenon, and asset market prices will also fluctuate with the fluctuation of asset returns. Therefore, it is reasonable for the valuation results of assets to have fluctuations. Therefore, although there are difficulties in valuing data assets using the present value of future income method, these difficulties can be overcome. Lyimo, A. J., and others introduced a better blockchain based IoT design that can display distributed control of IoT data collection, recording, auditing, and storage[10]. Josphineleela, R. et al. have introduced a novel optimized fuzzy architecture tailored for facilitating the exchange and communication of data among Internet of Things (IoT) devices through blockchain technology [11]. Taliep, N. et al. have proposed a method for managing private data stored on the blockchain. By using this method, even if the data is only available to authorized users, the transparency and tamper resistance of blockchain logs are maintained [12].

The present value of future income method reflects the profitability of data assets and demonstrates the advantages of data element income, which cannot be replaced by other methods. Using the present value of future income method to value data assets is a beneficial attempt to promote reasonable pricing of data assets and improve the distribution system of element income. The author will explore how to use the present value of future income method to value data assets based on the National Accounts system and relevant statistical accounting standards. Firstly, define the data assets discussed by the author and discuss their identification and classification issues; Secondly, explore the valuation approach of future income present value method for different types of data assets; Finally, analyze the forms of expected return functions and expected lifespan for different data. Therefore, the author provides practical ideas for the valuation of data assets, and expands the accounting and valuation of data assets.

3. Method.

3.1. Data Management, Data Resource Management, and Data Asset Management. As we move into the Big Data Age, data management is becoming more and more important. There are three major levels of data management at the moment: Basic Data Management, Resource Management, and Asset Management. Data encompasses symbols that capture and represent real-world events, including physical symbols or combinations thereof that describe the characteristics, states, and connections among objects. Data management refers to the use of computer technology to store, process, and utilize these data in an organized and efficient manner. Traditionally, data management has focused primarily on the physical aspects of data, emphasizing the structure of stored data and the relationships between different datasets. At this level of management, data is often seen merely as a vessel for information, with little attention given to the intricate relationships between data points. The International Association for Data Management characterizes data management as the governance of data resources, a concept closely aligned with data resource management. However, while data management tends to emphasize data processing, data resource management places greater emphasis on leveraging data for decision support. In simpler terms, data resource management builds upon the foundation of data management, focusing more on utilizing data for informed decision-making rather than just processing it [13].

Data asset management encompasses both data management and data resource management, but with a distinct focus on the strategic value of data to enterprises. Essentially, not all data is considered a valuable asset; only data resources that can contribute to future economic benefits qualify as such under data asset management principles. The relationship between data management, data resource management, and data asset management is shown in Figure 1. Enterprises must own and control these data assets. Data management primarily concerns

