Blockchain-Integrated Supply Chain Management Framework for Improving Transparency, Trust, and International Business Efficiency

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Abstract

Global supply chains are associated with different types of organizations and locations, giving rise to the problem of gaining visibility and establishing trust among them. Blockchain is viewed as the right technology solution in the form of a tamper-proof distributed ledger together with smart contracts, but evidence from empirical research shows that having a technology solution alone is not enough to be assured of success. The current paper presents a BiSCM (blockchain-integrated supply chain management) model with four levels tied to three outcomes (transparency, trust, and international business efficiency). Based on an interpretive and systematic review of the literature and theories of transaction cost economics, agency theory, trust theory, and the technology-organization-environment perspective, the paper presents seven propositions, with governance design, regulatory/cultural context, and partner preparedness acting as moderators. Using Walmart food traceability and the TradeLens shipping technology as case studies, it is evident that adoption is just as much about industry cooperation and incentives as it is about technology feasibility. The paper also offers a five-step adoption process, performance metrics, a cross-regional comparison, and research direction.

Keywords: Blockchain; Supply Chain Management; Transparency; Trust; International Business; Smart Contracts; Global Management.

I. INTRODUCTION

Supply chains of today consist of independent business entities that interact and engage in exchanges of goods, money, and information beyond geographical boundaries. Typically, each entity may conduct its activities through independent information management systems, making the processes of data exchange, coordination of transactions, product tracking, and information validation hard. Fragmented supply chain models may result in inefficiencies, poor visibility, record-keeping, and data integrity issues within the supply chain networks (Dudczyk et al., 2024). Hence, growing requirements for traceability, security, sustainability, and information exchange have made it crucial to develop digital supply chains (Karaduman & Gülhas, 2025).

Blockchain technology presents an alternative approach to the management and sharing of supply chain data. The technology presents a decentralized and immutable ledger system that allows authorized users to create, verify, and share transaction information while ensuring the integrity and traceability of information (Kumar et al., 2025). Smart contracts based on blockchain

can also automate predefined activities within the supply chain and create clear rules for execution (Ayadi et al., 2026). These features can enhance transparency, traceability, security, and coordination of supply chain processes through verifiable transaction history and information sharing (Karaduman & Gülhas, 2025).

However, blockchain does not necessarily solve all the issues associated with supply chains. There are still several problems associated with system security, privacy, smart contracts, communication, interoperability, and reliability of interconnected services that need to be addressed in blockchain-based supply chain systems (Al-Farsi et al., 2021). In addition to this, integration of blockchain with already existing enterprise systems is crucial as blockchain needs to coexist with other business systems and processes rather than work separately (Ravi et al., 2024). Thus, the key problem for supply chain managers is not only to utilize the potential of blockchain in order to obtain secure data, but to integrate it into the technology environment as well (Gohil & Thakker, 2021).

This paper answers the above question via three research questions:

- RQ1. How can blockchain be used in supply chain management in order to increase transparency and trust between international parties?
- RQ2. What mechanisms are involved in blockchain usage in increasing the efficiency of international business activities?
- RQ3. How does the international context affect the results due to the governance, regulation, culture, and readiness of partners?

Three main contributions are proposed in this study: an integrative multi-layer framework connecting the technology with the results; theory-based propositions outlining the mechanisms and boundary conditions; and practical recommendations with performance indicators for global managers. This paper is structured as follows: (Section 1) Introduction; literature review (Section 2); framework (Section 3); methodology (Section 4); analysis and discussion (Section 5); implementation recommendations (Section 6); implications (Section 7); limitations and further research (Section 8); and conclusion (Section 9).

II. LITERATURE REVIEW

2.1 Transparency and Trust Challenges Within the Global Supply Chains

The concept of supply chain transparency refers to the accessibility and visibility of the relevant information on products, transactions, processes, and organizations participating in the supply chain. Traditional supply chains are exposed to problems like fragmentation of information, inconsistencies in documentation, non-visibility, and transaction verification across different organizations (Kumar et al., 2025). These kinds of problems are intensified within the global supply chain where entities operate within very different technological and institutional environments. The use of blockchain technology helps enhance transparency by ensuring that verifiable records of transactions and movement are created (Frikha, 2026). Enhanced transparency would facilitate the enhancement of institutional trust since relevant information is available to all the interested parties who cannot alter it easily without authorization. It has been proved by these blockchain-based systems that verifiable transaction records contribute to

enhanced accountability and trust when sharing information in a transparent manner (Hasanah et al., 2026). Nevertheless, effective trust demands governance, involvement of stakeholders, proper data input, and clearly defined responsibilities.

