



The Future of Smart Contracts in Indonesia's Commercial and Business Law System

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Abstract

This research examines the future regulatory position of blockchain based smart contracts within Indonesia's commercial and business law system by focusing on the unresolved legal tensions between conventional contract doctrine and decentralized digital governance. The study applies normative juridical and doctrinal legal research methods supported by statutory, conceptual, and comparative approaches to analyze the Indonesian Civil Code, Government Regulation Number 71 of 2019, Law Number 1 of 2024 concerning Electronic Information and Transactions, and Law Number 4 of 2023 concerning Financial Sector Development and Strengthening. The findings demonstrate that Indonesian contract law remains structurally dependent upon conventional assumptions concerning consent, enforceability, jurisdiction, evidentiary authority, and institutional dispute settlement, while blockchain based transactions increasingly operate through autonomous computational execution beyond traditional judicial intervention. Comparative analysis reveals that several jurisdictions have adopted technologically adaptive regulatory models integrating blockchain governance, legal sandbox mechanisms, digital commercial supervision, and hybrid dispute resolution frameworks. The research concludes that Indonesia requires comprehensive legislative reform capable of harmonizing commercial modernization, algorithmic governance, and legal certainty within the expanding architecture of decentralized digital commerce.

Keywords : Smart Contracts, Blockchain Governance, Digital Commerce, Commercial Law, Regulatory Harmonization.



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INTRODUCTION

The rapid expansion of blockchain technology within the architecture of global digital commerce has fundamentally transformed contemporary understandings of contractual relations, particularly through the emergence of smart contracts as self executing legal instruments capable of automating transactional obligations without intermediary enforcement. Across multiple jurisdictions, smart contracts have increasingly been integrated into financial technology ecosystems, cross border commercial transactions, decentralized finance platforms, supply chain governance, and digital payment infrastructures, reflecting a broader transition from paper based contractual formalism toward algorithmically mediated legal relations. Recent developments in the United States, the European Union, Singapore, and several East Asian jurisdictions demonstrate that the legal discourse surrounding smart contracts no longer concerns merely technological feasibility, but increasingly addresses the normative implications of enforceability, jurisdictional authority, evidentiary legitimacy, and automated dispute settlement mechanisms within digitally networked economies. Singh argued that blockchain based smart contracts possess substantial transformative capacity for both commercial governance and public administration because their decentralized architecture enables transparency, immutability, and procedural efficiency that conventional contractual systems often fail to guarantee (Singh, 2022).

Parallel developments in Indonesia indicate that the digitalization of financial and commercial infrastructures has accelerated through the adoption of electronic transaction systems and digital payment frameworks, particularly following the increasing institutional attention toward central bank digital currencies and digital economic governance (Simran & Adam, 2023). Nevertheless, while

technological adoption continues to expand rapidly, the Indonesian legal system remains predominantly rooted in conventional civil law doctrines codified within the Indonesian Civil Code and traditional principles of consensual agreements that were constructed long before the emergence of decentralized computational contracts (Indonesian Civil Code).

Existing scholarship concerning smart contracts and blockchain governance has produced significant theoretical insights regarding the operational efficiency, legal autonomy, and commercial utility of algorithmic contractual systems, although substantial divergences remain concerning their juridical classification and enforceability within civil law jurisdictions. Rusakova and Frolova emphasized that the digitalization of legal relations has generated a new category of disputes characterized by transnational complexity, technological opacity, and procedural uncertainty that challenge the adequacy of conventional adjudicatory institutions (Rusakova & Frolova, 2022). Within the Indonesian context, Saputri highlighted that the absence of specific regulatory instruments governing smart contracts creates uncertainty concerning legal validity, evidentiary recognition, and institutional accountability in electronic transactions (Saputri, 2024).

Similar concerns were articulated by Warianto, Amboro, and Sudirman, whose comparative analysis between Indonesia and the United States demonstrated that jurisdictions with adaptive regulatory approaches tend to facilitate greater legal certainty for blockchain based transactions, whereas Indonesia continues to rely heavily upon generalized electronic transaction provisions incapable of addressing the technical specificity of automated contractual execution (Warianto et al., 2024). Sudarto further argued that from a civil law perspective, the principal challenge lies not merely in recognizing smart contracts as legally binding instruments, but in reconciling algorithmic execution mechanisms with doctrinal requirements concerning consent, capacity, good faith, and contractual interpretation embedded within traditional private law theory (Sudarto, 2025). Collectively, these studies reveal an emerging consensus that smart contracts cannot be understood solely as technological tools because their implementation inevitably restructures the normative foundations of contractual governance itself.

Despite the growing body of literature, current scholarship remains fragmented both conceptually and methodologically because most existing analyses either prioritize technological optimism without sufficiently interrogating doctrinal incompatibilities or focus narrowly on electronic transaction regulation without examining the broader transformation of contractual theory in the digital economy. A significant limitation within existing Indonesian scholarship concerns the tendency to interpret smart contracts merely as extensions of conventional electronic agreements under Government Regulation Number 71 of 2019 concerning the Implementation of Electronic Systems and Transactions, despite the fact that blockchain based contractual systems operate through decentralized validation mechanisms fundamentally different from centralized electronic transaction infrastructures contemplated by existing legislation (Government Regulation of the Republic of Indonesia Number 71 of 2019 concerning the Implementation of Electronic Systems and Transactions).

Current legal analyses also demonstrate inconsistency regarding whether smart contracts should be categorized as independent legal agreements, automated performance tools, or evidentiary instruments subordinate to traditional contractual arrangements. Such ambiguity generates unresolved questions concerning party intention, procedural fairness, liability allocation, coding errors, and judicial intervention in cases where algorithmic execution produces materially unjust outcomes. The comparative literature similarly remains underdeveloped because most studies focus on descriptive legal comparison rather than critically examining how divergent legal traditions shape the epistemological foundations of contractual legitimacy in digital environments. As a consequence, the existing literature has not yet produced a coherent analytical framework capable of explaining how Indonesia's civil law system can accommodate decentralized contractual automation without undermining foundational principles of contractual justice and legal certainty.

The unresolved nature of these doctrinal and regulatory tensions possesses substantial scientific and practical urgency because Indonesia is currently experiencing rapid digital economic expansion accompanied by increasing integration of blockchain based financial and commercial activities into mainstream economic transactions. The absence of a comprehensive legal framework governing smart contracts creates systemic uncertainty not only for private commercial actors, but also for judicial institutions, regulatory agencies, and digital platform providers attempting to navigate disputes emerging from automated contractual relationships. Rusakova and Frolova observed that digital

disputes frequently transcend territorial jurisdiction and conventional evidentiary procedures, thereby requiring legal systems to reconsider the institutional architecture of dispute settlement itself (Rusakova & Frolova, 2022).

