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FORCE MAJEURE IN SMART CONTRACTS: A CONFLICT BETWEEN REMEDIAL AND OBLIGATORY FRAMEWORKS

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Introduction

Smart Contracts have not been defined adequately; or rather, they do not have a single attributable definition. Some define them as autonomous machines, while others refer it to as contracts between parties stored on a blockchain.[1] It is a self-executing computer program stored on a blockchain network that automates the enforcement and execution of specific contractual terms when predefined, objective conditions are met. It functions either as the primary representation of an agreement or as a supplement to traditional contracts by carrying out automated transactions, such as transferring digital assets between parties. While current implementations are limited to precise "if this, then that" logic for relatively simple actions, complexity is expected to increase as more assets and transactions become digitised on-chain.[2] The central premise of smart contracts lies in the integration of contractual terms on collateral, bonding, or property rights, directly into technological systems, thereby making non-performance costly and deterrent.[3] By substantially lowering the costs of mediation, enforcement, and arbitration, Szabo[4] conceptualised smart contracts as a shift from traditional paper-based agreements to digitally governed systems, such as computer-supported financial networks and databases.

[1] Josh Stark, 'Making Sense of Blockchain Smart Contracts' (*CoinDesk*, 4 June 2016) https://perma.cc/37QL-6TCN accessed 22 October 2025.
[2] Stuart D Levi and Alex B Lipton, 'An Introduction to Smart Contracts and Their Potential and Inherent Limitations' (*Harv L Sch Forum on Corp Gov*, 26 May 2018) https://corpgov.law.harvard.edu/2018/05/26/an-introduction-to-smart-contracts-and-their-potential-and-inherent-limitations/ accessed 25 October 2025; Christopher D Clack, Vikram A Bakshi and Lee Braine, 'Smart Contract Templates: foundations, design landscape and research directions' (*Cornell University Working Paper*, 4 August 2016).
[3] Max Raskin, 'The Law and Legality of Smart Contracts' (2017) 1 Geo L Tech Rev 305.
[4] Nick Szabo, 'Smart Contracts: Building Blocks for Digital Markets'(1996) <https://www.fon.hum.uva.nl/rob/Courses/InformationInSpeech/CDROM/Literature/LOTwinterschool2006/szabo.best.vwh.net/smart_contracts_2.html> accessed 1 November 2025.

In *Ricketts v. Scothorn*[5], where a grandfather's monetary promise induced his granddaughter to leave her employment, and upon his death, the estate's refusal to honour that promise led the court to grant her relief on the ground of detrimental reliance. Transposed into the present context, the scenario illustrates how a smart contract could preclude such disputes. If the grandfather had encoded the promise within a program specifying whether or not revocation was permissible, the code itself would have governed performance. Once inscribed into the bank's system, the automated terms would operate with finality, rendering any subsequent change of intent quite impossible. However, despite their technological sophistication, smart contracts are not universally preferred over traditional contracts. Their rigid adherence to code often undermines the flexibility required to address unforeseen contingencies and exceptional circumstances. When integrated with verified digital identities, smart contracts enable complete automation of the authentication and validation of a transaction. For instance, ST Aerospace employs a blockchain-based 3D printing system that authenticates design origins, secures files through digital rights management, and autonomously initiates production in its Singapore facilities. Similarly, aviation authorities such as the Federal Aviation Administration have adopted blockchain tracing mechanisms to verify the provenance of aircraft components, reducing both costs and inefficiencies.[6] In the financial sector, Nasdaq's blockchain-based payment infrastructure facilitates automated execution of trades, liquidity adjustments, and reconciliations, effectively minimising reliance on intermediaries and lowering transaction expenses.[7]

A critical issue arises in relation to the non-compliance of smart contracts with the principle of *force majeure*, as embodied in Article 79 of the United Nations Convention on Contracts for the International Sale of Goods ["**CISG**"].[8] Traditional contracts allow parties to invoke *force majeure* when events beyond their control prevent performance, but smart contracts, being entirely co-dependent, lack the capacity to interpret or accommodate such disruptions. This rigidity raises profound questions about fairness, justice, and the accessibility to remedies in cases of supervening impossibility.