2.2 Blockchain Technology and Smart Contracts

Blockchain-powered supply chains have features such as distributed ledgers, cryptographic techniques, consensus algorithms, and smart contracts to manage information among the participants. These factors enable data integrity by reducing the number of unauthorized changes and allowing transaction validation over the entire network (Karaduman & Gülhas, 2025). Smart contracts further allow automation of conditions that pertain to approvals, transactions, verification, and other supply chain-related activities (Ayadi et al., 2026). The combination of blockchain and IoT also enables the collection of information related to product movement, environment, and physical events linked to digital records (Ismail et al., 2023). This combination provides better visibility and access to information within supply chain management activities (Gohil & Thakker, 2021). Frameworks for food supply chains also show the usefulness of integrating blockchain and IoT in terms of traceability and information sharing (Guixia et al., 2024). But blockchain on its own cannot guarantee that the data provided is correct, which requires using trusted sensors, data formats, verification process, and good governance. Security also needs to be provided for smart contracts, infrastructure, applications, and communication (Al-Farsi et al., 2021).

2.3 Applications of Blockchain Technology and Evidence in Supply Chains

The applications of the blockchain technology include spheres such as product traceability, provenance, transaction security, data sharing, logistics visibility, inventory coordination, sustainable management, and documentation (Dudczyk et al., 2024). The use of blockchain computing models has been found promising for solving problems like data silos, lack of real-time visibility, frauds, and vulnerabilities of traditional tracking systems (Kumar et al., 2025). In the context of agriculture supply chain, blockchain technology provides transparency and enables product and transaction tracing within different supply chain stages (Mwewa et al., 2025). Sustainable supply chain approaches claim that the problems of transparency and traceability should be solved together with the implementation obstacles and risks associated with technologies (Mangla et al., 2022). In the context of food supply chain, the use of blockchain technology combined with Internet of Things can improve product tracking and information exchange (Ismail et al., 2023). The application of blockchain technology is also associated with enterprise systems' integration and, specifically, ERP systems' integration can improve supply chain transparency (Ravi et al., 2024). E-commerce distribution includes the use of blockchain technology and is influenced by such factors as performance expectations, ease of use, facilitating conditions, social influence, and value perception (Tri, 2024).

2.4 Lenses to View Theory

There are several interrelated lenses that provide further views on blockchain adoption and value creation in supply chain management. The lens of transactions and coordination proposes that blockchain helps to overcome fragmentation of information and allows efficient verification and transactions with the help of shared information (Dudczyk et al., 2024). The use of smart

contracts allows to even further minimize manual transactions as it introduces predefined transaction rules (Ayadi et al., 2026). The lens of information transparency states that blockchain minimizes the issue of information asymmetry as all transactions become transparent and verifiable for the authorized participants (Frikha, 2026). The lens of trust is based on the assumption that trusted, immutable transactions build trust between the parties whereas governance and accuracy of the data are required (Hasanah et al., 2026). The technology adoption perspectives are also important because the user expectations concerning performance, effort, infrastructure, social influence, and perceived value affect users' willingness to adopt blockchain-integrated systems (Tri, 2024). Organizational implementation perspectives imply the problems of complexity, integration, strategic barriers, sustainability, and transformation (Mangla et al., 2022). Consequently, blockchain has to be considered as a part of the digital supply chain ecosystem, which includes enterprise systems, IoT, security systems, operations, and governance (Gohil & Thakker, 2021). The information systems of logistics enabled by blockchain highlight the significance of the combination of digital information management and blockchain (Frikha, 2026).

2.5 Research Gap

Three gaps arise. First, while a lot of models focus on technical architecture, they do not consider inter-organizational governance. Second, not much research is done on the link between characteristics of the technology and its impacts via specific mechanisms. Third, there is an absence of global environment modeling with regard to different regulations, institutions, and cultural factors.

