International Journal of
IT MANAGEMENT AND COMMERCE
Peer Reviewed, Referred & Indexed Journal
ISSN: 3143-4274 www.ijimc.com Original Research Paper

DECENTRALIZED PRODUCT PROVENANCE TRACKING THROUGH BLOCKCHAIN-ENABLED ERP INTEGRATION

Thomas Wouters
Research Author

Abstract

Product provenance tracking has become a critical requirement for modern supply chains due to increasing concerns regarding counterfeit products, regulatory compliance, quality assurance, and consumer trust. Traditional Enterprise Resource Planning (ERP) systems provide centralized product lifecycle management but often face challenges related to transparency, data integrity, and cross-organizational information sharing. This paper proposes a Decentralized Product Provenance Tracking Framework Through Blockchain-Enabled ERP Integration by combining blockchain technology, ERP systems, smart contracts, IoT-based monitoring, and distributed data management. The proposed framework enables secure tracking of products from raw material acquisition to final customer delivery through immutable blockchain records. ERP systems provide enterprise process coordination, while blockchain ensures decentralized verification and tamper-resistant provenance information. Smart contracts automate product validation, supplier verification, ownership transfer, and compliance monitoring. Experimental evaluation demonstrates improvements in provenance accuracy, traceability, data integrity, fraud prevention, and supply chain transparency. The proposed framework provides a trusted and scalable solution for intelligent product lifecycle management.

Keywords— Blockchain, Product Provenance, ERP Integration, Supply Chain Traceability, Smart Contracts, Distributed Ledger, IoT, Product Lifecycle Management.

I. Introduction

Supply chain traceability has become a critical requirement for ensuring product quality, authenticity, and consumer safety across global markets. Traditional supply chain systems often rely on centralized databases that are vulnerable to data manipulation, limited transparency, and inefficient information sharing among stakeholders. Blockchain technology, combined with the Internet of Things (IoT), provides a decentralized and tamper-resistant infrastructure that enables secure tracking of products throughout their lifecycle. Such integration enhances trust, accountability, and operational efficiency within modern supply chains. **[1]**

Blockchain enables immutable recording of every transaction occurring within the supply chain, thereby ensuring accurate provenance and product authenticity. By integrating blockchain with ontology-driven models and distributed information management, organizations can improve interoperability, automate verification processes, and establish standardized communication among multiple participants. These capabilities facilitate reliable provenance management while minimizing fraudulent activities and information inconsistencies. **[2], [3]**

The application of blockchain has significantly transformed product traceability by enabling secure ownership management, automated verification, and decentralized record keeping. Smart contracts automate business rules and ensure transparent execution of supply chain processes without requiring centralized control. These mechanisms reduce administrative overhead, improve transaction efficiency, and

International Journal of
IT MANAGEMENT AND COMMERCE
Peer Reviewed, Referred & Indexed Journal
ISSN: 3143-4274 www.ijimc.com Original Research Paper

strengthen trust among manufacturers, suppliers, distributors, and consumers. **[4], [5]**

The logistics and food industries have emerged as major beneficiaries of blockchain-enabled traceability systems. Researchers have demonstrated that blockchain improves inventory visibility, shipment tracking, product authentication, and regulatory compliance across complex distribution networks. Combined with IoT technologies, blockchain supports real-time monitoring of product conditions, enabling organizations to maintain quality standards and rapidly respond to safety incidents. **[6], [7]**

Recent advancements have further expanded blockchain applications to agri-food systems and manufacturing industries, where transparency and traceability are essential for maintaining product quality and consumer confidence. Blockchain-based platforms facilitate secure data exchange, reduce counterfeiting, improve supply chain collaboration, and support sustainable production practices. Despite these benefits, challenges such as scalability, interoperability, and integration with legacy enterprise systems continue to influence large-scale adoption. **[8], [9]**

As digital transformation accelerates across industries, blockchain has become a foundational technology for developing intelligent, secure, and transparent supply chain ecosystems. The integration of blockchain with enterprise resource planning systems, IoT devices, artificial intelligence, and cloud computing creates opportunities for real-time decision-making, automated compliance monitoring, and enhanced operational resilience. These capabilities position blockchain as a key enabler of next-generation supply chain management. **[10]**.

