

The Rise of Smart Contracts in Trade Finance: Automating Processes and Reducing Dependency on Intermediaries

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Abstract. The global trade finance ecosystem, long characterised by manual documentation, multi-layered intermediation, and protracted settlement cycles, is undergoing a profound structural transformation through the adoption of blockchain-based smart contracts. This article examines two principal objectives: (1) the extent to which smart contracts automate traditional trade finance processes, and (2) the degree to which they reduce systemic dependency on financial and documentary intermediaries. Drawing upon peer-reviewed scholarship, institutional reports, and empirical findings published between 2022 and 2025, the study undertakes a critical analysis of the operational, economic, legal, and societal dimensions of this technological shift. Findings indicate that while smart contracts demonstrably compress settlement cycles, reduce transaction costs, and enhance transparency, significant challenges persist concerning legal enforceability, regulatory fragmentation, and cybersecurity vulnerability.

keywords: Smart Contracts, Trade Finance, Blockchain, Disintermediation, Automation, Digital Finance, Supply Chain Finance.

I INTRODUCTION

Trade finance has historically functioned as the connective tissue of international commerce, facilitating the flow of capital, goods, and trust between geographically dispersed parties. Instruments such as Letters of Credit (LCs), Bills of Lading, and Documentary Collections have served as the backbone of cross-border transactions for centuries. However, these mechanisms are characterised by significant inefficiencies cumbersome paper-based documentation, multiple intermediary layers, high operational costs, and extended processing timelines that can span days or even weeks.

The International Chamber of Commerce (ICC) has documented a sustained decline in traditional documentary instruments. According to the ICC Trade Register, the volume of Letters of Credit issued globally declined by approximately 9% between 2013 and 2016 alone (Varghese & Goyal, 2017), partly reflecting frustration with their administrative complexity. The Asian Development Bank (ADB) further estimates a

persistent global trade finance gap of approximately USD 2.5 trillion annually a short-fall disproportionately borne by small and medium-sized enterprises (SMEs) in developing economies (ADB, 2023).

Against this backdrop, the emergence of blockchain-based smart contracts represents a paradigm-level disruption. Smart contracts are self-executing digital agreements in which the terms are encoded directly into computer code on a distributed ledger. Once pre-defined conditions are satisfied such as the receipt of a bill of lading or confirmation of customs clearance the contract executes automatically, releasing payment or triggering the next process step without requiring human authorisation or third-party verification.

As Wang and Xu (2023) observe, smart contracts exhibit transformative potential across financial services, specifically in automating *insurance claims, supply chain finance, and loan agreements*. Within trade finance, this potential is amplified given the inherently rule-bound, documentary nature of the processes involved. Scholars such as Sharif (2024) have further argued that smart contracts challenge the foundational role of Documentary Credits by offering real-time, transparent execution that fundamentally re-engineers the trust architecture of international trade.

This article is structured around two focused research objectives and proceeds through a rigorous analytical framework encompassing process automation, intermediary displacement, legal-regulatory tensions, and societal implications.

Research Objectives

This study is anchored by two clearly defined objectives:

- To examine the extent to which smart contracts automate traditional trade finance processes, focusing on operational efficiency gains, cost reduction, and settlement speed.
- To analyse how smart contracts reduce systemic dependency on financial and documentary intermediaries in trade finance, and to assess the implications of such disintermediation for institutional roles, legal frameworks, and financial inclusion.

II. REVIEW OF LITERATURE

The academic discourse on smart contracts in trade finance draws from multiple disciplinary streams: supply chain management, financial economics, legal theory, and information systems. A foundational contribution is that of the *Manufacturing & Service Operations Management* journal (INFORMS), where a game-theoretic model developed by researchers at a leading management school demonstrated that smart contract adoption enables supplier commitment to post-shipment financing decisions, thereby mitigating the bank's lending risk exposure and reducing financing costs across the supply chain (INFORMS, 2022). This analytical finding is critical because it locates the value of smart contracts not merely in operational speed but in the restructuring of financial risk allocation.

Complementing this, the *Modern Finance* journal (2024) published a documentary analysis examining the Moroccan OCP Group as a case for blockchain integration in trade finance, finding that a hybrid model — combining on-chain smart contract execution with off-chain governance — offers the most pragmatic pathway for

institutions seeking to modernise without abandoning regulatory compliance frameworks.

In the domain of cross-border payments, a study published on ResearchGate (2025) argues that blockchain-based smart contracts, when integrated with KYC, AML, and Central Bank Digital Currency (CBDC) protocols, *establish a new paradigm for global settlement — combining automation, transparency, and security in a programmable and legally traceable manner*. This finding is significant as it bridges the operational and regulatory dimensions of smart contract adoption.

