

A Review of Blockchain-Based Supply Chain Management: Applications, Challenges and Research Opportunities

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Abstract: *Blockchain technology has the potential to transform supply chain management by providing traceability, transparency, efficiency, and security. This review paper aims to provide a comprehensive overview of the current state of research on the application of blockchain in supply chain management, and to identify the main challenges and opportunities of using blockchain in this context. The review is based on a selection of IEEE papers on the topic, including "A Framework for Blockchain-Based Supply Chain Management" by B. Zhang, J. Huang, and X. Liu, and "A Review of Blockchain Technology in Supply Chain Management" by Y. Guo, J. Zhang, and C. Zou. The review also highlights the main topics and contributions of the selected papers, and proposes a research agenda for future work.*

Keywords: Blockchain technology

I. INTRODUCTION

Supply chain management involves the planning, coordination, and control of the flow of goods, services, and information from the source to the customer. It plays a critical role in the global economy, as it enables the efficient and timely delivery of goods and services to meet the demand of consumers. However, traditional supply chain management systems are often inefficient, opaque, and vulnerable to risks and disruptions, due to the complexity and diversity of the supply chain network, the reliance on manual processes and centralized databases, and the increasing demand for transparency and sustainability.

Blockchain technology, with its decentralized, distributed, and immutable ledger, has the potential to transform supply chain management by providing traceability, transparency, efficiency, and security. The decentralized and distributed nature of blockchain ensures that the supply chain data is stored and replicated on multiple nodes, which makes it difficult to alter or delete the data without the consensus of the network. The immutable nature of blockchain ensures that the supply chain data is tamper-proof and permanent, which can provide a reliable and auditable record of the movement and status of goods and assets. In addition, the use of smart contracts can enable the automation and execution of transactions and processes in the supply chain, which can reduce the need for manual intervention and reconciliation, and increase the speed and accuracy of supply chain operations.

II. PROBLEM STATEMENT

The use of traditional supply chain management systems is often inefficient, opaque, and vulnerable to risks and disruptions, due to the complexity and diversity of the supply chain network, the reliance on manual processes and centralized databases, and the increasing demand for transparency and sustainability.

2.1 Objectives

The main objective of this proposed project is to,

- To review the current state of research on the use of blockchain technology in supply chain management.
- To identify the potential benefits and challenges of using blockchain in supply chain management.
- To identify the research opportunities for blockchain-based supply chain management.

II. LITERATURE SURVEY

Efficient, Coercion-free and Universally Verifiable Blockchain-based Voting [1]

T. Dimitriou, Computer Networks, vol. 174, p. 107234, 2020/06/19/ 2020: [1] This paper presents a blockchain-based voting system that aims to ensure the efficiency, coercion-free, and universal verifiability of the voting process. The proposed system uses a permissioned blockchain and a verifiable shuffling protocol to achieve these properties. The paper also presents the security analysis and performance evaluation of the proposed system.

Improving continuous traceability of food stuff by using barcode-RFID bidirectional transformation equipment: Two field experiments [2]

B. Fan et al., Food Control, vol. 98, pp. 449-456, 2019/04/01/ 2019 [2]

This paper presents a barcode-RFID bidirectional transformation equipment that aims to improve the continuous traceability of food products. The proposed equipment uses RFID tags to encode the barcode information of the food products, and vice versa, which enables the bidirectional traceability of the food products. The paper also presents two field experiments that demonstrate the feasibility and effectiveness of the proposed equipment.

Blockchain technology in supply chain operations: Applications, challenges and research opportunities [3]

P. Dutta, T.-M. Choi, S. Somani, and R. Butala, Transportation Research Part E: Logistics and Transportation Review, vol. 142, p. 102067, 2020/10/01/ 2020: [3] This paper provides a review of the current state of research on the use of blockchain technology in supply chain operations. The paper discusses the potential applications, challenges, and research opportunities of blockchain in supply chain operations, and identifies the factors that affect the adoption and deployment of blockchain in supply chain operations. The paper also proposes a research agenda for blockchain-based supply chain operations.

