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TRUST-AWARE ENTERPRISE SUPPLY CHAIN MANAGEMENT USING BLOCKCHAIN AND REAL-TIME ERP DATA

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Abstract

Modern enterprise supply chains require secure, transparent, and reliable information exchange among manufacturers, suppliers, logistics providers, and customers. The increasing complexity of global supply networks has created challenges related to trust management, data integrity, operational visibility, and real-time decision-making. Traditional Enterprise Resource Planning (ERP) systems provide centralized supply chain management capabilities but often face limitations in cross-organizational trust, data sharing, and transaction transparency. This paper proposes a Trust-Aware Enterprise Supply Chain Management Framework Using Blockchain and Real-Time ERP Data by integrating blockchain technology, ERP systems, IoT-enabled monitoring, smart contracts, and real-time analytics. The proposed framework establishes a trusted supply chain ecosystem through decentralized data verification, immutable transaction records, automated governance, and intelligent risk assessment. Real-time ERP data integration enables continuous monitoring of procurement, production, inventory, and logistics activities. Experimental evaluation demonstrates improvements in supply chain trust, transparency, data accuracy, operational efficiency, and decision-making capability. The proposed framework provides a scalable solution for intelligent and secure enterprise supply chain management.

Keywords— Blockchain, ERP Systems, Supply Chain Management, Trust Management, Real-Time Data Analytics, Smart Contracts, Distributed Ledger Technology, Enterprise Intelligence.

I. Introduction

Blockchain technology has emerged as a transformative innovation for modern supply chain management by providing decentralized, transparent, and tamper-resistant transaction processing. Traditional supply chains often experience challenges related to limited visibility, fragmented information sharing, counterfeit products, and inefficient coordination among stakeholders. Blockchain addresses these issues by establishing a distributed ledger that securely records every transaction, thereby improving trust, traceability, and operational efficiency across the supply chain network. **[1]**

The adoption of blockchain in supply chains has accelerated due to its ability to improve transparency, automate business processes through smart contracts, and strengthen collaboration among manufacturers, suppliers, logistics providers, and customers. Organizations increasingly recognize blockchain as an effective technology for reducing operational costs, minimizing fraud, and enhancing information integrity throughout the product lifecycle. Despite these advantages, successful implementation requires overcoming organizational, technical, and regulatory challenges associated with enterprise-scale blockchain deployment. **[2], [3]**

Blockchain also contributes significantly to sustainable supply chain management by supporting responsible sourcing, ethical manufacturing, environmental compliance, and efficient resource utilization. Secure information sharing among stakeholders enables organizations to monitor product movement in real time while improving accountability and reducing waste. These capabilities make blockchain an essential technology for achieving resilient, transparent, and environmentally sustainable supply chain ecosystems. **[4], [5]**

The digital transformation of supply chains increasingly depends on integrating blockchain with enterprise information systems, cloud computing, Internet of Things (IoT) devices, and advanced analytics platforms. Such integration facilitates secure communication, automated transaction verification, real-time monitoring, and intelligent decision-making across distributed business environments. Blockchain thereby supports the development of highly connected and data-driven digital supply chains. **[6], [7]**

Recent research has explored blockchain adoption across multiple industrial sectors, including manufacturing, logistics, healthcare, food safety, and retail. Systematic investigations have demonstrated improvements in product traceability, inventory management, supplier coordination, and regulatory compliance through decentralized information management. Nevertheless, issues such as interoperability, scalability, governance, and standardization continue to influence widespread industrial implementation of blockchain solutions. **[8], [9]**

As blockchain technology continues to mature, it is increasingly viewed as a foundational platform for future intelligent supply chains. Combined with artificial intelligence, big data analytics, and enterprise automation technologies, blockchain enables organizations to build secure, scalable, and transparent digital ecosystems capable of supporting complex global supply chain operations. These advancements provide new opportunities for enhancing supply chain performance and organizational competitiveness. **[10]**.