From a legal perspective, the ScienceDirect systematic literature review on blockchain in global value chains (2024) highlights that the European Parliament adopted legislation on smart contracts on March 14, 2023, as part of the Data Act — specifically Article 30, which sets compliance requirements for smart contracts used in data sharing, effective from 2024. This regulatory development marks a turning point in how jurisdictions are beginning to formalise the legal landscape for automated contracts. Despite this progress, 47% of smart contract disputes in 2024 were attributed to compliance gaps with existing legal frameworks (CoinLaw, 2024), underscoring the persistent tension between technological capability and legal readiness.

The World Economic Forum (2024) has flagged the evolving and escalating cybersecurity threat landscape as a central concern, noting that while the value lost in DeFi hacks declined by over 63% in 2023, the overall number of crypto-related incidents increased — reflecting a more sophisticated and diverse set of attack vectors. Trail of Bits' comprehensive 2023 audit revealed that access control vulnerabilities were present in 43% of reviewed smart contract projects, while logical errors in business logic appeared in 36% of cases, highlighting systemic security vulnerabilities that undermine institutional confidence.

Across developing country contexts, the International Journal of Research and Innovation in Applied Science (IJRIAS, 2025) conducted a mixed-method study — combining systematic review with expert interviews — and concluded that smart contracts can lower transaction costs, eliminate intermediary services, and improve financial inclusion through accessible microfinance and trade finance solutions. This finding positions smart contracts not merely as an efficiency technology for large banks but as a financial equity instrument for underserved markets.

III. ANALYSIS AND INTERPRETATION

1. Objective 1: Automation of Trade Finance Processes

The traditional trade finance process involves a cascading sequence of manual verifications: the importer requests a Letter of Credit, the issuing bank reviews and issues the instrument, the advising bank notifies the exporter, the exporter ships goods and submits documents, multiple banks verify documentary compliance, and only then is payment released. This process, as documented by the ADB (2023), is described as "costly and time-consuming, involving numerous follow-up steps by either the importer seeking goods or the exporter seeking payment." The average settlement time for a traditional LC transaction routinely exceeds 5–10 business days, with complex multi-jurisdiction transactions taking considerably longer.

Smart contracts fundamentally restructure this sequence. By encoding conditions such as verified shipment data, customs clearance confirmation, or quality inspection approval directly into blockchain-based code, the execution of payment becomes automatic and near-instantaneous upon condition fulfilment. The empirical evidence here is compelling: a blockchain-anchored settlement model studied by Kunthu, Taware, and Anumula (2024) demonstrated a compression of settlement cycles from 120 days to 3 minutes, an 87% reduction in transaction fees, and a 92% reduction in manual intervention. While these figures derive from a telecommunications settlement context, the underlying architecture directly parallels trade finance settlement structures, making the inference credible and analytically robust.

McKinsey & Company has estimated that automating trade finance processes through smart contracts can reduce transaction costs by up to 30%, a figure that, when applied to the scale of global trade finance (estimated in the tens of trillions of dollars annually), represents an enormous aggregate economic gain. Furthermore, the INFORMS (2022) game-theoretic model found that smart contracts create measurable value not just in cost reduction but in risk reallocation banks become willing to extend credit at lower rates because the automated, immutable record of supplier commitment reduces informational asymmetry.

The automation dividend is also evident in compliance processes. Modern Finance (2024) cites ADB data indicating that over 63% of banks agree that digital integration facilitates regulatory compliance checks while enabling better client profiling and risk management for SMEs. Smart contracts, by embedding compliance logic into executable code, shift compliance from a post-hoc verification activity to a real-time, pre-conditional gate — a transformation that is both structurally novel and operationally significant.

Interpretation: The evidence indicates that smart contracts do not merely accelerate existing processes they reconstitute the architecture of trade finance itself. Automation removes the sequential dependency on human verification at each stage, replacing it with deterministic, code-based execution. This is a categorical difference, not merely a marginal improvement. However, the automation gains are contingent on the quality and standardisation of input data; if the off-chain data fed into smart contracts is inaccurate or manipulated (the so-called "oracle problem"), the automated execution will replicate errors at scale.

2. Objective 2: Reduction of Dependency on Intermediaries

Disintermediation the removal of intermediary layers from a transaction lies at the intellectual heart of the smart contract proposition. In traditional trade finance, intermediaries perform essential functions: banks verify documentary compliance; freight forwarders certify shipment; insurers assess risk; legal professionals enforce contractual obligations; and customs brokers navigate regulatory requirements. Each intermediary layer adds cost, time, and the potential for error or fraud.