Within Indonesia, such concerns become particularly acute because the persistence of doctrinal reliance upon classical contractual interpretation under the Indonesian Civil Code creates a regulatory asymmetry between rapidly evolving technological practices and relatively static legal norms (Indonesian Civil Code). Saputri identified that the lack of explicit recognition concerning smart contract enforceability risks discouraging investment and innovation within Indonesia's digital economy due to uncertainty surrounding legal protection and contractual reliability (Saputri, 2024). The practical implications extend beyond commercial efficiency because unresolved legal ambiguity potentially undermines public trust in digital governance systems and weakens Indonesia's competitiveness within the increasingly interconnected global digital marketplace. Accordingly, the issue of smart contract regulation cannot be reduced to a merely technical legal adjustment because it concerns the broader capacity of Indonesian commercial law to maintain normative legitimacy amid accelerating technological transformation.

This research positions itself within the evolving intersection between commercial law, digital governance, and blockchain jurisprudence by critically interrogating the structural incompatibility between Indonesia's conventional contract law paradigm and the decentralized logic of smart contract systems. Unlike prior studies that predominantly examine smart contracts through descriptive regulatory analysis or comparative observation, this study advances a doctrinal and conceptual examination concerning the extent to which Indonesian civil law principles can accommodate autonomous contractual execution mechanisms operating independently from traditional human interpretative processes. The research departs from existing scholarship by conceptualizing smart contracts not merely as technological innovations requiring regulatory adaptation, but as juridical phenomena that challenge foundational assumptions concerning consent, interpretation, liability, and enforceability within modern contract law. This analytical orientation enables the study to critically assess whether existing Indonesian legal doctrines remain normatively adequate in governing blockchain based transactions or whether more fundamental reconceptualization of contractual authority is required within the emerging digital legal order. In this regard, the study seeks to bridge the conceptual divide between technological determinism and legal formalism that continues to characterize much of the current discourse surrounding blockchain governance and smart contract legitimacy.

This research aims to analyze the future position of smart contracts within Indonesia's commercial and business law system by examining the legal validity, enforceability, and dispute settlement implications of blockchain based contractual mechanisms under the contemporary Indonesian legal framework. The study intends to construct a comprehensive doctrinal framework capable of explaining the interaction between decentralized contractual automation and civil law principles governing agreements, obligations, and legal accountability. The theoretical contribution of this research lies in its effort to reconceptualize smart contracts as hybrid juridical instruments situated between technological automation and normative legal authority, while its methodological contribution emerges from the integration of comparative legal reasoning, doctrinal interpretation, and digital governance analysis in examining the transformation of contractual law within the digital economy. The research ultimately seeks to contribute toward the development of adaptive legal frameworks capable of preserving legal certainty, contractual justice, and institutional legitimacy within Indonesia's rapidly evolving digital commercial environment.

RESEARCH METHODS

This study constitutes a non empirical legal research grounded primarily in normative juridical and doctrinal approaches aimed at examining the regulatory and conceptual position of blockchain based smart contracts within Indonesia's commercial and business law system. The research relies on primary legal materials consisting of the Indonesian Civil Code, Government Regulation of the Republic of Indonesia Number 71 of 2019 concerning the Implementation of Electronic Systems and Transactions, Law of the Republic of Indonesia Number 1 of 2024 concerning the Second Amendment to Law Number 11 of 2008 on Electronic Information and Transactions, and Law of the Republic of Indonesia Number 4 of 2023 concerning Financial Sector Development and Strengthening. Secondary

legal materials include scholarly monographs, peer reviewed journal articles, comparative legal studies, and international doctrinal literature concerning blockchain governance, digital contracts, and decentralized legal infrastructures, particularly the theoretical framework advanced by De Filippi and Wright regarding the transformation of legal authority within blockchain based systems (De Filippi & Wright, 2018). The study also adopts a comparative legal perspective by examining the regulatory evolution of smart contracts in several jurisdictions that have developed more adaptive legal responses toward decentralized contractual technologies, with the objective of identifying conceptual divergences and regulatory limitations within the Indonesian legal framework.

The analytical framework of this research employs statutory, conceptual, and comparative approaches to interpret the interaction between conventional principles of contract law and the autonomous operational logic of smart contracts. Legal interpretation is conducted through systematic and teleological methods in order to evaluate whether existing Indonesian legal norms concerning consent, contractual validity, enforceability, and dispute settlement remain doctrinally adequate in governing algorithmically executed agreements operating within decentralized blockchain environments. The study further utilizes qualitative doctrinal analysis to examine normative inconsistencies between classical civil law assumptions embedded within the Indonesian contract law regime and the emerging characteristics of self executing digital agreements. Comparative legal reasoning is applied not merely to identify regulatory differences across jurisdictions, but to critically assess how varying legal traditions conceptualize contractual autonomy, technological neutrality, and institutional authority in the context of digital commerce. Through this interpretative framework, the research seeks to construct a coherent juridical analysis capable of explaining the legal challenges and future regulatory direction of smart contracts within Indonesia's evolving digital economic order.

RESULTS AND DISCUSSION

Normative Reconstruction of Smart Contract Validity within Indonesian Commercial Law

The juridical transformation generated by blockchain based smart contracts has created significant pressure upon the classical structure of Indonesian contract law because the Indonesian Civil Code continues to conceptualize contractual relations through conventional assumptions regarding human intention, written consent, and centralized enforcement authority. Article 1320 of the Indonesian Civil Code establishes four cumulative requirements for contractual validity consisting of consent, legal capacity, specific object, and lawful cause, yet the provision was historically formulated within a transactional environment dependent upon human interpretation rather than algorithmic execution. Smart contracts operate through automated code embedded within decentralized blockchain infrastructures that execute contractual obligations without subsequent human intervention, thereby producing a doctrinal tension concerning whether algorithmic execution can be equated with legally recognizable consent under Indonesian private law doctrine. De Filippi and Wright explain that blockchain architecture transforms legal authority from institutional interpretation toward computational enforcement because contractual performance becomes technically predetermined by code based protocols rather than judicial supervision or discretionary interpretation by parties and state institutions (DE FILIPPI & WRIGHT, 2018). Indonesian legal scholarship increasingly recognizes that this transformation challenges the ontological foundation of contract law because contractual autonomy becomes partially transferred from subjective legal intention toward objective computational execution embedded within decentralized technological systems (ABIDIN, 2023).