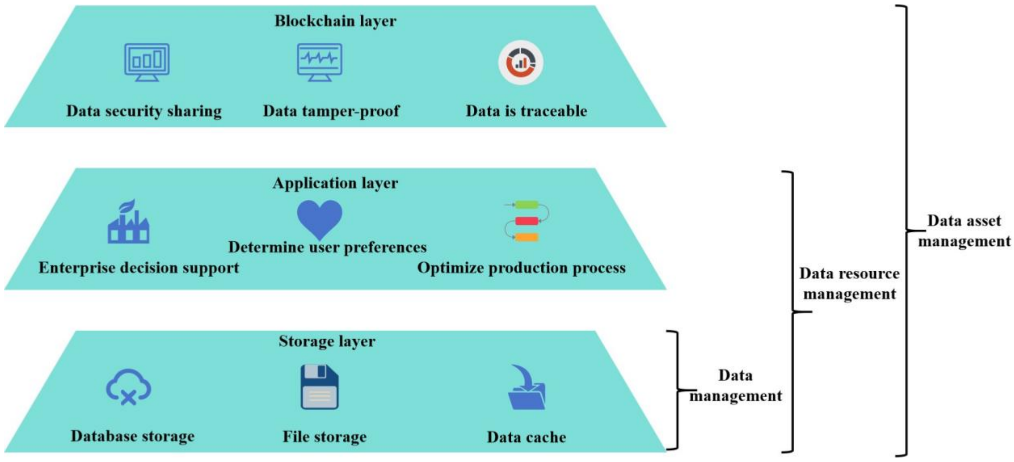

Fig. 3.1: Data Management Hierarchy

itself with the storage layer, encompassing tasks such as data storage and caching. On the other hand, data resource management goes beyond storage, recognizing data as a valuable resource in its own right. This perspective extends to the application layer, where the emphasis lies on leveraging data resources to drive decision-making, optimize production processes, and more effectively support enterprise objectives. In simpler terms, while data management deals with storing data, data resource management sees data as a resource to be utilized, and data asset management specifically focuses on maximizing the economic benefits derived from these valuable data resources. Data asset management represents a paradigm shift, elevating data from mere information to a strategic asset. It entails treating data as a unique asset class, capable of not only enhancing internal operations but also serving as a valuable commodity that can be traded for revenue generation. In this framework, data asset management goes beyond traditional data management and resource management by incorporating considerations of data security, privacy, and sharing mechanisms. An emerging approach in this regard involves leveraging blockchain technology. By harnessing blockchain's inherent features such as secure sharing, tamper resistance, and traceability, data assets can be safeguarded and effectively managed [14].

3.2. Data assetization process. In essence, not all data resources possess the potential to become data assets. The process of converting these resources into assets, thereby extracting value from them, is termed data resource assetization. Figure 3.2 illustrates the specific steps involved in this process. During the production phase, enterprises inevitably generate data resources linked to their products. Subsequently, these resources can be transformed into data assets through two primary methods. The first scenario entails data possessing inherent value. For instance, monetizing such data resources directly under appropriate and lawful conditions represents the most straightforward approach. Conversely, in the second scenario, the data itself might not hold standalone value. However, it can empower existing business operations. For example, various applications utilize data mining techniques to analyze user behavior, yielding insights into user needs. By scrutinizing these data resources, production and business methodologies can be refined, indirectly enhancing the revenue generated by current products. This constitutes an indirect avenue for monetizing data resources[15].

3.3. A New Data Asset Allocation Model Based on Blockchain Technology. The current DQM framework within the blockchain is only focused on some aspects, and there is considerable scope to improve the full integration of blockchain and data asset management. Hence, the author suggests a new model of data asset management utilizing blockchain technology. The new model not only makes use of specific layers in the blockchain, but also integrates and optimizes all the layers of the network, the agreement, the data, the intelligent contract, and the application. Figure 3.3 gives an overview of the proposed concrete framework. The security and sharing of data are enhanced at the network and the consensus level by the node authorization classification and the custom consensus mechanism. In the data layer, we can improve the efficiency of data