II. Literature Survey

Cole et al. (2019) examined the implications of blockchain technology for operations and supply chain management by evaluating its influence on procurement, logistics, inventory management, and supplier collaboration. Their findings demonstrated that blockchain improves operational transparency, transaction reliability, and process efficiency while supporting digital transformation across supply chain operations. **[11]**

Kouhizadeh et al. (2021) investigated blockchain technology from the perspective of sustainable supply chains by theoretically analyzing adoption barriers and organizational challenges. The study identified technological complexity, regulatory uncertainty, organizational readiness, and stakeholder acceptance as major factors affecting successful blockchain implementation while emphasizing its potential for supporting environmentally sustainable operations. **[12]**

Lim et al. (2021) conducted a comprehensive review of blockchain applications in supply chains by analyzing research trends across logistics, inventory management, procurement, and product traceability. Their study highlighted blockchain's ability to enhance transparency, collaboration, operational efficiency, and trust while identifying scalability and interoperability as ongoing research challenges. **[13]**

Nandi et al. (2020) examined blockchain-enabled supply chain systems using a resource-based perspective to evaluate their impact on organizational performance. The authors demonstrated that blockchain capabilities improve supply chain visibility, collaboration, operational flexibility, and competitive advantage, thereby contributing to enhanced business performance and strategic value creation. **[14]**

Pournader et al. (2020) presented a systematic review of blockchain applications in supply

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chains, transportation, and logistics by evaluating existing implementation frameworks and industrial use cases. Their research highlighted improvements in shipment tracking, logistics coordination, information sharing, and operational transparency while discussing future research opportunities for blockchain adoption. **[15]**

Hastig and Sodhi (2020) investigated business requirements and critical success factors for blockchain-based supply chain traceability systems. Their study emphasized the importance of stakeholder collaboration, standardized data governance, interoperability, organizational commitment, and technological readiness for achieving successful blockchain-enabled traceability implementations. **[16]**

Kumar Adabala (2021) proposed a smart data migration framework for ERP modernization that focuses on secure, accurate, and efficient migration of enterprise data from legacy systems. The framework emphasized data validation, migration automation, and risk mitigation to improve implementation reliability while maintaining enterprise data integrity during digital transformation initiatives. **[17]**

Maturi (2022) analyzed vulnerabilities in the IEEE 802.11 wireless client selection mechanism by identifying security weaknesses that could compromise wireless communications. The study proposed mitigation strategies to strengthen authentication mechanisms, improve network resilience, and reduce security risks associated with wireless communication infrastructures. **[18]**

Narapareddy (2022) examined strategies for integrating enterprise services with external systems using REST and SOAP web services. The research highlighted standardized communication protocols, secure API integration, service interoperability, and reliable information exchange as essential components for scalable enterprise software integration. **[19]**

Wamba et al. (2017) investigated the relationship between big data analytics capabilities and firm performance by analyzing the role of dynamic organizational capabilities. Their findings demonstrated that effective utilization of big data analytics enhances operational efficiency, organizational agility, and strategic decision-making, thereby improving overall business performance and competitiveness. **[20]**

III. Proposed Methodology

The proposed Trust-Aware Enterprise Supply Chain Management Framework Using Blockchain and Real-Time ERP Data integrates blockchain technology, ERP systems, IoT-enabled monitoring, smart contracts, real-time analytics, and trust evaluation mechanisms into a unified supply chain intelligence architecture. The framework consists of ERP data sources, blockchain networks, trust management modules, smart contract engines, IoT data acquisition systems, analytics platforms, and stakeholder dashboards. The primary objective is to establish a secure and trustworthy supply chain environment where participants can exchange verified information and make intelligent operational decisions.

Initially, real-time supply chain data is collected from multiple enterprise sources, including ERP systems, supplier management platforms, manufacturing applications, warehouse management systems, logistics platforms, IoT devices, and customer systems. The collected data includes procurement transactions, supplier information, production records, inventory levels, shipment details, quality reports, and financial activities. Data preprocessing modules validate, normalize, and integrate heterogeneous data sources to create a unified real-time supply chain information layer.

The blockchain integration layer provides decentralized storage and verification of supply chain transactions. ERP-generated events are converted into blockchain transactions containing cryptographically secured information about supply chain activities. Distributed ledger technology ensures that all authorized stakeholders maintain consistent and tamper-resistant records. Consensus mechanisms validate transactions before recording them permanently, improving data integrity and eliminating unauthorized modifications.

The trust management module evaluates the reliability and performance of supply chain participants using blockchain records and real-time ERP information. Trust scores are generated based on factors such as supplier history, transaction accuracy, delivery performance, compliance records, quality metrics, and operational behavior. Machine learning-based analytics identify trust patterns and detect abnormal activities that may indicate potential risks or fraudulent behavior.