III. PROPOSED BLOCKCHAIN-INTEGRATED SCM FRAMEWORK

3.1 Framework Architecture

The BiSCM architecture (Figure 1) is made up of four layers that link supply chain actors to three possible outcomes. The data & IoT layer captures information from its source using technologies like RFID tags, barcodes, sensors, and enterprise systems, addressing the oracle issue through improved data quality before data entry. The blockchain network layer provides the permissioned blockchain, consensus, digital identity, and interoperability. The smart contract & governance layer contains the business logic of how to release payments after verification of deliveries, among other business rules. The application layer provides use cases like provenance, electronic bill of lading, trade finance, regulatory reporting, and product recall management.

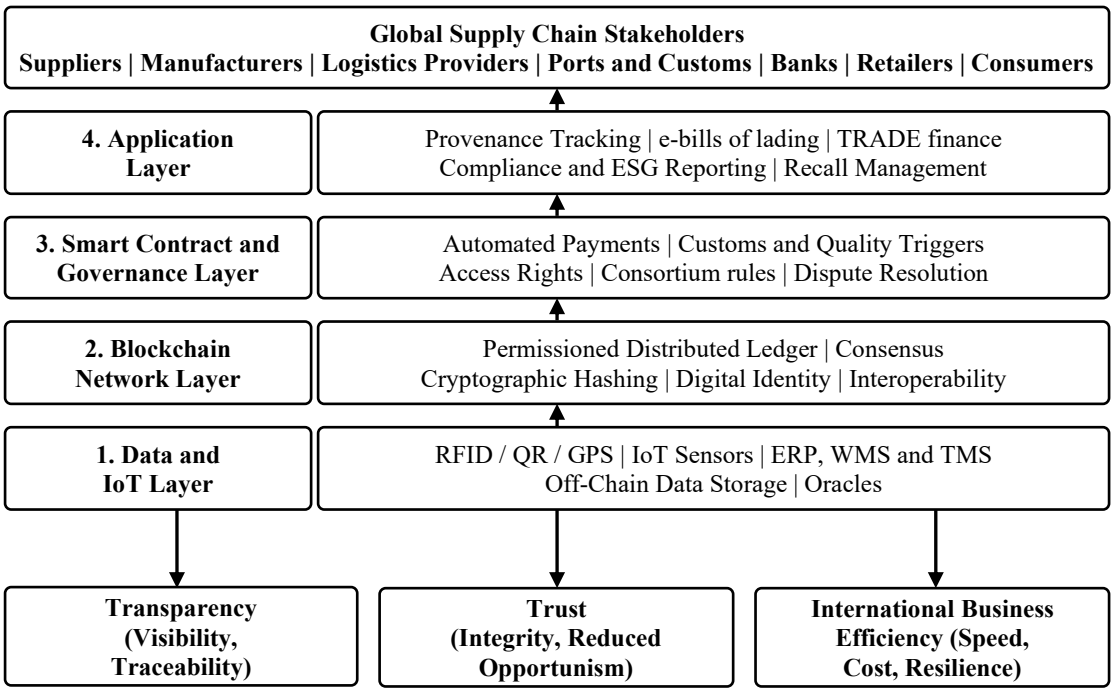

Figure 1: Blockchain-Integrated Supply Chain Management (BiSCM) Framework

3.2 Constructs and Mechanisms

It is believed that transparency will be increased since all authorized parties see the same record. It is believed that trust will be increased since the integrity of records does not depend on a particular party and since automatic rules work in the same way for everybody. It is believed that efficiency will be increased since reconciliation will be minimized, faster document circulation, early problem detection, and cheaper monitoring will be provided. Table 1 shows the relationship between the layers mentioned above and the mechanisms/theories discussed above.

Table 1: Framework Layers, Mechanisms, And Theoretical Grounding

Layer	Key mechanism	Main outcome	Theory
Data and IoT	Automated, Verified Data Capture at Source	Transparency	Agency Theory
Blockchain network	Shared, Tamper-Resistant Ledger and Identity	Trust	Trust Theory
Smart Contract and Governance	Self-Executing Rules; Clear Membership and Dispute Processes	Efficiency; trust	Transaction Cost Economics
Application	Use-Case Solutions for Traceability, Finance, Compliance	All three outcomes	TOE Framework

3.3 Propositions

P1. The use of blockchain technology along with IoT-based data collection makes supply chains more transparent as it eliminates information asymmetry and opportunities for undocumented or modified events.