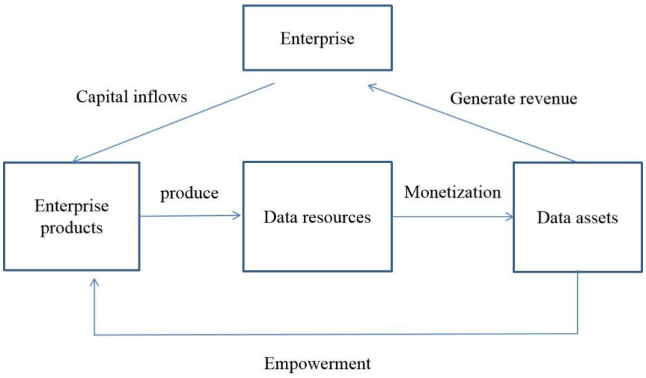

Fig. 3.2: Data assetization process

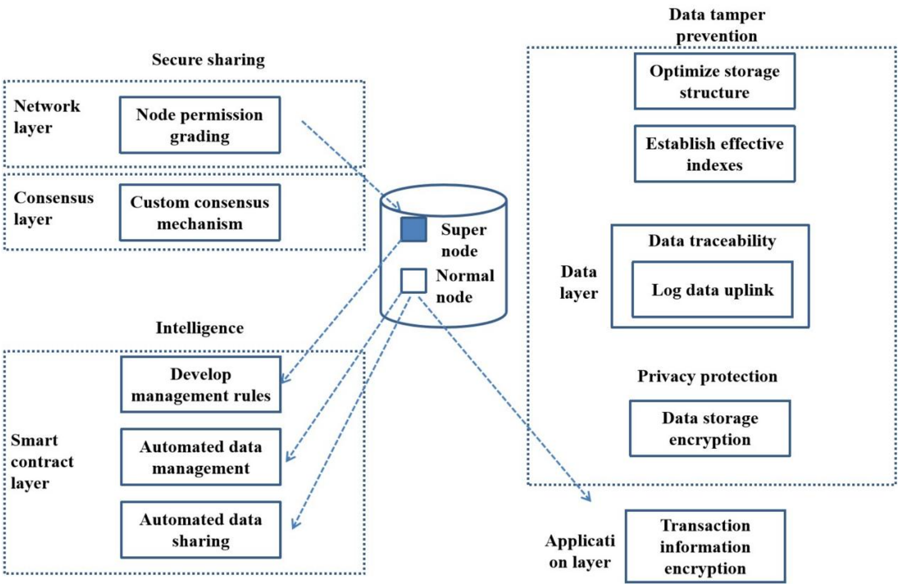

Fig. 3.3: A new model framework for data asset management based on blockchain

query through optimization of memory structure and query methods, including establishing efficient indexes. Additionally, data traceability is ensured through log data chaining, while privacy is maintained via encryption algorithms applied to data. In the Intelligent Contract Layer, the data management is partially automated by deploying Intelligent Contract Program Segments. Finally, security measures are put in place to protect sensitive user information, including transaction data encryption.

In the traditional blockchain data layer, data is organized using a linked list structure for block connection and a Merkle tree structure for data storage within blocks. This design grants blockchain its hallmark feature of resistance to data tampering. Moreover, the inclusion of a timestamp field ensures temporal coherence, allowing for the restoration and tracing of all historical operations based on immutable data. However, traditional blockchains feature a single data structure and straightforward query methods, resulting in suboptimal efficiency for on-chain data queries. In data asset management scenarios, where frequent data interactions occur, high query efficiency is paramount. Thus, in the data layer of the new data asset management model, blockchain technology is employed to uphold data tamper resistance while enhancing efficiency[16,17]. Figure 3.4 illustrates

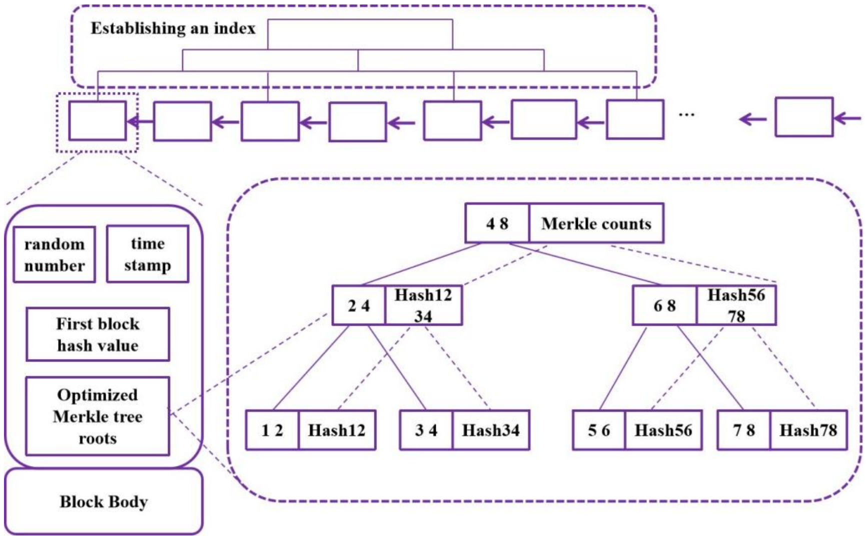

Fig. 3.4: Schematic diagram of data layer optimization

strategies for optimizing the blockchain data structure to enhance query efficiency without compromising data integrity. One approach involves modifying the Merkle tree structure within blocks and integrating it with other balanced tree structures. This hybrid structure ensures that data remains resistant to tampering while improving query efficiency. Furthermore, without altering the fundamental chain structure of the blockchain, query indexes like skip tables can be implemented. These indexes streamline data retrieval processes, making on-chain queries more efficient. Moreover, uploading log-type data onto the blockchain, which is inherently resistant to tampering, facilitates the traceability of all historical operations. This feature proves invaluable in defining responsibility for unexpected occurrences during data asset management and circulation processes.