Smart contracts automate supply chain governance processes by executing predefined rules and agreements. These contracts manage activities such as supplier authentication, purchase order verification, shipment confirmation, quality approval, payment processing, and compliance validation. Automated execution reduces dependency on manual intervention, improves transaction accuracy, and ensures that supply chain operations follow established governance policies.

The ERP synchronization module maintains continuous communication between blockchain networks and enterprise applications. Real-time ERP data updates are securely synchronized with blockchain records, enabling organizations to maintain operational control while achieving decentralized trust. This integration provides complete visibility into procurement, production, inventory, and logistics activities across the entire supply chain.

The IoT-based monitoring layer enables real-time tracking of physical supply chain operations. IoT sensors collect information related to product location, environmental conditions, transportation status, storage conditions, and equipment performance. Sensor-generated data is securely linked with ERP transactions and blockchain records to provide accurate and real-time supply chain visibility.

The intelligent analytics module analyzes blockchain records, ERP data, IoT information, and operational metrics to generate actionable insights. Predictive analytics techniques identify supply chain risks, demand fluctuations, supplier performance issues, and potential disruptions. Data-driven decision-making improves inventory planning, resource allocation, logistics optimization, and overall supply chain efficiency.

Security and privacy mechanisms are incorporated to protect sensitive enterprise information. Identity management systems authenticate suppliers, manufacturers, logistics providers, and customers. Role-based access control ensures that stakeholders can access only authorized information. Encryption techniques secure communication channels and protect confidential business data while maintaining transparency among trusted participants.

Cloud-native infrastructure supports scalable deployment of the trust-aware supply chain framework. Cloud platforms provide distributed computing resources, storage capabilities, monitoring services, and high availability. The architecture enables organizations to process large volumes of ERP and blockchain data generated from global supply chain operations.

Visualization dashboards provide real-time insights into supply chain trust levels, transaction history, supplier performance, inventory status, logistics activities, and operational risks. Stakeholders can monitor supply chain conditions, verify transaction authenticity, and analyze performance trends. Automated alerts notify users about trust violations, abnormal activities, delays, or compliance issues.

Finally, continuous improvement mechanisms evaluate framework performance using trust accuracy, transaction reliability, data consistency, supply chain transparency, processing efficiency, and stakeholder satisfaction metrics. Feedback from participants, blockchain records, and analytics results are used to improve trust evaluation models and optimize supply chain operations. The adaptive framework continuously enhances enterprise supply chain security, transparency, and operational intelligence.

IV. Results and Discussion

Experimental evaluation demonstrated that the proposed trust-aware blockchain and ERP framework improved supply chain transparency, data reliability, and stakeholder confidence compared with traditional centralized supply chain management approaches. Blockchain integration provided secure and immutable records, improving information accuracy across distributed supply chain networks.

The trust management mechanism effectively evaluated supplier reliability and operational performance by analyzing real-time ERP information and blockchain transaction history. Intelligent trust scoring improved partner selection, risk identification, and decision-making efficiency within supply chain ecosystems.

Real-time ERP data integration enabled continuous monitoring of procurement, production, inventory, and logistics activities. IoT-based information exchange improved product visibility and supported faster identification of operational issues and supply chain disruptions.

Smart contracts improved automation by reducing manual verification activities and enabling reliable execution of business rules. Overall, the proposed framework achieved improvements in supply chain trust, transparency, data integrity, operational efficiency, and enterprise decision-making capability.

V. Conclusion

This paper presented a Trust-Aware Enterprise Supply Chain Management Framework Using Blockchain and Real-Time ERP Data by integrating blockchain technology, ERP systems, smart contracts, IoT monitoring, trust evaluation mechanisms, and intelligent analytics. The proposed framework enables secure data exchange, decentralized verification, automated governance, and real-time supply chain intelligence.

Experimental analysis demonstrated improvements in supply chain transparency, trust evaluation, operational efficiency, transaction security, and decision-making capabilities. Future research may investigate AI-driven trust prediction models, autonomous supply chain governance agents, privacy-preserving blockchain solutions, digital twin-based supply chain management, and adaptive enterprise intelligence frameworks to further enhance secure and intelligent supply chain ecosystems.

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