The conceptual incompatibility between classical consensualism and automated contractual execution becomes increasingly evident when Article 1338 paragraph 1 of the Indonesian Civil Code is interpreted systematically alongside Article 18 paragraph 1 of Law Number 1 of 2024 concerning Electronic Information and Transactions. Article 1338 paragraph 1 recognizes the binding force of legally formed agreements, whereas Article 18 paragraph 1 validates electronic contracts conducted through electronic systems, yet neither provision explicitly addresses agreements executed autonomously through self executing blockchain code. A grammatical interpretation of the phrase electronic contract under Law Number 1 of 2024 demonstrates that the Indonesian legislature continues to rely upon technologically neutral terminology without constructing doctrinal parameters capable of distinguishing conventional electronic agreements from decentralized smart contracts. Fikrina, Deswari, Sucia, and Putri argue that Indonesian contract law remains normatively dependent upon analog legal assumptions because existing regulations merely extend conventional contractual

categories into digital transactions without fundamentally reconstructing the doctrinal meaning of contractual intention within algorithmic environments (FIKRINA ET AL., 2025). The absence of explicit legislative differentiation generates interpretative uncertainty regarding whether blockchain based execution satisfies the legal threshold of consensual intent required under Indonesian private law doctrine.

The doctrinal ambiguity concerning legal consent also emerges from the operational characteristics of blockchain transactions that eliminate opportunities for renegotiation, cancellation, or discretionary suspension once coded conditions are fulfilled within decentralized networks. Article 1321 of the Indonesian Civil Code invalidates agreements formed through mistake, coercion, or fraud, yet smart contracts frequently execute automatically without institutional mechanisms capable of suspending contractual performance when defects of consent subsequently become apparent. Atiyah, Manap, and Ibrahim emphasize that smart contracts create legal difficulties because automated execution structurally minimizes the role of human interpretative discretion that traditionally functions as a corrective instrument within conventional contract law systems (ATIYAH ET AL., 2025). Teleological interpretation of Article 1321 indicates that Indonesian contract law seeks to preserve substantive fairness and authentic intention within contractual relations, whereas blockchain protocols prioritize deterministic execution regardless of subsequent evidentiary disputes regarding subjective consent. The resulting normative contradiction demonstrates that Indonesian contract law currently lacks doctrinal instruments capable of reconciling algorithmic certainty with substantive contractual justice.

Comparative legal analysis further demonstrates that several jurisdictions have adopted more adaptive approaches toward recognizing smart contracts within commercial transactions while maintaining legal safeguards concerning consent and enforceability. Certain jurisdictions within the United States recognize smart contracts through state legislation that explicitly acknowledges blockchain based records and electronic signatures as legally enforceable contractual instruments, whereas Singapore and the United Kingdom rely upon technologically neutral interpretations supplemented by judicial recognition of digital assets and decentralized contractual structures. Warianto, Amboro, and Sudirman explain that the United States legal framework approaches smart contracts through functional equivalence doctrine by emphasizing transactional outcomes rather than technological formality, thereby reducing doctrinal resistance toward decentralized commercial innovation (WARIANTO ET AL., 2024). Indonesian law continues to rely heavily upon codified civil law traditions inherited from continental European legal structures that prioritize formal doctrinal certainty and centralized institutional supervision. Comparative interpretation therefore reveals that Indonesian legal conservatism regarding contractual formalism contributes substantially to the regulatory delay affecting blockchain based commercial agreements.

The interaction between Government Regulation Number 71 of 2019 and Law Number 1 of 2024 further illustrates the fragmented normative construction governing decentralized digital transactions within Indonesia's commercial law regime. Article 46 paragraph 2 of Government Regulation Number 71 of 2019 requires electronic contracts to contain identifiable parties, object specifications, transaction procedures, and dispute settlement mechanisms, yet decentralized smart contracts frequently operate through pseudonymous blockchain identities rather than conventionally identifiable legal subjects. Baso, Yusuf, Djaoe, Iswandi, and Ramadhany observe that enforceability problems emerge because blockchain based agreements often prioritize cryptographic authentication instead of formal identification procedures traditionally recognized within national legal systems (BASO ET AL., 2024). Systematic interpretation of Article 46 paragraph 2 demonstrates that Indonesian electronic transaction law continues to presume the existence of identifiable contracting parties subject to territorial jurisdiction and institutional supervision. Smart contracts executed through decentralized blockchain networks partially disrupt these assumptions because contractual participation may occur across transnational infrastructures lacking centralized verification mechanisms. The resulting normative inconsistency demonstrates that Indonesian digital transaction regulations have not yet fully adapted to decentralized contractual environments characterized by algorithmic autonomy and distributed ledger governance.

The inadequacy of Indonesian legal doctrine becomes more apparent when blockchain based contractual relations are examined through the theoretical framework of technological governance developed by De Filippi and Wright. The theory of code based governance explains that blockchain

systems replace institutional discretion with predetermined computational logic because contractual obligations become embedded directly within executable code rather than mediated through judicial interpretation or administrative supervision (DE FILIPPI & WRIGHT, 2018). Indonesian contract law nevertheless continues to conceptualize agreements as interpretative legal relationships requiring institutional oversight, equitable assessment, and discretionary judicial enforcement. Halaburda, Levina, and Min argue that strong smart contracts establish a new form of transactional governance because economic coordination increasingly depends upon automated digital infrastructures rather than relational trust or centralized institutional monitoring (HALABURDA ET AL., 2024). Indonesian legal doctrine currently lacks normative principles capable of determining whether automated blockchain execution constitutes an extension of contractual autonomy or an independent technological governance structure operating beyond traditional private law assumptions. The absence of doctrinal clarity therefore produces legal uncertainty concerning the conceptual status of blockchain contracts within Indonesian commercial law.

Table 1. Normative Comparison between Indonesian Contract Law and Blockchain Based Smart Contracts

Legal Aspect	Indonesian Civil Code and Electronic Transaction Law	Characteristics of Smart Contracts	Normative Implication
Contractual Consent	Article 1320 of the Indonesian Civil Code requires subjective agreement between contracting parties	Consent is embedded within algorithmic code and cryptographic digital signatures	Ambiguity concerning the legal recognition of computational consent
Contractual Enforcement	Article 1338 of the Indonesian Civil Code relies upon judicial enforceability and contractual binding force	Contractual execution occurs automatically through blockchain protocols	Reduced institutional discretion within contractual dispute settlement
Identification of Parties	Article 46 of Government Regulation Number 71 of 2019 requires identifiable legal subjects	Blockchain transactions may utilize pseudonymous or anonymous digital identities	Jurisdictional and evidentiary uncertainty regarding legal accountability
Dispute Resolution	Conventional contractual disputes are resolved through litigation or arbitration mechanisms	Automated execution minimizes opportunities for post contractual intervention	Limited corrective mechanisms for defective consent and contractual imbalance
Regulatory Orientation	Indonesian electronic transaction law adopts technologically neutral regulatory language	Smart contracts operate through decentralized and autonomous infrastructures	Regulatory fragmentation and doctrinal inconsistency within commercial law

Source: Constructed by the author based on the Indonesian Civil Code, Government Regulation Number 71 of 2019, Law Number 1 of 2024, and comparative doctrinal studies by De Filippi and Wright (2018), Abidin (2023), Baso et al. (2024), and Warianto et al. (2024).