In traditional blockchain systems, the smart contract layer ensures automated and trustworthy operations, free from human intervention. These operations are traceable and irreversible, thus maintaining the automated nature of the blockchain technology. In the new Data Asset Management Model, officials create a common transaction rule by making use of an automatic script code. These agreements also allow for authentication and verification of data by super nodes in the network, which guarantees the legality of data asset sharing transactions. Users, both official and ordinary, utilize smart contracts to automate data asset management processes. They can also facilitate automated data asset sharing among themselves. Similar to traditional blockchain systems, deploying smart contracts in the new model is treated as a special transaction on the chain. In this model, however, the super-nodes package their published smart contracts into blocks and upload them to the blockchain for deployment. On the other hand, contracts from normal nodes must be verified by super nodes before deployment on the blockchain. This ensures the integrity and security of the deployed contracts within the data asset management framework [18].

In the application layer of traditional blockchain, transactions can be encrypted using asymmetric encryption algorithms, making them highly private. In the scenario of data asset management, nodes participating in data exchange need to protect sensitive information during their transaction process, while data owners need to protect their own data assets. Therefore, in the new model of blockchain based data asset management, it is not only necessary to support the encryption of sensitive information in transactions, but also to support data encryption in the process of data asset sharing. For sensitive information in transactions, encryption algorithms can be used directly for encryption, and only encryption nodes can access the transaction information they participate in. For the shared data assets, the data owner needs to encrypt them using the public key related to the data asset sharee, and share them with the data asset sharee. In the new blockchain-based data asset management model, the recipient of a data asset utilizes their private key for decryption before

Table 3.1: Data Income Changes Table

Project	Revenue generated in the first year of data collection	Revenue generated in the second year of data collection	Revenue generated in the third year of data collection	......
Data collected in phase T		-	-	-
Data collected in T-1 period			-	-
Data collected in T-2 phase				-
......				

accessing the content of the asset. Furthermore, the model allows ordinary nodes to employ their encryption algorithms for managing data assets. This additional feature enhances the privacy protection measures compared to traditional blockchain methods [19].

In the new model of blockchain-based data asset management, data security sharing requirements are effectively met by implementing node permission control and customizing the consensus mechanism. This ensures that only authorized nodes can access and manipulate sensitive data, enhancing overall data security within the management framework. Moreover, by optimizing the block structure and implementing indexes, the model guarantees efficient querying of data stored on the blockchain. This optimization ensures that users can swiftly retrieve relevant information, enhancing operational efficiency in data asset management tasks. To address the need for data traceability, the model uploads log data onto the blockchain. This practice ensures that a comprehensive record of all transactions and operations is maintained, facilitating auditing and accountability within the data asset management system. The sensitive data protection needs in data asset management are met through mechanisms that can encrypt and customize data and transaction information.

3.4. Benefit distribution method. The MCRS method is a simple calculation method that only considers the maximum profit and minimum profit in a major alliance, without considering the initial stage of alliance formation. Therefore, it is more suitable for more stable alliances, that is, stronger alliances.

The simplified MCRS method, namely the maximum minimum cost method. The calculation formula for this method is:

$$\omega_i = X_i min \frac{X_i max - X_i min}{\sum_{i \in N}(X_i max - X_i min)}[V(N) - \sum_{i \in N} X_i min]\forall_i \in N \tag{3.1}$$

Among them, the expected benefits of each partner are allocated as their highest benefit, and the actual benefits that each partner should receive are allocated as their lowest benefit, that is

$$\begin{gathered} X_i max = V(N) - V(N-i)\forall_i \in N \\ X_i min = V(N)_i = X_i \end{gathered} \tag{3.2}$$

Generally speaking, the expected lifespan of a data asset is the expected time for the asset to generate significant economic benefits. According to Table 3.1, it can be determined that the data will no longer generate significant economic benefits after several years of collection. It should be noted that sometimes the emergence of new data can lead to the retirement of old data, but this does not mean that old data cannot create significant economic benefits anymore [20].

3.5. Experimental preparation. The experiment was performed on a PC with a 2.6 GHz Intel Core i7 processor and 16 GB memory. In the experiment, we build a blockchain platform with Python programming language, which aims to realize a new model of data asset management. The platform consists of a super node and 2, 4, 6 and 8 common nodes.