P2. Increased transparency of supply chains results in higher inter-firm trust, as parties will be able to verify the claims of one another.

P3. The use of smart contracts allows increasing international business efficiency by reducing transaction costs regarding monitoring, enforcement, and document processing.

P4. Transparency and trust act as moderators between the use of blockchain technology integration and international business efficiency due to better information availability and lower levels of perceived opportunistic behavior.

P5. Good quality of governance (including clear membership rules, decision rights, and incentive structures) moderates the positive impact of blockchain technology integration; poorly governed platforms generate lower levels of participation and value generation.

P6. The partner readiness (digitalization, quality of data and data interoperability) moderates the impact of blockchain technology integration on outcomes.

P7. The regulatory and cultural environment moderates outcomes; recognition of digitalized records and norms of data sharing make positive impacts stronger, whereas data localization policies and unwillingness to share information reduce the effects.

IV. METHODOLOGY

A design of an interpretive, systematic narrative review, supported by illustrative case analysis is employed. This design is appropriate given that the subject matter represents an emergent interdisciplinary topic where theory building is the purpose. Four steps were involved in the process. First, literature was identified through the use of Scopus, Web of Science and Google Scholar, combining the search terms blockchain, supply chain management, traceability, transparency, trust, smart contracts and international trade. Second, sources were selected according to their relevance to supply chains and/or inter-organizational exchange, written in English, published since 2015; theoretical and technological sources of foundational nature have been included regardless of publication date. Third, coding of benefits, mechanisms, barriers, contextual conditions and their organization into the framework layers was done thematically. Fourth, two illustrative cases, the food traceability project at Walmart and the TradeLens platform, have been analyzed based on published academic and industry sources.

Since the research is based on secondary evidence, the propositions have been formulated with further empirical testing in mind and should not be interpreted as established effects. Reliability was ensured by clear inclusion criteria and grounding each of the propositions in cited work.

V. ANALYSIS AND DISCUSSION

5.1 Transparency and Trust

In terms of transparency, the research shows that blockchain is more effective if it is integrated with reliable data collection. In other words, the implementation of a shared ledger filled with manually collected data simply transfers existing inaccuracies to another system. Integrating it with sensors and scanners along with standard identification systems will add credibility to the collected data. As for trust, there is a more complicated connection between blockchain and trust.

On the one hand, it offers institution-based trust in the consistency of the stored information. On the other hand, partner trust is determined by benevolence and integrity. Blockchain helps to achieve fast trust and collaboration in humanitarian supply chains, but these findings cannot be transferred directly to business supply chains, since the latter include competitors.

5.2 Efficiency in International Business Operations

In international business, there are several documents involved like bill of lading, certificate of origin, customs declarations, and letter of credit, and all these documents need to be verified. By using smart contracts and digital documents, there is less chance of duplication, and at the same time, there will be quicker payment if conditions are satisfied. Visibility will help in making businesses resilient because with the help of sharing of events in near real-time, one can see disruption early and divert shipments. Efficiency improvement also depends on the number of participants in the process.

5.3 Illustrative Case: Walmart Food Traceability

Walmart collaborated with IBM on a pilot of a permissioned blockchain for tracking food items like mangoes and pork. According to the example of a pilot involving mangoes, the time taken to trace an item from its farm of origin would reduce from around seven days to a few seconds. This case demonstrates P1 and P3 – the value of digitized information and shared information in reducing traceability costs, which is helpful for food safety and product recall. P5 and P6 have been illustrated here because it involved a dominant buyer who could make the supplier adopt a blockchain, and a supplier willing to collect digital data about their products.

5.4 Illustrative Case: TradeLens

The goal of TradeLens was to provide an information service in which global shipping information would be captured and tracked via a blockchain-based platform; at the time of its greatest success, hundreds of users used the platform. Still, in November 2022, Maersk and IBM announced that the platform was no longer going to operate, as even though it was technologically feasible, it lacked industry-wide cooperation and commercial viability. The example confirms P5, as neutrality, shared governance, and aligned incentives of competing carriers were preconditions of this kind of platform's success. Furthermore, it demonstrates how technical feasibility is not enough to be successful.