The comparative structure presented within Table 1 demonstrates that Indonesian commercial law remains anchored within centralized legal assumptions that differ fundamentally from the decentralized operational logic of blockchain based agreements. The Indonesian Civil Code conceptualizes contracts as juridical relationships mediated through judicial interpretation and state

enforcement, whereas smart contracts rely upon computational determinism and decentralized verification mechanisms operating independently from conventional institutional supervision. Hassanah, Wahyudi, and Aziz explain that Indonesian civil law doctrine traditionally prioritizes substantive contractual fairness and interpretative flexibility because standard contractual clauses within digital commerce frequently create imbalances requiring judicial intervention (HASSANAH ET AL., 2023). Smart contracts partially eliminate this corrective flexibility because contractual outcomes become technically irreversible once algorithmic conditions are satisfied within blockchain infrastructures. Teleological interpretation therefore suggests that the Indonesian legal system faces a structural challenge concerning how to preserve substantive fairness while simultaneously accommodating technological automation within digital commercial transactions.

The doctrinal limitations of Indonesian law are also reflected in the absence of judicial precedents specifically addressing the legal validity of blockchain based smart contracts within Indonesian courts. The Supreme Court and Constitutional Court have not yet formulated interpretative standards capable of determining whether decentralized contractual code satisfies the requirements of lawful agreement under Article 1320 of the Indonesian Civil Code. Rusakova and Frolova argue that digital disputes emerging within technologically decentralized environments require judicial institutions to reconstruct evidentiary and jurisdictional principles because conventional legal doctrines remain dependent upon territorially centralized assumptions regarding contractual authority and dispute resolution (Rusakova & Frolova, 2022). Indonesian procedural law continues to prioritize documentary evidence, identifiable parties, and territorially ascertainable legal relationships, whereas blockchain transactions frequently operate through distributed infrastructures lacking centralized evidentiary control. The absence of judicial interpretation therefore intensifies normative uncertainty because courts have not yet articulated principles concerning the admissibility, enforceability, or interpretative status of blockchain based contractual code. Indonesian commercial actors consequently encounter substantial legal risk when utilizing smart contracts for high value digital transactions.

The integration of blockchain technologies into broader sectors of digital commerce further intensifies the urgency of regulatory reform because smart contracts increasingly influence financial technology, virtual asset transactions, intellectual property management, and digital payment infrastructures. Law Number 4 of 2023 concerning Financial Sector Development and Strengthening recognizes the strategic significance of digital financial innovation within Indonesia's economic transformation agenda, yet the statute does not specifically regulate the juridical structure of decentralized smart contracts operating within blockchain ecosystems. Simran and Adam explain that digital payment regulation in Indonesia increasingly depends upon technological adaptation because decentralized financial infrastructures challenge traditional assumptions concerning institutional control, transactional verification, and regulatory oversight (Simran & Adam, 2023). Putranti and Putri further demonstrate that blockchain based smart contracts are increasingly utilized within non fungible token transactions involving intellectual property enforcement and automated royalty distribution, thereby extending smart contract relevance beyond conventional electronic commerce (Putranti & Putri, 2024). Indonesian commercial law nevertheless continues to approach these developments through fragmented sectoral regulations lacking integrated doctrinal coherence. The absence of comprehensive legal harmonization therefore undermines legal certainty concerning the future enforceability of decentralized commercial agreements.

The future legitimacy of smart contracts within Indonesia's commercial and business law system ultimately depends upon whether Indonesian legal doctrine can reconstruct the conceptual meaning of contractual autonomy within technologically decentralized environments. Indonesian contract law historically evolved within a legal tradition emphasizing human intentionality, judicial supervision, and institutional enforcement, whereas blockchain governance increasingly prioritizes computational certainty, automated execution, and decentralized verification structures. Saputri argues that Indonesian smart contract regulation requires explicit statutory recognition capable of distinguishing blockchain based agreements from ordinary electronic contracts because technological neutrality alone cannot adequately resolve doctrinal ambiguities concerning enforceability and legal validity (Saputri, 2024). Sudarto similarly contends that civil law doctrine must reinterpret contractual consent and legal capacity through technologically adaptive principles capable of accommodating autonomous code based transactions within digital commerce (Sudarto, 2025). Comparative and teleological interpretation therefore indicate that Indonesia requires a comprehensive normative reconstruction integrating private

law doctrine, electronic transaction regulation, and decentralized technological governance into a coherent legal framework capable of preserving legal certainty while accommodating innovation within the national digital economy.

Enforceability and Dispute Settlement Challenges in Blockchain Based Commercial Transactions

The enforceability of blockchain based smart contracts within Indonesian commercial law raises substantial juridical difficulties because automated contractual execution operates through decentralized computational mechanisms that frequently bypass institutional enforcement procedures traditionally exercised through courts and arbitration bodies. Article 5 paragraph 1 of Law Number 1 of 2024 recognizes electronic information and electronic documents as valid legal evidence, yet the provision does not determine whether autonomous blockchain execution may independently satisfy the juridical threshold of enforceability without subsequent judicial authorization. Baso, Yusuf, Djaoe, Iswandi, and Ramadhany argue that the legal enforceability of smart contracts remains uncertain because decentralized execution structures reduce the practical role of courts in supervising contractual performance and dispute correction within commercial transactions (Baso et al., 2024). Indonesian contract enforcement doctrine historically relies upon institutional intervention through litigation, execution orders, and judicial interpretation, whereas blockchain infrastructures execute obligations automatically once predetermined digital conditions are fulfilled. Systematic interpretation of Article 1338 of the Indonesian Civil Code alongside Article 5 paragraph 1 of Law Number 1 of 2024 demonstrates that Indonesian law recognizes contractual binding force and electronic evidence, although no statutory mechanism presently clarifies the relationship between autonomous code execution and formal judicial enforcement authority.

The doctrinal distinction between algorithmic execution and state based enforcement authority becomes increasingly problematic when blockchain transactions generate irreversible economic consequences without procedural opportunities for corrective intervention. Smart contracts embedded within decentralized ledgers may automatically transfer digital assets, release payments, or terminate access rights even when disputes subsequently emerge concerning coding defects, fraudulent manipulation, or external force majeure circumstances. Halaburda, Levina, and Min explain that digitally automated contractual governance transforms commercial coordination into technologically predetermined execution systems that substantially diminish the corrective flexibility historically preserved through conventional legal institutions (Halaburda et al., 2024). Indonesian procedural law nevertheless remains dependent upon adjudicative principles requiring evidentiary examination, judicial interpretation, and proportional remedies before contractual obligations may be coercively enforced against disputing parties. Teleological interpretation therefore indicates that existing Indonesian enforcement doctrine was constructed for relational contractual environments mediated through institutional discretion rather than decentralized infrastructures governed through computational finality.