The concrete experiments are as follows: 2, 4, 6 and 8 common nodes upload data into the blockchain network within a given time frame, with the same number of data being uploaded per common node. There are two phases to upload data: the beginning and the end of the upload. Upload start is a command sent by a normal node to send data, and send end means that it has already been added to the block copy of every regular

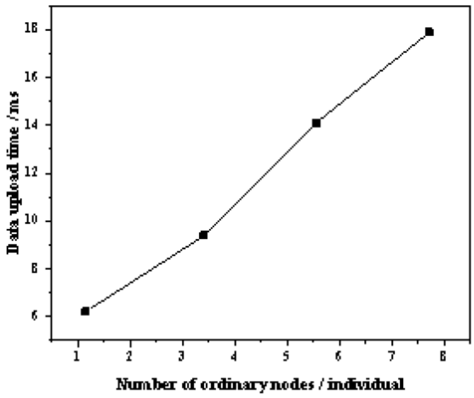

Fig. 4.1: Time for uploading data to the blockchain platform

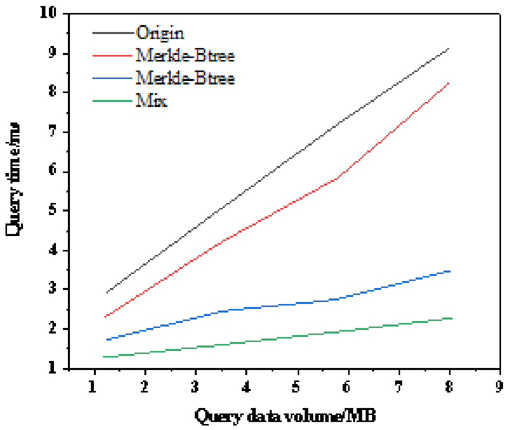

Fig. 4.2: Comparison of data query times using different methods

node. Thus, the time to upload the data to the blockchain platform is the time period from the beginning to the end of the upload.

4. Results and Discussion. In Figure 4.1, it's evident that as the number of nodes increases consistently, the data upload time demonstrates a stable and expected growth pattern, displaying a linear distribution overall. This observation validates the stability of the author's proposed model for data asset management leveraging blockchain technology. By examining the data upload times across multiple nodes, it becomes apparent that this new model significantly reduces upload times, showcasing its efficiency.

The experiment encompasses four distinct methods for querying data asset information: The first method employs conventional blockchain techniques for querying, referred to as the "origin method." The second method optimizes the existing data structure for querying by utilizing the Merkle B tree method. The third method employs the skip list structure for querying, denoted as the "skip list method." The fourth method, termed the "mix method," introduces the querying technique proposed in this article, integrating elements from blockchain methods. These methods are applied to query data asset information of varying capacities, with the query time recorded for each scenario. The results of the query time are illustrated in Figure 4.2.

Comparing the query times among the four methods reveals that the optimized structures (Merkle-B tree method, skip list method, mix method) outperform the origin method in terms of query speed. Notably, the mix method demonstrates the highest query efficiency, followed by the skip list method, with the Merkle B tree method trailing behind once more. This ranking can be attributed to several factors. The Merkle-B tree method, while optimizing the block data structure, only yields a modest increase in speed (17%) due to the relatively small amount of data within each block. In contrast, the skip list method's introduction of indexes between blocks significantly enhances query speed, resulting in a 1.24 times improvement. However, the mix method combines the strengths of both the Merkle-B tree method and the skip list method. By leveraging the advantages of both approaches, it achieves the fastest data query speed, performing 2.25 times faster than the origin method. This demonstrates the effectiveness of integrating optimized structures to enhance query efficiency.

5. Conclusion. The author suggests exploring a novel approach to distributing revenue from data assets, known as the "dual contribution" model, leveraging blockchain technology for enhanced trustworthiness. With the advent of big data, effective management of data assets becomes paramount, and blockchain offers promising solutions for ensuring robust security, privacy, and auditability in data asset management. While existing blockchain-based mechanisms for data asset management often focus on specific layers within the blockchain system framework, this proposed model aims to integrate multiple layers for a more comprehensive approach.

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Edited by: Bradha Madhavan
Special issue on: High-performance Computing Algorithms for Material Sciences
Received: May 31, 2024
Accepted: Aug 2, 2024