5.5 Global Perspective: Regional Contexts

Block chain initiatives occur in a variety of institutional environments. Table 2 highlights stylized differences that the management needs to take into account; they are just general observations and things change rapidly.

The two major implications for global management are the following. Firstly, there is inconsistency across jurisdictions regarding the legal acceptance of electronic records and smart contracts, so the cases of cross-border usage should be confirmed jurisdiction by jurisdiction. Secondly, there are different cultural approaches to information sharing, which influence the readiness of companies to share their business information; the aspects of uncertainty avoidance and individualism may affect it. The governance techniques that guarantee the protection of commercial confidential information become highly significant in this context in table 3.

Table 2: Regional Considerations for Blockchain-Integrated Supply Chains

Region	Enabling factors	Constraints	Management focus
North America	Strong enterprise IT base; large buyers able to set standards	Fragmented state and federal rules; legacy systems	Industry consortia and buyer-led adoption
Europe	Strong regulation of data, sustainability, and product passports	Data protection constraints on immutable records; varied national practices	Compliance-by-design and privacy-preserving architectures
East and Southeast Asia	Dense manufacturing and port networks; government-backed digital trade initiatives	Multiple competing platforms; differing standards	Interoperability and public-private partnerships
South Asia	Large supplier base; fast-growing digital payment systems	Uneven digital maturity among small suppliers	Capability building and low-cost onboarding
Middle East, Africa, and Latin America	National digital and logistics strategies; trade hub ambitions	Infrastructure gaps; institutional variability	Phased pilots and trusted intermediaries

5.6 Challenges and Mitigation

Table 3: Key Challenges and Recommended Mitigation Strategies

Challenge	Description	Mitigation
Data Quality (Oracle Problem)	Inaccurate Input Data Is Permanently Recorded	IoT capture, standardized identifiers, third-party verification
Interoperability	Multiple Platforms and Incompatible Standards	Adopt open standards; design for cross-chain integration
Governance and Incentives	Competitors Reluctant to Share Data or Cost	Neutral consortium governance; clear value-sharing rules
Cost and Capability	Integration Costs and Skills Gaps, Especially for SMEs	Phased rollout; shared infrastructure; training and subsidies
Regulation and Privacy	Data Protection and Cross-Border Legal Uncertainty	Store personal data off-chain; legal review per jurisdiction
Scalability and Energy Use	Performance limits of some networks	Permissioned networks with efficient consensus mechanisms

VI. IMPLEMENTATION ROADMAP AND PERFORMANCE MEASUREMENT

Since the majority of risk factors are organizational in nature, the implementation should happen in phases to generate buy-in from partners and validation of value. The process is illustrated in figure 2, which shows a roadmap consisting of five phases. In Phase 1, the organizations identify the problem they face, choose a suitable use case with pain points and

engaged partners, and audit data readiness. Phase 2 is the definition of governance, architecture, standards, and legal frameworks. Phase 3 pilots one product/trade lane with IoT and enterprise integration and defines baseline metrics. Phase 4 expands the solution with more partners and regions, considering interoperability and training. Phase 5 is optimization with analytics and finance services.

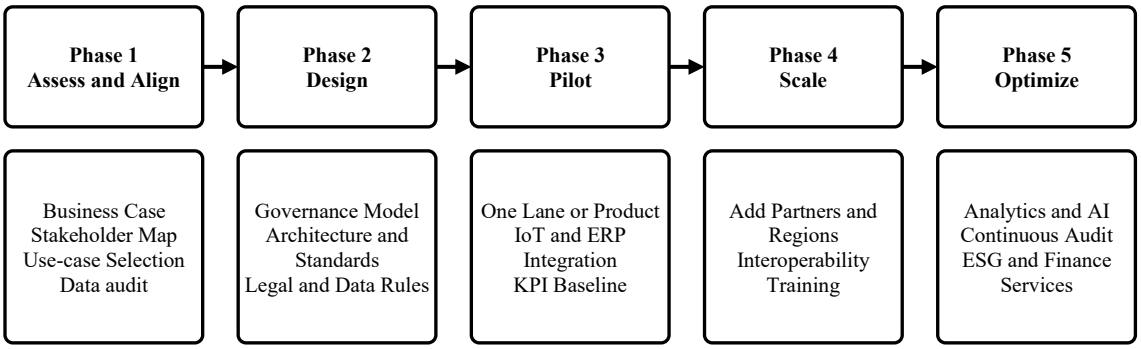

Figure 2: Five-Phase Implementation Roadmap for Blockchain-Integrated SCM

Performance should be compared with the baseline values determined prior to the pilot. Table 4 suggests indicators for each outcome.

