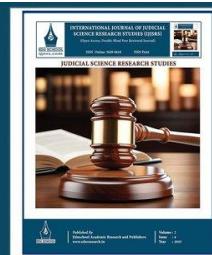


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Smart Contracts in International Arbitration: Legal Challenges in the Blockchain Era

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Abstract

The diffusion of blockchain-based smart contracts is reshaping the landscape of international commercial dispute resolution. Self-executing code that performs contractual obligations without human intervention challenges foundational arbitration doctrines concerning consent, arbitrability, seat, enforceability, and the role of the arbitrator. This paper offers a doctrinal analysis of the intersection between smart contracts and the arbitration frameworks established by the UNCITRAL Model Law on International Commercial Arbitration, the New York Convention on the Recognition and Enforcement of Foreign Arbitral Awards 1958, and the institutional rules of the ICC, LCIA, HKIAC, SIAC, and JAMS. The analysis distinguishes automated contracts from purely on-chain blockchain-native agreements and evaluates decentralized dispute-resolution platforms such as Kleros and Aragon Court. Drawing on Niriella's (2024) critical review, the paper identifies four doctrinal pressure points: the form requirements of the arbitration agreement, the seat and *lex arbitri* of code-based transactions, the enforcement of awards against autonomous wallets, and the interaction between decentralized adjudication and the New York Convention. The paper concludes that hybrid human–algorithmic arbitration, supported by explicit choice-of-law and seat provisions, is the most coherent path for reconciling smart contracts with existing arbitration architecture.

Keywords:- Smart contracts, blockchain, international arbitration, UNCITRAL Model Law, New York Convention, decentralized dispute resolution, *lex arbitri*

I. INTRODUCTION

The idea of a self-executing agreement traces at least to Szabo's (1997) formulation of smart contracts as computerized protocols that enforce contractual performance. The emergence of public blockchains, beginning with Bitcoin in 2009 and expanding through Ethereum's programmable virtual machine in 2015, converted that idea from a theoretical device into operational infrastructure (De Filippi & Wright, 2018). Smart contracts now underpin decentralized finance, supply-chain attestation, parametric insurance, intellectual-property licensing, and a growing share of cross-border commercial activity.

The rise of smart contracts disrupts fundamental assumptions of contract law and dispute resolution. Classical doctrine presupposes a contract authored by the parties, interpreted by a tribunal, and enforced by state organs through post-hoc coercion. Smart contracts invert this sequence: enforcement is *ex ante*, embedded in code, and self-executing upon the satisfaction of cryptographically verified conditions. Where disputes arise, the traditional arbitration framework must absorb a transactional object that is partially or wholly machine-authored and whose performance cannot be stopped by judicial injunction without blockchain-level intervention.

International commercial arbitration, the dominant mechanism for resolving cross-border disputes, is presently adapting to this shift. This paper examines four doctrinal pressure points: the form requirements of the arbitration agreement, the seat and *lex arbitri* of code-mediated transactions, the enforcement of awards against wallets and smart contracts, and the status of decentralized dispute-resolution platforms under the New York Convention. The analysis builds on the recent critical examination of Niriella (2024), who treats the role of the smart contract in arbitration with particular attention to the asymmetry between procedural expectations and technological architecture.

II. SMART CONTRACTS: TECHNICAL AND LEGAL ARCHITECTURE

A smart contract, as deployed on contemporary blockchains such as Ethereum, Solana, and Polkadot, is executable code stored at a specific address on a distributed ledger. Its functions are triggered by transactions that meet defined input conditions; upon triggering, the contract modifies state variables and, where relevant, transfers digital assets. The salient technical features for legal analysis are determinism, immutability, transparency, and trustlessness the last referring to the property that performance does not require the parties to trust one another or a central intermediary.

Legal scholarship distinguishes three models of smart-contractual arrangement. The first is the external or ancillary model, in which the smart contract automates performance of a traditional natural-language agreement that remains the legally binding instrument. The second is the hybrid or 'Ricardian' contract, which pairs human-readable prose with machine-executable logic, each referencing the other (Grigg, 2004). The third is the fully code-native agreement, where the code is intended to constitute the agreement itself, with no privileged natural-language text.