The institutional limitations of Indonesian enforcement mechanisms become more visible when disputes arise concerning blockchain transactions conducted across transnational digital networks involving unidentified or pseudonymous participants. Government Regulation Number 71 of 2019 requires electronic system operators to ensure accountability, reliability, and legal compliance within electronic transactions, although decentralized blockchain infrastructures frequently operate without identifiable centralized administrators subject to territorial jurisdiction. Rusakova and Frolova observe that digital disputes within decentralized systems challenge conventional procedural assumptions because territorial jurisdiction, evidentiary authority, and institutional competence become increasingly fragmented within transnational digital environments (Rusakova & Frolova, 2022). Indonesian civil procedure traditionally presumes identifiable legal subjects and territorially ascertainable legal relationships capable of being summoned before competent judicial institutions, whereas blockchain based transactions may occur through distributed networks lacking centralized operational authority. Comparative interpretation consequently demonstrates that decentralized smart contract disputes generate procedural uncertainty regarding forum determination, applicable law, and enforceability of judicial decisions across digitally distributed infrastructures.

The complexity of jurisdictional determination also affects the implementation of arbitration and alternative dispute resolution mechanisms within blockchain based commercial disputes because decentralized transactions frequently involve parties located across multiple legal systems. Article 18

paragraph 4 of Law Number 1 of 2024 permits parties engaged in international electronic transactions to determine applicable law and dispute settlement forums, although smart contracts may execute autonomously without explicit textual clauses specifying jurisdictional authority or arbitration procedures. Singh explains that blockchain based commercial transactions increasingly depend upon automated digital infrastructures operating independently from centralized governmental oversight, thereby complicating the application of conventional jurisdictional doctrines developed within territorially bounded commercial relations (Singh, 2022). Indonesian commercial arbitration law continues to rely upon written arbitration agreements and identifiable legal relationships, whereas decentralized smart contracts may operate through coded interactions lacking formally drafted dispute settlement provisions. Comparative legal reasoning therefore suggests that Indonesian commercial law requires adaptive procedural standards capable of integrating decentralized digital transactions into legally enforceable dispute resolution mechanisms.

The admissibility of blockchain generated evidence further intensifies the juridical complexity surrounding smart contract enforcement because Indonesian evidentiary doctrine continues to prioritize documentary authenticity and procedural verification conducted through institutional mechanisms. Article 6 of Law Number 1 of 2024 recognizes electronic information as legally equivalent to written documents provided that accessibility, integrity, and accountability requirements are fulfilled, yet blockchain evidence frequently originates from decentralized systems operating outside state supervised certification frameworks. Harianja and Satya argue that blockchain immutability may strengthen evidentiary reliability because decentralized ledger structures preserve transactional integrity through cryptographic verification mechanisms resistant to unilateral modification (Harianja & Satya, 2026). Indonesian evidentiary law nevertheless lacks explicit procedural standards concerning judicial verification of blockchain records, cryptographic signatures, decentralized timestamps, and algorithmically generated transactional data. The absence of technical evidentiary guidelines consequently creates uncertainty regarding whether blockchain records may independently establish contractual breach, ownership transfer, or financial liability within Indonesian judicial proceedings.

Table 2. Juridical Challenges of Enforcing Smart Contracts in Decentralized Commercial Transactions

Issue	Indonesian Legal Framework	Blockchain Characteristics	Juridical Consequence
Jurisdiction	Indonesian procedural law relies upon territorial competence and identifiable parties	Transactions occur through decentralized cross border networks	Uncertainty regarding forum authority and applicable law
Evidence	Article 5 and Article 6 of Law Number 1 of 2024 recognize electronic evidence	Blockchain records rely upon cryptographic verification and distributed ledgers	Absence of procedural standards for blockchain evidentiary admissibility
Dispute Resolution	Litigation and arbitration require formal procedural agreements	Smart contracts execute automatically without institutional intervention	Limited opportunities for corrective dispute settlement
Liability	Civil liability doctrine presumes identifiable accountable legal subjects	Decentralized infrastructures involve anonymous developers and users	Difficulty determining legal responsibility for contractual losses
Code Malfunction	Indonesian contract law lacks specific regulation concerning algorithmic defects	Coding vulnerabilities may trigger unintended contractual execution	Ambiguity concerning compensation and contractual remedies

Cybersecurity	Government Regulation Number 71 of 2019 requires secure electronic systems	Blockchain systems remain vulnerable to hacking and exploit attacks	Regulatory uncertainty regarding security based liability
Enforcement Authority	Judicial execution remains state centered and territorially limited	Blockchain execution operates autonomously through digital protocols	Institutional limitations in reversing decentralized transactions

Source: Constructed by the author based on Law Number 1 of 2024, Government Regulation Number 71 of 2019, Indonesian Civil Code provisions concerning contractual enforcement, and doctrinal analyses developed by Baso et al. (2024), Rusakova and Frolova (2022), Alaba et al. (2024), Harianja and Satya (2026), and Singh (2022).

The normative mapping presented within Table 2 demonstrates that Indonesian commercial law continues to conceptualize enforceability through centralized procedural authority, whereas blockchain transactions operate through decentralized computational infrastructures resistant to institutional interruption. The divergence between territorial legal authority and distributed technological execution generates structural limitations affecting dispute settlement, evidentiary assessment, and remedial intervention within smart contract disputes. Hassanah, Wahyudi, and Aziz explain that Indonesian commercial law traditionally preserves judicial supervision to prevent contractual imbalance and procedural unfairness within electronic transactions involving unequal bargaining positions (Hassanah et al., 2023). Blockchain execution mechanisms partially eliminate this institutional supervision because contractual performance may occur instantaneously without opportunities for suspension, renegotiation, or equitable judicial correction. Systematic interpretation therefore indicates that Indonesian enforcement doctrine currently lacks procedural instruments capable of reconciling decentralized digital execution with principles of proportional justice and procedural accountability.

The determination of legal liability within blockchain based transactions also remains insufficiently regulated because decentralized contractual infrastructures frequently involve multiple technological actors whose juridical responsibilities are not explicitly recognized within Indonesian commercial legislation. Smart contract failures may emerge from coding vulnerabilities, software incompatibility, oracle malfunction, cybersecurity breaches, or exploit attacks committed through external manipulation of blockchain protocols. Alaba, Sulaimon, Marisa, and Najeem explain that smart contract security vulnerabilities constitute one of the principal operational risks within blockchain systems because coding errors and exploit mechanisms may produce irreversible financial consequences affecting commercial participants (Alaba et al., 2024). Indonesian civil liability doctrine continues to rely upon fault attribution, identifiable legal subjects, and demonstrable causation relationships, whereas decentralized technological systems distribute operational functions across anonymous developers, network validators, and autonomous code infrastructures. Comparative doctrinal interpretation therefore demonstrates that Indonesian law requires explicit allocation principles determining developer liability, platform accountability, and compensation mechanisms for blockchain related contractual losses.