Table 4: Suggested Key Performance Indicators

Outcome	Indicator	Measurement approach
Transparency	Percentage of shipments with end-to-end traceability; time to trace a product to origin	Pilot audit; system logs
Trust	Number and duration of data disputes; partner satisfaction and perceived reliability	Dispute records; partner survey
Efficiency	Document processing time; order-to-cash cycle; cost per transaction; days to customs clearance	Before-and-after comparison
Resilience and sustainability	Time to detect and respond to disruption; share of suppliers with verified compliance data	Incident logs; compliance reports

VII. IMPLICATIONS

7.1 Theoretical Implications

The framework is designed based on mechanisms that relate technological characteristics to outcomes using concepts drawn from transaction cost economics, agency theory, trust theory, and TOE framework as response to call for theorization of blockchain in supply chain management literature. The focus of the framework is on governance and contextual boundary conditions rather than on technical characteristics.

7.2 Managerial Implications

- Begin from the problem, not the solution: select use cases where multi-party reconciliation, provenance, or compliance adds cost.

- Governance first: reach agreement on membership, data ownership, costs, and dispute resolution prior to construction, and look for neutral stewardship in case competitors join.
- Mend the data: invest in IoT, identifiers, and verifications so that the data recorded can be trusted.
- Interoperability and the law: make use of open standards and get legal advice in each jurisdiction.
- Help out smaller partners: give them tools for onboarding so that they can join the network, since network effects rely on reach.

7.3 Policy Implications

Policymakers may foster adoption through legal recognition of electronic trade documents and smart contracts, promotion of open standards, and clarification of how data protection applies to distributed ledgers. Port- and customs authority-based public-private pilots can produce shared infrastructure which individual companies cannot afford to build on their own.

VIII. LIMITATIONS AND FUTURE RESEARCH

Limitations of this study include that it is conceptual and based on secondary sources, which means that propositions are yet to be tested. Also, the two cases used are taken from publicly available sources, hence cannot be taken as representative of different experiences, and such reports may be positive or sponsored. Comparison among regions is stylized; moreover, the technology under investigation and its regulation have been developing rapidly.

Future research may take four possible paths. First, empirical research based on surveys using structural equation modeling can test mediating effects of transparency and trust (P2-P4) and the moderating effects of governance, readiness, and environment (P5-P7). Second, longitudinal studies on multiple cases, including failed platforms, can show the dynamics of the evolution of consortium governance. Third, quantitative studies can calculate the cost and time savings resulting from pilot projects. Fourth, studies can analyze interaction between blockchain technology and other technologies and regulatory requirements for sustainable development in international supply chains.

IX. CONCLUSION

Nevertheless, the utilization of blockchain technology can greatly contribute to the enhancement of transparency, trust, and efficiency of international supply chains; however, these contributions will be possible only in the case of proper implementation in terms of data, governance, and institutional issues. The proposed framework of BiSCM comprises all these aspects in a four-level structure, which concentrates on data and IoT, blockchain network, smart contracts and governance, as well as functions of applications, in connection with the results of transparency, trust, and efficiency in international business. It is important to note that the framework highlights the idea that blockchain should be considered not just as a technological tool but rather as a component of the system as a whole. However, the example of Walmart and TradeLens shows how technical capabilities by themselves do not ensure the success of any implementation attempts. Collaboration among partners, common incentives, governance,

interoperability, and readiness of organizations are some other factors which will play an important part in the successful implementation of initiatives for creating value via blockchains. Managers have to adopt a staged approach to implementation where each stage should start with clear business problems, use cases, data sources, and performance metrics. The pilot tests should be rigorously examined before any implementation is attempted across partners, products, and geographies. Any future research should empirically verify the proposed model across other industries and geographies, and the influence of governance, partner readiness, regulations, and digital infrastructure should also be studied.

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