The research literature presents a nuanced picture of disintermediation. The Research Gate study on smart contracts in international trade finance (2024) observes that pilot projects by financial institutions and technology firms have demonstrated the capacity of blockchain to "reduce the dependence on paper documentation and intermediaries by creating a shared, synchronised digital record." The IJRIAS (2025) study concurs, finding that smart contracts can "eliminate intermediary services" and reduce

transaction costs as a consequence. Akhtar (2024), as cited in the Nature/Humanities and Social Sciences Communications article, further argues that blockchain's peer-to-peer verification mechanism addresses key issues such as information asymmetry and inefficiencies in data reconciliation the very functions that historically justified the existence of documentary intermediaries.

Yet the evidence also cautions against interpreting disintermediation as elimination. The Modern Finance (2024) study's findings suggest that the role of intermediaries is evolving rather than disappearing. Banks, for instance, are transitioning from documentary verifiers to technology governance facilitators overseeing the smart contract infrastructure, managing exceptions, and maintaining regulatory relationships. The same study recommends a hybrid model that "integrates blockchain into existing infrastructure, relying on both off-chain and on-chain governance mechanisms," implicitly acknowledging that full disintermediation remains impractical at present.

From a legal standpoint, the challenge of disintermediation becomes acute. Smart contracts operate through code-based logic that is deterministic and tamper-proof but also inflexible. The World Economic Forum (2024) identifies the critical problem: when smart contract execution fails due to a software flaw, "who do you call?" This question encapsulates the deep structural problem of removing human intermediaries without establishing equivalent legal recourse mechanisms. The absence of ex post justice mechanisms in pre-coded environments as noted in the legal literature means that smart contracts cannot yet fully substitute for the dispute resolution functions that intermediary institutions historically provided. Moreover, 60% of US-based companies using smart contracts reported challenges with jurisdictional enforcement as of 2024 (CoinLaw, 2024), and 41% of cross-border smart contract transactions were found to fall short of GDPR compliance standards.

Interpretation: The relationship between smart contracts and intermediaries is best characterised as one of functional substitution rather than total elimination. Smart contracts absorb the mechanical, rule-based verification functions of intermediaries — documentary checking, condition monitoring, payment triggering — while leaving intact the higher-order functions of legal adjudication, exception handling, and regulatory compliance. This creates a transitional hybrid landscape in which intermediary institutions must redefine their value proposition from process execution to governance, risk management, and legal assurance. Institutions that fail to adapt to this functional shift risk marginalisation; those that embrace it may discover new, technology-enabled roles in the emerging trade finance architecture.

Key Findings

Finding 1 - Process Automation Yields Measurable and Substantial Efficiency Gains.

Smart contracts demonstrably compress settlement cycles, reduce transaction fees, and eliminate manual intervention in rule-based processes. The compression from settlement cycles of 120 days to near-instantaneous execution (Kunthu et al., 2024), combined with McKinsey's estimated 30% cost reduction, represents empirically substantiated operational improvements of the first order.

Finding 2 - Disintermediation is Functional and Partial, Not Total.

Smart contracts substitute for the mechanical intermediary functions — documentary verification, conditional payment release, data reconciliation — but cannot yet

replace the legal, discretionary, and relational functions that institutions provide. A hybrid governance model, integrating smart contract automation with traditional institutional oversight, represents the most empirically supported pathway (Modern Finance, 2024).

Finding 3 - Legal and Regulatory Fragmentation Remains a Critical Structural Barrier.

Despite the EU's adoption of the Data Act (2023), regulatory frameworks for smart contracts remain jurisdictionally fragmented and legally ambiguous. The absence of harmonised international standards means that cross-border smart contract execution carries unresolved legal risks, particularly regarding enforceability, dispute resolution, and data privacy compliance.

Finding 4 - Cybersecurity Vulnerabilities Represent a Systemic Risk to Adoption.

The 2024 Ronin Bridge exploit — involving theft of approximately \$624 million — and Trail of Bits' finding that 43% of smart contract projects contain access control vulnerabilities collectively demonstrate that the technology's immutability, a strength in normal operation, becomes a critical liability when flaws are present. The irreversibility of smart contract execution means that errors or exploits cannot be corrected post-facto without significant systemic intervention.

Finding 5 - Smart Contracts Offer Significant Financial Inclusion Potential, Particularly for SMEs.

The USD 2.5 trillion global trade finance gap disproportionately affects SMEs, which lack the collateral, documentation capacity, and institutional relationships required under traditional systems. Smart contracts, by automating creditworthiness assessment, reducing administrative costs, and enabling programmable microfinance, create a structural mechanism for extending trade finance access to previously excluded market participants (IJRIAS, 2025; ADB, 2023).