The interaction between cybersecurity obligations and commercial enforceability further illustrates the fragmented regulatory structure governing blockchain transactions within Indonesia's digital economy framework. Government Regulation Number 71 of 2019 obligates electronic system operators to implement reliable security systems capable of protecting confidentiality, integrity, and availability of electronic information, although decentralized blockchain networks frequently operate beyond conventional centralized system administration models. Putranti and Putri demonstrate that blockchain based intellectual property transactions involving non fungible tokens may expose commercial participants to unauthorized exploitation, security vulnerabilities, and automated transactional abuse capable of undermining legal protection for digital rights holders (Putranti & Putri, 2024). Indonesian cybersecurity regulation nevertheless remains oriented toward centralized electronic system operators rather than decentralized digital infrastructures governed through distributed verification mechanisms. The resulting regulatory gap weakens commercial certainty because

contractual enforcement may become ineffective when blockchain vulnerabilities generate financial losses beyond the practical reach of domestic supervisory institutions.

Commercial sectors increasingly integrating smart contracts into operational activities further intensify the urgency of establishing coherent dispute settlement and enforcement standards within Indonesia's evolving digital economy. Ameyaw, Edwards, Kumar, Thurairajah, Owusu Manu, and Oppong explain that blockchain enabled contractual infrastructures are increasingly adopted within construction and commercial sectors because automated execution mechanisms may improve transactional efficiency and reduce administrative uncertainty within complex contractual networks (Ameyaw et al., 2023). Hsiao, Chen, Chang, and Chang similarly demonstrate that smart contracts are becoming integrated into commercial health insurance systems involving algorithmically automated claims verification and financial disbursement procedures requiring high levels of technological reliability and legal predictability (Hsiao et al., 2025). Manimuthu, Venkatesh, Shi, Sreedharan, and Koh further identify the growing integration of smart contracts within industrial automation and federated artificial intelligence systems where contractual execution directly influences operational manufacturing processes and commercial supply chains (Manimuthu et al., 2022). Indonesian commercial law presently lacks sector specific procedural standards capable of addressing liability allocation, evidentiary verification, and dispute settlement within technologically integrated smart contract ecosystems.

The juridical implications of decentralized enforceability also extend toward emerging forms of digital property and virtual commercial transactions increasingly recognized within contemporary digital economies. Amalia explains that metaverse based virtual land transactions involve significant legal uncertainty because ownership transfer, investment protection, and transactional verification frequently depend upon blockchain based infrastructures operating beyond conventional property law assumptions (Amalia, 2023). Daulay and Cahyono similarly identify substantial inheritance law complications involving non fungible token assets because decentralized digital ownership structures challenge traditional doctrines concerning succession, legal possession, and enforceability of inheritance rights within private law systems (Daulay & Cahyono, 2025). Indonesian commercial and civil law frameworks nevertheless continue to prioritize tangible property assumptions and territorially identifiable ownership verification mechanisms when determining enforceability and legal remedies. Teleological interpretation therefore indicates that the expansion of blockchain based economic activities requires comprehensive procedural adaptation capable of integrating decentralized digital assets into enforceable legal relationships governed through coherent dispute settlement institutions.

The future effectiveness of Indonesian smart contract governance ultimately depends upon whether Indonesian legal institutions can reconstruct procedural doctrines capable of harmonizing decentralized technological execution with principles of legal accountability, institutional supervision, and commercial fairness. Saputri argues that Indonesian smart contract regulation requires specialized procedural frameworks addressing dispute settlement, evidentiary admissibility, cybersecurity obligations, and decentralized enforcement mechanisms because conventional electronic transaction regulations remain conceptually inadequate for algorithmically governed commercial relations (Saputri, 2024). Marditia and Yanto further contend that Indonesian commercial law should formulate adaptive regulatory models capable of integrating automated contractual systems into enforceable legal structures while preserving judicial oversight concerning proportionality and public order within digital transactions (Marditia & Yanto, 2025). Rahman, Muhtar, Mongdong, Setiawan, Setiawan, and Siburian similarly emphasize that harmonization between digital transaction regulation and emerging commercial technologies constitutes a necessary precondition for sustainable legal development within Indonesia's digital economic transformation agenda (Rahman Et Al., 2024). Comparative and systematic interpretation therefore demonstrate that enforceability within blockchain based commercial transactions cannot rely exclusively upon technological automation because juridical legitimacy ultimately depends upon the continued capacity of legal institutions to provide accountability, procedural fairness, and effective dispute resolution within decentralized commercial environments.

Regulatory Harmonization and Future Governance Models for Smart Contracts within Indonesia's Digital Commercial Law System

The future development of smart contract regulation within Indonesia requires comprehensive harmonization between conventional civil law doctrines and emerging digital commercial

infrastructures operating through decentralized technological systems. Indonesian commercial regulation continues to rely heavily upon contractual assumptions rooted within the Indonesian Civil Code, while contemporary blockchain based transactions increasingly function through autonomous digital environments involving algorithmic execution, tokenized assets, and distributed commercial governance structures. Law Number 4 of 2023 concerning Financial Sector Development and Strengthening demonstrates an initial governmental attempt to modernize Indonesian financial regulation through digital economic integration, although the legislation still lacks specific provisions governing blockchain based contractual infrastructures and decentralized commercial protocols. Comparative doctrinal studies indicate that legal modernization within digital commerce cannot rely solely upon technological neutrality because blockchain based governance mechanisms possess structural characteristics fundamentally different from conventional electronic transactions regulated under traditional civil law assumptions (Fikrina et al., 2025). Indonesian regulatory reform therefore requires systematic harmonization capable of integrating commercial certainty, technological innovation, institutional accountability, and procedural adaptability within a coherent juridical framework responsive to decentralized digital economies (Rahman et al., 2024).