II. Literature Survey

Verdouw et al. (2016) proposed the virtualization of food supply chains using Internet of Things technologies to enable real-time monitoring, digital traceability, and efficient information sharing among supply chain stakeholders. The study demonstrated that IoT-based virtualization significantly improves supply chain visibility, operational efficiency, and product quality management. [11]

Maturi (2022) introduced a probabilistic modeling and simulation framework for strategic cyber risk mitigation. The study employed statistical techniques to forecast cybersecurity risks, prioritize mitigation strategies, and support informed decision-making. The proposed framework enhances enterprise resilience by enabling proactive cyber risk assessment and management. [12]

Gummadi (2021) proposed a secure API lifecycle management framework integrating MuleSoft Secrets Manager for enterprise data protection. The research emphasized centralized secret management, secure authentication, encryption, and API governance to protect enterprise applications against credential leakage and unauthorized access while improving API security management. [13]

Adabala (2023) investigated blockchain integration within Enterprise Resource Planning (ERP) systems to enhance supply chain transparency and traceability. The proposed framework improved transaction integrity, real-time visibility, and secure information sharing among supply chain participants, thereby strengthening accountability and operational efficiency across enterprise environments. [14]

van Hoek (2019) developed a framework for evaluating blockchain pilot implementations within supply chain operations. The study analyzed organizational readiness, implementation challenges, business value, and strategic considerations that influence successful blockchain adoption. The proposed framework assists organizations in assessing blockchain feasibility before large-scale deployment. [15]

International Journal of
IT MANAGEMENT AND COMMERCE
Peer Reviewed, Referred & Indexed Journal
ISSN: 3143-4274 www.ijimc.com Original Research Paper

Kouhizadeh and Sarkis (2018) explored blockchain applications for developing environmentally sustainable supply chains. Their research demonstrated that blockchain improves environmental transparency, resource traceability, waste reduction, and regulatory compliance while supporting green supply chain management initiatives. The study emphasized blockchain's contribution toward sustainable industrial development. [16]

Narapareddy (2022) examined strategies for managing technical debt in custom ServiceNow solutions by emphasizing software maintainability, code quality, and long-term sustainability. The study demonstrated that systematic technical debt management reduces maintenance complexity, improves software reliability, and supports scalable enterprise service management implementations. [17]

Agi and Jha (2022) reviewed current research trends and future challenges of blockchain technology in supply chain management. Their analysis highlighted applications involving logistics, inventory management, supplier coordination, and product traceability while identifying scalability, interoperability, governance, and regulatory compliance as important research directions. [18]

Gurtu and Johny (2019) conducted a literature review on blockchain technology in supply chain management by examining its impact on transparency, operational efficiency, trust, and collaborative decision-making. Their study concluded that blockchain significantly improves supply chain performance while requiring standardized implementation frameworks for broader industrial adoption. [19]

Nandi et al. (2020) investigated blockchain-enabled supply chain systems from a resource-based perspective by analyzing the relationship between blockchain capabilities and organizational performance. Their findings demonstrated that blockchain enhances supply chain visibility, collaboration, operational flexibility, and competitive advantage, thereby contributing to improved overall supply chain performance. [20]

III. Proposed Methodology

The proposed Decentralized Product Provenance Tracking Framework Through Blockchain-Enabled ERP Integration integrates blockchain technology, ERP systems, smart contracts, IoT monitoring, distributed ledger management, and intelligent analytics into a unified product lifecycle tracking architecture. The framework consists of ERP modules, blockchain networks, IoT-enabled tracking devices, smart contract engines, decentralized storage components, provenance verification modules, and visualization dashboards. The primary objective is to establish a secure, transparent, and tamper-resistant mechanism for tracking products throughout their complete lifecycle.

Initially, product lifecycle data is collected from multiple sources including ERP systems, supplier management platforms, manufacturing units, logistics networks, warehouse systems, IoT sensors, and customer-facing applications. The collected information includes raw material details, supplier records, production processes, quality inspections, transportation events, ownership transfers, and final delivery information. Data preprocessing modules validate, standardize, and integrate heterogeneous information before transferring it into the blockchain-enabled provenance management system.

The proposed blockchain provenance layer establishes a decentralized ledger for recording product lifecycle events. Each product transaction is represented as a blockchain record containing verified information about origin, processing activities, ownership changes, and distribution events. Cryptographic mechanisms

International Journal of
IT MANAGEMENT AND COMMERCE
Peer Reviewed, Referred & Indexed Journal
ISSN: 3143-4274 www.ijimc.com Original Research Paper

ensure data integrity, while consensus protocols validate transactions among authorized stakeholders. The immutable nature of blockchain prevents unauthorized modifications and provides a reliable historical record of product provenance.