To address these concerns, this paper proposes the incorporation of a model clause that introduces a multi-tier dispute resolution mechanism within smart contracts. Such a framework would enable

[5] *Ricketts v. Scothorn* [1898] 57 Neb 51, 77 NW 365.
[6] Ibrahim A, Fernando Y, Shaharudin MS, Ganesan Y, Ahmad NH and Amran A, 'Aerospace supply chains using blockchain technology: implications for sustainable development goals' (2024) 26 Foresight 470.
[7] Nasdaq, 'Nasdaq and Citi Announce Pioneering Blockchain and Global Banking Integration' (Nasdaq, 22 May 2017) https://www.nasdaq.com/articles/nasdaq-and-citi-announce-pioneering-blockchain-and-global-banking-integration-2017-05-22 accessed 31 October 2025; 'Nasdaq All In on Blockchain Technology' (*TheStreet*, 28 June 2017) https://www.thestreet.com/investing/nasdaq-all-in-on-blockchain-technology-14551134 accessed 31 October 2025.
[8] U.N. Convention on Contracts for the International Sale of Goods art 79, 11 April 1980, 1489 UNTS 3.

parties to first resort to negotiation and mediation before invoking arbitration as the final means of redress. By embedding a structure similar to the 'Arb-Med-Arb' clause embodied in the Singapore International Arbitration Centre ["**SIAC**"] Rules[9], parties would retain the opportunity to communicate, reassess obligations, and resolve disputes in good faith before irreversible execution of the contract occurs. The authors ultimately argue that smart contracts should evolve from being purely obligatory instruments to becoming remedial frameworks that integrate human judgment, equitable relief, and adaptive dispute resolution in the face of unforeseen circumstances.

The Problems with Smart Contracts

Despite the operational advantages that smart contracts bring with them, as written at length above, the utility of smart contracts remains circumscribed. In circumstances of substantial or impossible performance, their inflexibility becomes a liability. Consequently, while courts may prefer smart contracts for their certainty and precision, they are likely to favour traditional contracts when confronted with unprecedented situations which demand a novel interpretation or remedial intervention by adjudicative bodies.[10]

Are smart contracts affected by problems of ambiguity?

Ambiguity, though integral to human expression in literature and communication, is incompatible with computer language, which derives its utility from precision and predictability. Unlike natural language, programming languages demand completeness and fixed interpretation; a computer cannot comprehend meanings beyond its coded parameters. Consequently, when contracts are expressed in code, the scope for misinterpretation diminishes significantly, as every instruction must be predefined and logically coherent.

Despite this structural clarity, traditional contract doctrines such as unconscionability and illegality continue to apply. For instance, a smart contract that enables a certain vending machine to sell alcohol to minors, or sell alcohol at extremely high prices, or in prohibited jurisdictions, would still be void under the law.[11] Such situations may be addressed either *ex ante* through regulatory safeguards (such as mandatory verification systems) or *ex post* (through redressal mechanisms).

Thus, while the principles governing the formation of any contract remain consistent across traditional and smart contracts, their implementation diverges in precision. Smart contracts

[9] Singapore International Arbitration Centre, SIAC Arbitration Rules (7th edn, SIAC 2025).
[10] Pragna Kolli and others, Making Sense of Blockchain: How Firms Can Chart a Strategic Path Forward (The Mack Institute, Wharton School, University of Pennsylvania, Fall 2018) https://mackinstitute.wharton.upenn.edu/wp-content/uploads/2018/10/Blockchain_Strategic-Path_White-Paper.pdf accessed 30 October 2025.
[11] *Modern Cigarette, Inc v Town of Orange* 774 A 2d 969, 970–71 (Conn, 2001).

remove uncertainty in interpretation but cannot adapt to contextual nuances. The code invariably executes as written, even when the result deviates from the parties' intended purpose. Nevertheless, their rule-bound predictability provides a closer approximation to the parties' agreed terms than the inherently variable interpretations of natural language.

The common law principle of substantial performance allows a contract to be upheld even when execution falls short of its exact terms, provided the essential purpose is fulfilled. For example, a contract for a custom interior design that depends on the homeowner's personal taste involves subjective judgment that an automated computer code cannot adequately replicate. Parties may attempt to address this by incorporating a degree of flexibility within the programmed terms or by opting against the use of smart contracts, in cases where subjective judgment is essential. However, when such contractual performance departs from the parties' legitimate expectations, the question remains whether the issue should be addressed through prospective regulation or retrospective judicial intervention.

Force majeure clauses and smart contracts

One of the most complex challenges concerning smart contracts lies in their capacity for modification. Traditional contract law recognises doctrines such as impossibility and impracticability, which excuse performance or necessitate alteration when compliance becomes illegal or unfeasible. Smart contracts, are inherently the opposite. For instance, if a contract was made to import certain goods that were later banned by the government, the performance of the contract becomes legally impossible. The contract is thereby discharged due to the supervening illegality caused by the change in law. This is akin to the scenario where an automated contract code would continue execution on outdated terms despite the legal change.[12] While programming languages permit insertion of new code into existing code, contracts involving irrevocable terms pose a distinct legal dilemma. In such cases, judicial intervention becomes inevitable, as judges must balance the enforcement of previously coded obligations with principles that may override them. Ultimately, party autonomy embedded in such code cannot supersede the foundational principles of legality and public policy upheld by judicial systems at the state level.