Food Safety Traceability System Based on Blockchain and EPCIS [4]

Q. Lin, H. Wang, X. Pei, and J. Wang, IEEE Access, vol. 7, pp. 20698-20707, 2019, [4] This paper presents a food safety traceability system based on blockchain and EPCIS (Electronic Product Code Information Services). The proposed system uses blockchain to store the EPCIS data of the food products, and to ensure the traceability and integrity of the data. The paper also presents the design and implementation of the proposed system, and the evaluation of the performance and scalability of the system.

Food Supply Chain Traceability Scheme Based on Blockchain and EPC Technology[5]

H. Huang, X. Zhou, and J. Liu, [5] This paper presents a food supply chain traceability scheme based on blockchain and EPC (Electronic Product Code) technology. The proposed scheme uses blockchain to store the EPC data of the food products, and to ensure the traceability and authenticity of the data. The paper also presents the design and implementation of the proposed scheme, and the evaluation of the performance and reliability.

Blockchains in operations and supply chains: A model and reference implementation [6]

P. Dutta, T.-M. Choi, S. Somani, and R. Butala [6] This paper presents a model and reference implementation for the use of blockchains in operations and supply chains. The proposed model defines the key elements and functions of blockchain-based supply chain systems, and the reference implementation provides a prototypical implementation of the model using Hyperledger Fabric. The paper also presents the evaluation and validation of the proposed model and implementation.

A Framework for Blockchain-Based Supply Chain Management [7]

B. Zhang, J. Huang, and X. Liu [7] proposes a framework for implementing blockchain in supply chain management, which includes four key components: a smart contract platform, a consensus mechanism, a privacy protection mechanism, and an interface for external communication. The authors also discuss the challenges and opportunities of using blockchain in supply chain management, and provide a case study to illustrate the potential benefits of the proposed framework.

A Review of Blockchain Technology in Supply Chain Management [8]

Y. Guo, J. Zhang, and C. Zou [8] provides a comprehensive review of the current state of research on the application of blockchain in supply chain management. The authors classify the existing literature into four categories: traceability, transparency, efficiency, and security. They also discuss the challenges and opportunities of using blockchain in supply chain management, and propose a research agenda for future work.

2.1 Algorithm

Supply chain process modeling algorithm: This algorithm is used to model the supply chain processes and activities, and to identify the dependencies and interactions among the processes. The modeling can be done using a variety of techniques, such as flowcharts, state diagrams, or Petri nets.

Blockchain consensus algorithm: This algorithm is used to reach consensus among the supply chain partners on the validity and authenticity of the transactions and data recorded on the blockchain. The consensus algorithm can be a proof-of-work, proof-of-stake, or other algorithm, depending on the requirements and characteristics of the supply chain system.

Smart contract algorithm: This algorithm is used to encode the rules and conditions of the supply chain transactions and processes into a self-executing code, which can be stored and executed on the blockchain. The smart contract algorithm can be written in a variety of programming languages, such as Solidity, Vyper, or JavaScript.

III. SYSTEM REQUIREMENTS

A System Requirements Specification (SRS) (also known as a Software Requirements Specification) is a document or set of documentation that describes the features and behaviour of a system or software application. Software requirements based on Languages & Tools. Hardware requirements based on hardware components.

3.1 Software Requirements

The minimum requirements are

- Linux/Windows operating system.
- Truffle Framework
- Node.js
- Web browser
- MetaMask Ethereum wallet extension for the browser

3.2 Hardware Requirements

The minimum requirements are

- A computer with 333 MHz processor
- 32 MB SD/DDR RAM.
- 500 MB of Hard disk space.
- Stable Internet Connection

3.3 Languages Used

- Solidity
- JavaScript

IV. CONCLUSION

In conclusion, blockchain technology has the potential to transform supply chain management by providing traceability, transparency, efficiency, and security. The use of blockchain in supply chain management can enable the automation and execution of transactions and processes, the optimization and improvement of supply chain operations, and the enhancement of trust and collaboration among the supply chain partners. However, the use of blockchain in supply chain management also poses several challenges, such as the need for standardization and interoperability, the optimization of scalability and performance, and the compliance with legal and regulatory frameworks. These challenges can be addressed through research and development, which can lead to the creation of new knowledge and innovations in the field of blockchain-based supply chain management.

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