The harmonization of Indonesian commercial law with blockchain governance frameworks also necessitates reinterpretation of institutional authority within digital transactions because decentralized systems redistribute regulatory functions traditionally monopolized by state institutions. Government Regulation Number 71 of 2019 concerning the Implementation of Electronic Systems and Transactions establishes administrative obligations concerning electronic system reliability and digital security, yet the regulation does not specifically address decentralized blockchain infrastructures functioning beyond centralized institutional supervision. Comparative scholarship concerning algorithmic governance demonstrates that blockchain based commercial systems increasingly replace institutional verification with cryptographic consensus mechanisms capable of autonomously validating commercial transactions without direct governmental intervention (De Filippi & Wright, 2018). This transformation challenges conventional assumptions concerning legal sovereignty because contractual compliance, evidentiary authentication, and transactional enforcement are increasingly embedded within technological protocols rather than administratively supervised institutions. Indonesian commercial modernization consequently requires a hybrid regulatory architecture capable of reconciling decentralized technological autonomy with constitutional principles concerning legal certainty, accountability, and institutional legitimacy within national commercial governance systems (Sudarto, 2025).

Comparative legal analysis demonstrates that several jurisdictions have adopted more adaptive regulatory approaches toward smart contracts through technologically responsive legislation and specialized digital commerce governance mechanisms. The United States has implemented state based recognition models through legislation enacted in jurisdictions such as Arizona, Tennessee, and Wyoming that expressly acknowledge blockchain signatures and smart contracts as enforceable commercial instruments within digital commerce. Singapore has adopted technologically neutral regulatory approaches through the Payment Services Act and innovation oriented financial supervision policies that facilitate blockchain experimentation while preserving institutional oversight concerning financial stability and digital compliance obligations (Warianto et al., 2024). The European Union has emphasized comprehensive digital governance through the Markets in Crypto Assets Regulation and data protection frameworks designed to balance technological innovation with consumer protection, cybersecurity accountability, and institutional transparency. Comparative legal developments across these jurisdictions indicate that successful smart contract governance depends upon adaptive legislative flexibility, procedural interoperability, and coordinated institutional supervision rather than rigid application of conventional contractual doctrines developed for centralized commercial systems.

The regulatory experiences of Malaysia, Pakistan, Saudi Arabia, and Turkey further demonstrate how jurisdictions influenced by mixed legal traditions increasingly attempt to harmonize digital commercial modernization with domestic legal principles and institutional structures. Malaysia has pursued fintech oriented digital governance through regulatory sandbox mechanisms supervised by Bank Negara Malaysia, thereby enabling controlled experimentation concerning blockchain based financial technologies while preserving financial oversight and consumer protection mechanisms (Azam et al., 2025). Pakistan and Saudi Arabia have approached blockchain regulation through gradual institutional adaptation emphasizing compatibility between digital financial innovation and national

legal principles grounded within religious and sovereign regulatory frameworks. Turkey has increasingly integrated blockchain governance discussions within broader digital economy modernization policies emphasizing technological competitiveness, financial innovation, and cross border commercial integration. Comparative analysis across these jurisdictions illustrates that successful regulatory modernization depends upon contextual adaptation rather than direct transplantation of foreign legal models because digital governance frameworks must remain compatible with domestic institutional structures, constitutional principles, and economic policy objectives.

Table 3. Comparative Regulatory Models of Smart Contract Governance across Selected Jurisdictions

Jurisdiction	Regulatory Model	Recognition of Smart Contracts	Regulatory Strength	Relevance for Indonesia
United States	State based adaptive blockchain legislation	Explicit recognition through state statutes	Strong commercial flexibility and contractual autonomy	Demonstrates adaptive legislative recognition models
Singapore	Technology neutral fintech governance	Recognized through digital commerce and fintech regulations	Strong institutional supervision and innovation support	Relevant for regulatory sandbox development
European Union	Integrated supranational digital governance	Recognized within digital asset and electronic transaction frameworks	Strong consumer protection and compliance mechanisms	Relevant for comprehensive digital governance
Malaysia	Fintech centered regulatory sandbox	Gradual recognition through financial technology supervision	Moderate flexibility with institutional oversight	Relevant for Islamic and mixed legal harmonization
Saudi Arabia	Centralized financial technology supervision	Limited but expanding digital finance recognition	Strong sovereign regulatory control	Relevant for state centered digital governance
Turkey	Digital economy modernization strategy	Emerging blockchain regulatory accommodation	Moderate integration within commercial modernization	Relevant for transitional regulatory adaptation
Indonesia	General electronic transaction framework	Indirect recognition through electronic transaction law	Fragmented regulatory coordination	Requires comprehensive harmonization reform

Source: Constructed by the author based on comparative doctrinal studies developed by De Filippi and Wright (2018), Warianto et al. (2024), Azam et al. (2025), Abidin (2023), Marditia and Yanto (2025), and Rahman et al. (2024).

The comparative regulatory matrix above demonstrates that Indonesia remains positioned within a fragmented legal environment because existing electronic transaction regulation has not yet evolved toward specialized governance mechanisms capable of addressing decentralized commercial infrastructures. Law Number 1 of 2024 recognizes electronic information, digital signatures, and

electronic transactions as legally significant instruments within Indonesian commercial activity, yet the statute still conceptualizes digital transactions primarily through centralized institutional assumptions rather than decentralized blockchain governance structures. Comparative legal reasoning indicates that technologically neutral regulation alone cannot adequately address algorithmic commercial infrastructures because decentralized blockchain systems generate novel juridical issues concerning governance authority, procedural accountability, and autonomous digital enforcement mechanisms (Marditia & Yanto, 2025). Indonesian regulatory reform therefore requires more than incremental legislative amendment because doctrinal transformation must also address institutional coordination between financial regulators, electronic transaction authorities, commercial courts, and digital dispute resolution mechanisms. The absence of integrated blockchain governance policies consequently risks creating regulatory inconsistency capable of undermining legal certainty within Indonesia's rapidly expanding digital economy sector.

Future legislative reform within Indonesia should therefore consider the establishment of a specialized smart contract regulatory framework capable of addressing decentralized commercial transactions through coordinated statutory and institutional mechanisms. Such reform may include amendment of Law Number 1 of 2024 through explicit recognition of blockchain based contractual execution, evidentiary standards concerning distributed ledger verification, and jurisdictional mechanisms for cross border decentralized disputes. Indonesian lawmakers should also consider establishing a blockchain supervisory authority functioning through collaborative coordination between financial regulators, cybersecurity institutions, and digital commerce supervisory agencies in order to ensure regulatory consistency within decentralized financial ecosystems (Simran & Adam, 2023). Comparative studies concerning fintech governance demonstrate that regulatory sandbox mechanisms may facilitate controlled technological experimentation while preserving governmental oversight concerning cybersecurity obligations, consumer protection, and systemic financial stability (Ameyaw et al., 2023). The future of Indonesian digital commercial law consequently depends upon the capacity of legislative institutions to construct adaptive governance frameworks capable of integrating technological innovation with constitutional commitments concerning legal certainty and institutional accountability.