Enforcement of contractual obligations in the context of smart contracts may occur through both 'traditional or non-traditional mechanisms'.[13] Traditional enforcement encompasses established processes such as arbitration or the intervention of courts, and non-traditional methods represent a paradigm in which compliance is ensured at the network level through code itself. This model

[12] Indian Contract Act 1872, s 56.
[13] Clack, Bakshi and Braine (n 2).

envisions 'tamper-proof' systems[14] that execute obligations automatically, rendering breach or deviation theoretically impossible. Such mechanisms, while efficient, signify a departure from conventional legal oversight, replacing *ex post* adjudication with *ex ante* enforcement embedded within the technological architecture of the contract.

Smart contracts presently lack an efficient mechanism for amendment, creating practical difficulties for parties seeking to modify their agreements. Unlike traditional contracts, which can be readily adjusted through mutual consent or supplementary documentation, smart contracts operate within immutable blockchain systems that severely restrict alterations post-deployment. This inflexibility not only complicates the process of incorporating any necessary changes but also elevates transaction costs and the risk of inaccuracies in reflecting revised terms. Accordingly, while smart contracts provide certainty, they do so at the expense of the flexibility that is found in traditional contracts.

It is quite apparent from the preceding discussion that the inherent nature of smart contracts (specifically, their immutability), renders the enforceability of a *force majeure* clause embedded within the contract, absolutely impossible.

Multi-tier Dispute Resolution: Way towards Remedial Frameworks

The principal flaw of existing smart contracts lies in their obligatory architecture: once deployed, they function as irreversible instructions enforcing performance regardless of fairness or feasibility. Multi-stage contracts exemplify the *"endless execution problem."* Transactions continue even when the underlying purpose has collapsed or the obligations have become impossible to fulfil. Traditional contract remedies, such as rescission, injunction, or reformation, cannot operate effectively because the contract is self-enforcing; by the time a dispute arises, execution is already complete. The future calls for reconceptualising smart contracts as remedial tools rather than mere automatic executors, integrating some mechanisms for human judgment alongside the certainty of automation.

Multi-tier dispute resolution framework

A practical solution involves incorporating multi-tier dispute resolution ["**MDR**"] clauses directly within smart contract code. MDR clauses require parties to exhaust negotiation and mediation before resorting to formal arbitration. This staged approach aligns automation with equitable relief, preserving efficiency whilst restoring contextual judgment. An integrated MDR framework would incorporate a *"pause function"* triggerable upon dispute invocation. Upon invocation, parties engage

[14] Ibid.

with decentralised interfaces for negotiation. If negotiation fails, disputes then shift to mediation by neutral third parties, who exercise equitable judgment to assess whether unforeseen circumstances justify relief. Where such mediation does not result in settlement, disputes proceed to formal arbitration under previously agreed procedural rules, which enables arbitrators to determine whether supervening events constitute a *force majeure* event, and to decide the appropriate remedies. This structure mirrors the SIAC's Arb-Med-Arb model, which integrates mediation within arbitration proceedings.

Emerging technologies

Kleros, a decentralised arbitration protocol built on Ethereum, employs crowdsourced jurors selected through stake-weighted random sampling, with appeals available through larger jury pools.[15] Kleros demonstrates that decentralised decision-making can serve as a scalable dispute resolution mechanism, enabling subjective judgment through human deliberation rather than deterministic code.[16]

The Aragon Network Court ["**ANT**"] uses governance tokens to encourage participation, requiring jurors to stake tokens in exchange for the right to resolve disputes, with a system of multi-round appeals that allows matters to be reviewed by increasingly larger juries.[17] These systems demonstrate the feasibility of embedding human judgment within smart contracts.

Framework of Article 6.2.3 of the UPICC

The UNIDROIT Principles of International Commercial Contracts ["**UPICC**"] mandate renegotiation as the first tier of remedial action in situations of hardship.[18] Where performance becomes excessively onerous due to altered circumstances, Article 6.2.3(1) of the UPICC[19] requires that *"in case of hardship, the disadvantaged party is entitled to request renegotiations. The request shall be made without undue delay and shall indicate the grounds on which it is based."* The UPICC framework establishes a binding four-tier mechanism: first, the disadvantaged party must request renegotiation (mandatory, not discretionary); second, parties must attempt negotiation in good faith; third, if negotiation fails, *"either party may resort to the court"*; and fourth, the court may either *"terminate the*