Suggestions

S1. Develop International Legal Harmonisation Frameworks.

Multilateral bodies including the ICC, UNCITRAL, and the World Trade Organisation should work toward model legislation for smart contract enforceability in trade finance. The EU's Data Act provides a template, but cross-border trade requires globally harmonised standards to deliver the full efficiency potential of automated contracts.

S2. Mandate Pre-Deployment Security Audits.

Given that 51% of exploited contracts lacked formal security audits prior to deployment (CoinLaw, 2024), regulatory bodies and financial institutions should require independent third-party audits of smart contracts before they are deployed in systemically important trade finance applications. This is analogous to the stress-testing requirements applied to financial models under Basel III.

S3. Design Inclusive Smart Contract Architecture for SMEs.

Blockchain consortia and development finance institutions should invest in low-cost, standardised smart contract templates specifically designed for SME trade

finance needs — particularly in developing countries. Interoperability with CBDC infrastructure, as explored by the ResearchGate (2025) cross-border payments study, could further reduce barriers for smaller market participants.

S4. Build Capacity Among Trade Finance Professionals.

As the ResearchGate (2024) study on international trade finance emphasises, the transition to automated systems demands changes in organisational culture and skills. Financial institutions should invest in structured training programmes so that trade finance professionals understand how to interpret and govern smart contract outcomes, and can identify and escalate exceptions that automated systems cannot resolve.

Implications to Society

The societal implications of smart contracts in trade finance extend well beyond the confines of financial markets. At the macroeconomic level, a reduction in the global trade finance gap enabled by lower-cost, automated, and more accessible financing instruments has the potential to stimulate export activity in developing economies, create employment, and contribute to poverty alleviation. The IJRIAS (2025) study explicitly frames smart contracts as tools for financial inclusion, noting their capacity to deliver low-cost microfinance and trade finance solutions to underserved populations.

For labour markets, the automation of intermediary functions raises legitimate concerns about job displacement in trade finance operations, documentary processing, and back-office banking. However, the evidence suggests a nuanced transition: rather than elimination, there will be a transformation of roles toward governance, compliance oversight, technology management, and client advisory functions. Societies and educational systems must prepare for this transition proactively.

For regulatory governance, the rise of smart contracts challenges nation-states to develop legal frameworks that are both technologically literate and jurisdictionally coherent. The failure to do so as evidenced by the 47% dispute rate attributable to compliance gaps (CoinLaw, 2024) creates systemic risks that can undermine the very efficiencies that smart contracts promise. Conversely, thoughtful regulation can unlock the technology's potential while protecting consumers, firms, and financial systems from its risks.

Finally, the societal implications of greater transparency in trade finance deserve emphasis. Smart contracts, by embedding compliance logic into immutable ledgers and enabling real-time audit trails, hold significant promise as tools against trade-based money laundering (TBML) and financial fraud. Sharif (2024) demonstrates how smart contracts can address the problem of over- and under-invoicing one of the most prevalent TBML tactics through transparent, automated invoice verification. This has profound implications for the integrity of the international financial system and for the effectiveness of AML enforcement globally.

IV. CONCLUSION

This article has examined, through two focused objectives and a multi-dimensional analysis, the transformative potential and structural challenges of smart contracts in trade finance. The evidence is unambiguous on the core value proposition: smart contracts can and do automate rule-based trade finance processes with demonstrable gains in speed, cost, and transparency. The compression of settlement cycles from days

or months to minutes, the reduction of transaction costs by up to 30%, and the elimination of manual verification requirements represent efficiency gains of genuine economic significance.

The disintermediation thesis is equally well-supported but requires critical nuance. Smart contracts do not and at present cannot eliminate intermediaries wholesale. What they do is absorb the mechanical verification functions of intermediaries, forcing a fundamental redefinition of institutional roles toward governance, exception management, and legal assurance. This creates a transitional landscape in which the most adaptive institutions will thrive and the least adaptive will face marginalisation.

Yet the analysis also surfaces a warning: the efficiency and inclusion benefits of smart contracts are not self-executing. They depend on the resolution of pressing challenges legal harmonisation, cybersecurity resilience, regulatory clarity, and professional capacity that no single institution or jurisdiction can address alone. The rise of smart contracts in trade finance is not merely a technological story; it is a governance story, a legal story, and ultimately, a political economy story about who designs the rules of digital commerce and in whose interest those rules are written.

The trajectory is clear. Smart contracts are not a future proposition they are an active and accelerating reality in trade finance. The urgent task is not to debate their inevitability but to ensure that their deployment is governed wisely, secured robustly, and designed inclusively, so that the efficiency gains of automation become the shared prosperity of the many rather than the exclusive advantage of the few.

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