INTEROPERABLE BLOCKCHAIN ARCHITECTURE FOR SECURE AND TRANSPARENT SUPPLY CHAIN MANAGEMENT

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The rapid development of blockchain technology has transformed supply chain management by enhancing traceability, transparency, and data security. This study presents an innovative model aimed at resolving key interoperability and standardization challenges within blockchain-based supply chains. The proposed framework introduces the use of verifiable credentials, digital signatures, and metadata schemas to support the cross-platform tracking of assets while ensuring regulatory compliance and data immutability.

The model is structured around a credential verification ecosystem involving four key participants: issuer, owner, verifier, and data registry. These entities interact through cryptographically validated claims, supported by digital signature mechanisms and public key infrastructure. This structure ensures semantic compatibility across different blockchain systems and promotes automated schema expansion to meet evolving regulatory and operational needs. The integration of W3C-compliant data formats enables seamless communication and validation processes between disparate platforms.

One of the primary applications highlighted is the traceability of pharmaceuticals and medical equipment. Through digital signatures recorded on decentralized ledgers, each asset's history can be independently verified at every stage of the supply chain. This capability reduces fraud, enhances audit efficiency, and fosters trust among stakeholders [1], [2].

The model's adaptability allows for its deployment in multi-stakeholder environments, facilitating real-time collaboration and the secure exchange of credentialed data. As emphasized in recent studies, blockchain's potential lies not only in data integrity but also in establishing trust without central authority [3], [4].

This research advances blockchain application by combining verifiable credentials with decentralized control, thereby contributing to the development of intelligent, interoperable, and secure supply networks for next-generation logistics infrastructures.

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