[15] Clement Lesaege, Federico Ast, and William George, Kleros: A Decentralized Application to Arbitrate Disputes (Kleros White Paper, September 2019).
[16] Luis Bergolla, 'Kleros: A Socio-Legal Case Study of Decentralized Justice and Blockchain Arbitration' (2022) 37 Ohio State Journal on Dispute Resolution 55.
[17] Aragon Foundation, Aragon Network Whitepaper: An Opt-In Digital Jurisdiction for DAOs and Sovereign Individuals (April 2017).
[18] UNIDROIT, *Principles of International Commercial Contracts* (2016), arts 6.2.1-6.2.3.
[19] UNIDROIT *Principles on International Commercial Contracts* (2016) art 6.2.3(1).

contract at a date and on terms to be fixed" or *"adapt the contract with a view to restoring its equilibrium."*[20] This directly parallels the MDR structures proposed for smart contracts. Significantly, UPICC Article 6.2.3 operates through an *ex-post* evaluation, which is an assessment made after changed circumstances arise, permitting contextual judgment about whether adaptation is warranted. This demonstrates that international commercial law recognises tiered dispute resolution not merely as best practice but as a binding doctrine.[21]

Recent international jurisprudence reinforces the enforceability of MDR mechanism as binding contractual obligations, establishing that multi-tier resolution is not discretionary but legally mandatory. In *Max Engineering Works Pte Ltd v. PQ Builders Pte Ltd,*[22] the Hon'ble High Court of Singapore issued a specific performance order compelling parties to proceed to mediation despite pending arbitration, treating MDR compliance how is it mandatory contractual obligation. Justice Steven Chong held that while the court would ordinarily refrain from compelling mediation, the contractual language "*shall refer the dispute to mediation"* created an inforce liable obligation binding the parties throughout the arbitration process.

This jurisprudential development establishes that MDR compliance is enforceable through arbitration itself, creating a self-executing mechanism by which arbitrators can compel adherence to staged resolution. This development is significant, given the direction which international jurisprudence on the subject has taken recently.

The Holdup Problem and Smart Contracts Remedial Design

Beyond legal and equitable considerations, economic theory offers a compelling rationale for incorporating MDR mechanisms into smart contracts. The *"holdup problem",* which arises in contract renegotiation, happens when changed circumstances after contract formation enable one party, holding superior bargaining leverage, to exploit the other party, who is now facing changed circumstances. For example, a supplier facing unexpected production disruptions may be forced to accept significantly higher prices from a buyer who threatens to source from competitors if contract prices are not renegotiated upward. In such situations, the supplier, facing a production crisis, may lack realistic alternatives and accept exploitative renegotiation terms.[23] Traditional contract theory addresses the holdup problem through two mechanisms: commitment devices that impose irreversible consequences

[20] Ibid.
[21] Nupur Trivedi, 'Application of Force Majeure and Hardship Principles Under CISG and UNIDROITt' (2015) 5(1) International Journal of Reviews and Research in Social Sciences 1.
[22] *Max Engineering Works Pte Ltd v PQ Builders Pte Ltd* [2023] SGHC 71 (Singapore High Court, 26 May 2023).
[23] Oliver Hart, *Firms, Contracts, and Financial Structure* (Clarendon Press, Oxford, 1995).

for breach, and equitable remedies that permit contract adaptation when changed circumstances warrant it. However, these mechanisms create a tension: tools designed to prevent bad-faith hold-ups can also block mutually beneficial renegotiation when genuine changes in circumstances call for adapting the contract. Professor Richard Holden's analysis demonstrates that blockchain-based smart contracts with immutable commitment devices can resolve this tension.[24] Smart contracts can impose a credible commitment to enforce original terms while simultaneously embedding staged renegotiation mechanisms. Specifically, MDR-embedded smart contracts incorporate: (1) coded verification that original contract terms will be enforced absent mutual agreement to modification; (2) mandatory negotiation and mediation stages permitting parties to propose and discuss adaptation; and (3) arbitration mechanisms for neutral assessment of whether changed circumstances justify adaptation. This architecture permits parties to distinguish between illegitimate holdup and legitimate adaptation.

Conclusion

Smart contracts mark a significant advance in how agreements are formed and enforced, but their immutable nature limits their ability to respond to unprecedented *force majeure* events. Incorporating stages of negotiation, mediation, and arbitration allows human judgment to operate alongside automation, ensuring that fairness and efficiency are maintained. Until technology develops further, a broader and more purposive interpretation of existing laws can help bridge the gap between innovation and justice.

[24] Richard Holden, 'Can Blockchains Solve the Holdup Problem in Contracts?' (Becker Friedman Institute for Research in Economics, University of Chicago, Working Paper No. 2018-12, February 2018).