Each model raises distinct questions for arbitration. In the external model, standard arbitration clauses embedded in the natural-language document govern. In the hybrid model, divergence between the natural-language and code components generates interpretive conflicts about which version controls. In the fully code-native model, the very existence and content of the arbitration agreement may be contested. Niriella (2024) argues that the hybrid model is likely to dominate near-term commercial practice and that arbitral institutions must develop interpretive protocols for resolving natural-language/code divergence.

III. ARBITRATION FRAMEWORKS AND SMART CONTRACT INTEGRATION

The international arbitration framework rests on three pillars: the UNCITRAL Model Law on International Commercial Arbitration (1985, revised 2006), the New York Convention on the Recognition and Enforcement of Foreign Arbitral Awards (1958), and the procedural rules of arbitral institutions. Article 7 of the UNCITRAL Model Law requires that an arbitration agreement be in writing; the 2006 amendments expanded 'writing' to include electronic communications. The New York Convention similarly requires an 'agreement in writing,' defined under Article II(2) to include signed contracts or exchanges of letters and telegrams. The literal text predates blockchain by decades; however, the UNCITRAL Recommendation of 2006 endorses an inclusive interpretation that accommodates digital formats.

A smart contract carrying an embedded arbitration clause, whether expressed in code or in a referenced natural-language document, satisfies the writing requirement under a purposive reading because the agreement is recorded on a persistent, verifiable ledger. The more difficult question is whether the code itself can constitute the arbitration agreement absent any natural-language expression. The prevailing scholarly position is that a pure code clause, without an expression of the parties' intent in a form capable of judicial interpretation, fails the purposive test because it does not communicate the substance of the arbitration undertaking to the enforcing court (Ortolani, 2019; Mik, 2017).

Institutional rules have begun to address these questions. The ICC Arbitration Rules (2021) permit the electronic submission of pleadings; the HKIAC issued guidelines in 2022 on the use of technology in arbitration; JAMS launched a Blockchain Dispute Resolution track; and the Silicon Valley Arbitration and Mediation Center published its Guidelines on the Use of Artificial Intelligence in Arbitration (2024). These developments position institutional arbitration to host smart-contract disputes while preserving doctrinal coherence. Niriella (2024) observes that the cumulative effect is the emergence of a hybrid procedural template in which the automated performance layer coexists with a human tribunal invested with interpretive authority.

IV. JURISDICTIONAL AND ENFORCEMENT CHALLENGES

The *lex arbitri* of a smart-contract transaction is notoriously difficult to determine in the absence of an express choice. A smart contract is deployed to an address that exists on a globally distributed ledger; the nodes validating the contract are located in multiple jurisdictions; the parties may be pseudonymous. Classical connecting factors place of contracting, place of performance, habitual residence become indeterminate or artificial. The most workable solution, adopted in the practice of the HKIAC and SIAC, is to require parties to specify a seat and governing law in the arbitration clause, whether embedded in the code or a paired natural-language document. Where no seat is specified, tribunals have tended to default to the jurisdiction with the closest connection to the parties' off-chain identity, typically their principal place of business.

Enforcement against blockchain-held assets presents distinct challenges. A New York Convention award, once obtained, is enforceable in the 172 contracting states. However, the practical execution of a monetary award denominated in cryptocurrency requires cooperation from exchanges, wallet providers, or in extremis the parties themselves. Decentralized wallets, governed solely by private keys, cannot be compelled through traditional garnishment. Jurisdictions such as Singapore, through the High Court's decision in *CLM v. CLN* (2022), and the United Kingdom, in *AA v. Persons Unknown* (2019), have recognized cryptocurrency as property susceptible to proprietary injunctions, thereby offering a doctrinal bridge between the Convention's enforcement architecture and blockchain-resident assets.