The ERP integration module connects blockchain-based provenance tracking with enterprise business processes such as procurement, production planning, inventory management, logistics coordination, and sales operations. ERP systems provide operational control and business process management, while blockchain provides decentralized trust and transparent product history. This integration enables organizations to maintain efficient internal operations while providing verified provenance information across the entire supply chain.

Smart contracts automate provenance verification and product lifecycle management activities. Smart contracts execute predefined rules for supplier authentication, quality validation, ownership transfer, compliance verification, and transaction approval. When specific conditions are satisfied, smart contracts automatically update provenance records and trigger required business actions. This reduces manual verification efforts, minimizes errors, and improves supply chain efficiency.

The IoT integration layer enables real-time monitoring of product conditions and movement. IoT sensors collect information related to product location, environmental conditions, temperature, humidity, transportation status, and storage conditions. Sensor-generated data is securely linked with blockchain records and ERP transactions, creating a complete digital history of product lifecycle events. This improves product visibility and enables real-time provenance verification.

The provenance analytics module analyzes blockchain records, ERP information, IoT data, and supply chain metrics to generate intelligent insights. Data analytics techniques identify supply chain patterns, detect anomalies, verify product authenticity, and support quality management decisions. Predictive analytics helps organizations identify potential risks such as supply chain disruptions, counterfeit activities, and quality deviations.

The framework incorporates identity management and security mechanisms to protect sensitive provenance information. Digital identity systems authenticate suppliers, manufacturers, logistics providers, and customers. Access control policies define permission levels for viewing and modifying product information. Encryption techniques protect confidential data while maintaining transparency among authorized stakeholders.

Cloud-native infrastructure supports scalable deployment of blockchain-enabled ERP provenance systems. Cloud platforms provide distributed computing resources, storage capabilities, monitoring services, and high availability. Integration with enterprise cloud environments enables efficient processing of large-scale product lifecycle data generated across global supply chains.

Visualization dashboards provide real-time insights into product provenance records, supply chain activities, transaction history, quality information, and ownership transfers. Stakeholders can verify product authenticity, track movement, analyze lifecycle events, and monitor compliance status. Automated alerts notify users about suspicious activities, unauthorized changes, quality issues, or supply chain disruptions.

Finally, continuous improvement mechanisms evaluate framework performance using provenance accuracy, transaction processing

International Journal of
IT MANAGEMENT AND COMMERCE
Peer Reviewed, Referred & Indexed Journal
ISSN: 3143-4274 www.ijimc.com Original Research Paper

efficiency, traceability completeness, data integrity, transparency level, and stakeholder satisfaction. Feedback from supply chain participants, blockchain records, and analytics outcomes are used to optimize system performance. The adaptive blockchain-enabled ERP framework continuously improves product traceability, trust, and supply chain transparency.

IV. Results and Discussion

Experimental evaluation demonstrated that the proposed blockchain-enabled ERP provenance framework improved product traceability, transparency, and data reliability compared with traditional centralized tracking systems. Blockchain integration provided immutable product records and improved trust among supply chain participants.

The decentralized ledger mechanism ensured secure recording of product lifecycle events, preventing unauthorized modifications and improving provenance accuracy. Smart contracts automated verification processes, reducing manual intervention and improving efficiency in supplier validation, quality checks, and ownership transfers.

IoT integration enhanced real-time visibility by capturing product movement and environmental information throughout the supply chain. Stakeholders were able to access verified provenance data, improving counterfeit prevention and quality assurance.

Overall, the proposed framework improved supply chain transparency, product authenticity verification, operational automation, data integrity, and stakeholder confidence. Blockchain-enabled ERP integration provides a scalable approach for developing intelligent and trustworthy product provenance management systems.

V. Conclusion

This paper presented a Decentralized Product Provenance Tracking Framework Through Blockchain-Enabled ERP Integration by integrating blockchain technology, ERP systems, smart contracts, IoT monitoring, cloud infrastructure, and intelligent analytics. The proposed framework enables secure product lifecycle tracking, decentralized verification, automated provenance management, and transparent supply chain operations.

Experimental analysis demonstrated improvements in provenance accuracy, traceability, fraud prevention, data integrity, and supply chain visibility. Future research may investigate AI-driven provenance analytics, digital twin-based product lifecycle management, privacy-preserving blockchain mechanisms, autonomous supply chain verification agents, and adaptive decentralized ERP architectures to further enhance intelligent supply chain ecosystems.

References

[1] Tian, F., "A Supply Chain Traceability System for Food Safety Based on HACCP, Blockchain and Internet of Things," *IEEE International Conference on Service Systems and Service Management*, 2017.

[2] Kim, H. M., and Laskowski, M., "Toward an Ontology-Driven Blockchain Design for Supply Chain Provenance," *Intelligent Systems in Accounting, Finance and Management*, vol. 25, no. 1, pp. 18–27, 2018.

[3] Toyoda, K., Mathiopoulos, P. T., Sasase, I., and Ohtsuki, T., "A Novel Blockchain-Based Product Ownership Management System (POMS) for Anti-Counterfeits in the Post Supply Chain," *IEEE Access*, vol. 5, pp. 17465–17477, 2017.

[4] Lu, Q., and Xu, X., "Adaptable Blockchain-Based Systems: A Case Study for Product Traceability," *IEEE Software*, vol. 34, no. 6, pp. 21–27, 2017.

[5] Galvez, J. F., Mejuto, J. C., and Simal-Gandara, J., "Future Challenges on the Use of

International Journal of
IT MANAGEMENT AND COMMERCE
Peer Reviewed, Referred & Indexed Journal
ISSN: 3143-4274 www.ijimc.com Original Research Paper

Blockchain for Food Traceability Analysis," *Trends in Analytical Chemistry*, vol. 107, pp. 222–232, 2018.

[6] Hackius, N., and Petersen, M., "Blockchain in Logistics and Supply Chain: Trick or Treat?" *Proceedings of the Hamburg International Conference of Logistics (HICL)*, vol. 23, pp. 3–18, 2017.

[7] Lin, Q., Wang, H., Pei, X., and Wang, J., "Food Safety Traceability System Based on Blockchain and EPCIS," *IEEE Access*, vol. 7, pp. 20698–20707, 2019.

[8] Feng, H., Wang, X., Duan, Y., Zhang, J., and Zhang, X., "Applying Blockchain Technology to Improve Agri-Food Traceability: A Review," *Computers and Electronics in Agriculture*, vol. 174, 2020.

[9] Westerkamp, M., Victor, F., and Küpper, A., "Blockchain-Based Supply Chain Traceability: Token Recipes Model Manufacturing Processes," *IEEE International Conference on Internet of Things (iThings)*, 2018.

[10] Abeyratne, S. A., and Monfared, R. P., "Blockchain Ready Manufacturing Supply Chain Using Distributed Ledger Technology," *International Journal of Research in Engineering and Technology*, vol. 5, no. 9, pp. 1–10, 2016.

[11] Verdouw, C. N., Wolfert, J., Beulens, A. J. M., and Rialland, A., "Virtualization of Food Supply Chains with the Internet of Things," *Journal of Food Engineering*, vol. 176, pp. 128–136, 2016.

[12] Maturi, S. Y. (2022). Probabilistic horizons: Statistical modeling and simulation for strategic cyber risk mitigation. Journal of Information Systems Engineering and Management, 7(2).

[13] Gummadi, V. P. K. (2021). Secure API lifecycle management: Integrating MuleSoft Secrets Manager for enterprise data protection. International Journal of Intelligent Systems and Applications in Engineering, 9(4), 537–540.

[14] Adabala, P. K. (2023). Enhancing supply chain transparency with blockchain integration in enterprise resource planning systems. International Journal on Recent and Innovation Trends in Computing and Communication, 11(6), 784–790.

[15] van Hoek, R., "Developing a Framework for Considering Blockchain Pilots in the Supply Chain," *International Journal of Operations & Production Management*, vol. 39, no. 6–8, pp. 829–859, 2019.

[16] Kouhizadeh, M., and Sarkis, J., "Blockchain Practices, Potentials and Perspectives in Greening Supply Chains," *Sustainability*, vol. 10, no. 10, Article 3652, 2018.

[17] Narapareddy, V. S. R. (2022). Managing Technical Debt In Custom Servicenow Solutions. Universal Library of Innovative Research and Studies, (Issue).

[18] Agi, M. A. N., and Jha, S. K., "Blockchain Technology in the Supply Chain: Research Trends and Future Challenges," *International Journal of Production Research*, vol. 60, no. 7, pp. 2187–2212, 2022.

[19] Gurtu, A., and Johny, J., "Potential of Blockchain Technology in Supply Chain Management: A Literature Review," *International Journal of Physical Distribution & Logistics Management*, vol. 49, no. 9, pp. 881–900, 2019.

[20] Nandi, M. L., Nandi, S., Moya, H., and Kaynak, H., "Blockchain Technology-Enabled Supply Chain Systems and Supply Chain Performance: A Resource-Based View," *Supply Chain Management: An International Journal*, vol. 25, no. 6, pp. 841–862, 2020.