A further layer of complexity arises in the interaction between automated performance and award enforcement. If a smart contract has already executed a disputed transfer by the time an arbitral award issues, the tribunal's remedy is reduced to restitution, which again depends on cooperation or jurisdictional reach. This asymmetry between *ex ante* code execution and *ex post* tribunal authority is the most pronounced conceptual challenge identified by Niriella (2024).

V. DECENTRALIZED DISPUTE RESOLUTION AND THE NEW YORK CONVENTION

Alongside institutional arbitration, a class of decentralized dispute-resolution platforms has emerged on public blockchains. Kleros, launched in 2018, uses a token-weighted juror selection model in which stakeholders are drawn from a

pool, commit staked tokens to a decision, and are rewarded or penalized based on consensus. Aragon Court operates on similar principles, and the Openlaw and Jur platforms offer related services.

The legal status of decisions rendered by these platforms under the New York Convention is contested. An award qualifying under Article I must be made by arbitrators or an arbitral institution in a contracting state. Where the juror pool is globally distributed and the platform lacks a juridical seat, the awards do not readily satisfy the Convention's seat requirement. Ast (2018) has argued that Kleros decisions are more appropriately characterized as contractual determinations or expert decisions than as arbitral awards. If so, enforcement would depend on contractual incorporation into a follow-on arbitration or litigation rather than direct Convention recognition.

A practical compromise is the 'anchor arbitration' model, in which parties incorporate a decentralized-platform determination into a subsequent institutional arbitration clause, thereby preserving Convention enforcement while retaining the efficiency benefits of on-chain adjudication. The HKIAC and JAMS have signaled openness to this hybrid approach, and pilot programs are underway.

VI. RECOMMENDATIONS

Four reforms would substantially clarify the treatment of smart contracts in international arbitration. First, arbitral institutions should issue model smart-contract arbitration clauses that specify the seat, governing law, language, and tribunal composition in machine-readable and human-readable form. The HKIAC's 2022 model clause for technology disputes offers a starting point; parallel initiatives at ICC, SIAC, and LCIA would harmonize practice.

Second, tribunals should develop interpretive protocols for natural-language/code divergence. A presumption in favor of the human-readable document where the code fails to capture the parties' commercial intent accommodates ordinary interpretive expectations while preserving the automation benefits of code.

Third, enforcement-side reforms are required at the national level. Jurisdictions hosting significant cryptocurrency activity should legislate explicit recognition of digital assets as property, standardize the form of proprietary injunctions against on-chain holdings, and establish judicial cooperation channels for wallet identification. Singapore's Payment Services Act 2019 and the UK Law Commission's 2023 Report on Digital Assets provide comparative benchmarks.

Fourth, the UNCITRAL Working Group II on Dispute Settlement should consider a soft-law instrument addressing blockchain-era arbitration agreements. A Model Protocol, without amending the Convention itself, could clarify the writing requirement, the seat, and the interaction with decentralized platforms. Niriella (2024) supports such a calibrated soft-law response as preferable to premature treaty revision.

VII. CONCLUSION

Smart contracts are not replacing arbitration; they are reshaping the transactional substrate on which arbitration operates. The doctrinal challenges are real but manageable within existing frameworks, provided that institutional rules, national enforcement laws, and interpretive protocols evolve in tandem. The paper has argued that a hybrid human–algorithmic model code executing performance, tribunals resolving contested questions, national courts enforcing monetary awards offers the most coherent path.

Two conclusions warrant emphasis. First, the pure code-native model, though theoretically elegant, generates enforcement vulnerabilities that make it unsuitable for high-value cross-border commerce absent a paired natural-language expression. Second, decentralized dispute-resolution platforms are best understood as contractual adjunct mechanisms rather than substitutes for New York Convention arbitration. Building on Niriella's (2024) critical analysis, this paper suggests that the future of smart-contract arbitration lies in structured hybridity: preserving the commercial efficiencies of automation while retaining the interpretive and enforcement guarantees of the existing international framework.

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