The development of hybrid dispute resolution mechanisms also constitutes an essential component within future Indonesian smart contract governance because conventional litigation procedures remain insufficient for resolving decentralized digital commercial conflicts. Indonesian civil procedure continues to rely heavily upon territorial jurisdiction, physical documentary evidence, and centralized adjudicative authority, while blockchain disputes frequently involve transnational actors, cryptographic evidence, and algorithmically executed transactions. Comparative legal developments indicate increasing reliance upon online dispute resolution systems, digital arbitration mechanisms, and technologically integrated adjudicative procedures capable of accommodating decentralized commercial infrastructures (Hsiao et al., 2025). Hybrid dispute resolution mechanisms integrating institutional arbitration with blockchain verification technologies may therefore provide a more effective framework for resolving smart contract disputes while preserving procedural legitimacy and evidentiary reliability. Indonesian commercial law reform should consequently integrate digital procedural modernization within broader blockchain governance strategies in order to ensure institutional adaptability within evolving transnational commercial environments.

The increasing integration of smart contracts within industrial automation, financial technologies, artificial intelligence infrastructures, and digital supply chain management systems further reinforces the urgency of comprehensive legal modernization within Indonesia. Contemporary technological studies demonstrate that blockchain based contractual systems are increasingly utilized within manufacturing governance, automated insurance systems, decentralized financial infrastructures, and artificial intelligence coordination mechanisms involving high levels of commercial complexity (Manimuthu et al., 2022). The expansion of these technological applications transforms smart contracts from experimental digital instruments into institutional infrastructures capable of restructuring commercial governance and transactional coordination across multiple economic sectors. Indonesian legal institutions consequently face significant pressure to develop anticipatory regulatory models capable of addressing emerging technological convergence involving blockchain systems, artificial intelligence governance, and decentralized commercial automation. Failure to construct adaptive

commercial governance frameworks may consequently weaken Indonesia's competitiveness within regional digital economic integration and transnational technological commerce.

The theoretical implications of blockchain governance also indicate a profound transformation concerning the relationship between law, institutional authority, and technological regulation within contemporary commercial systems. De Filippi and Wright (2018) argue that blockchain infrastructures facilitate the emergence of rule of code paradigms in which normative enforcement increasingly operates through computational architecture rather than conventional institutional coercion. This transformation generates substantial jurisprudential consequences because algorithmic governance systems redistribute regulatory authority from courts, administrative agencies, and legislatures toward decentralized technological infrastructures capable of autonomously executing normative functions. Indonesian legal doctrine traditionally conceptualizes sovereignty through centralized institutional authority operating within territorially bounded governance structures, while blockchain governance introduces deterritorialized mechanisms of transactional coordination functioning beyond conventional institutional supervision. The future trajectory of Indonesian commercial law therefore depends not merely upon legislative amendment but also upon deeper theoretical reconsideration concerning the role of technological infrastructures within the evolving architecture of legal authority and commercial governance.

CONCLUSION

The juridical transformation generated by blockchain based smart contracts demonstrates that Indonesia's commercial and business law system is entering a period of structural tension between conventional civil law doctrine and decentralized technological governance. Existing legal instruments, including the Indonesian Civil Code, Government Regulation Number 71 of 2019, Law Number 1 of 2024 concerning Electronic Information and Transactions, and Law Number 4 of 2023 concerning Financial Sector Development and Strengthening, have not yet constructed an integrated regulatory framework capable of addressing the validity, enforceability, dispute settlement, institutional supervision, and liability dimensions of algorithmically executed commercial agreements. The research confirms that smart contracts challenge traditional assumptions concerning judicial authority, territorial jurisdiction, contractual enforcement, evidentiary mechanisms, and legal accountability because blockchain infrastructures operate autonomously through immutable digital protocols that frequently exceed conventional state centered regulatory structures. Comparative doctrinal analysis further indicates that jurisdictions such as the United States, Singapore, the European Union, Turkey, Malaysia, Pakistan, and Saudi Arabia have gradually developed more adaptive approaches through technologically neutral regulation, legal sandbox mechanisms, digital commerce governance, and blockchain oriented supervisory models that accommodate innovation while preserving institutional legal certainty. The future development of Indonesian commercial law therefore requires comprehensive legislative harmonization through the establishment of specialized smart contract regulation, modernization of electronic transaction law, recognition of hybrid dispute resolution mechanisms, and formulation of blockchain governance principles capable of reconciling algorithmic autonomy with constitutional principles of legal protection, commercial certainty, and regulatory sovereignty within the evolving architecture of the digital economy.

REFERENCES

- Abidin, M. I. (2023). Legal review of the validity of the use of smart contracts in business transactions in Indonesia and its regulation in various countries. *Unnes Law Journal*, 9(2), 289-310. <https://doi.org/10.15294/ulj.v9i2.37195>
- Alaba, F. A., Sulaimon, H. A., Marisa, M. I., & Najeem, O. (2024). Smart contracts security application and challenges: A review. *Cloud Computing and Data Science*, 15-41. <https://doi.org/10.37256/ccds.5120243271>
- Amalia, R. F. (2023, January). Legal protection for virtual land trading investment transactions in the Metaverse. In *3rd International Conference on Business Law and Local Wisdom in Tourism (ICBLT 2022)* (pp. 488-496). Atlantis Press. https://doi.org/10.2991/978-2-494069-93-0_58

- Ameyaw, E. E., Edwards, D. J., Kumar, B., Thurairajah, N., Owusu-Manu, D. G., & Oppong, G. D. (2023). Critical factors influencing adoption of blockchain-enabled smart contracts in construction projects. *Journal of Construction Engineering and Management*, 149(3), 04023003. <https://doi.org/10.1061/JCEMD4.COENG-12081>
- Atiyah, G. A., Manap, N. A., & Ibrahim, A. I. (2025). Legal Issues Faced by Smart Contracts from the Perspective of Conventional Contracts. *UUM Journal of Legal Studies*, 16(1), 34-53. <https://doi.org/10.32890/uumjls2025.16.1.3>
- Azam, M., Mashdurohaturun, A., Firmansyah, A. N., Saktiawan, M. D., & Jaya, K. O. P. (2025). Harmonizing Contemporary International Commercial Law with Sharia-Based National Legal Systems: A Comparative Study of Pakistan, Turkey, Indonesia, Malaysia, and Saudi Arabia. *MILRev: Metro Islamic Law Review*, 4(2), 1074-1096. <https://doi.org/10.32332/milrev.v4i2.11334>
- Baso, F., Yusuf, D. U., Djaoe, A. N. M., Iswandi, I., & Ramadhany, A. (2024). The Overview of Smart Contract: Legality and Enforceability. *Dialogia Iuridica*, 16(1), 096-111. <https://doi.org/10.28932/di.v16i1.10024>
- Daulay, E. N. S., & Cahyono, A. B. (2025). Legal Protection for Heirs with Non-Fungible Token Heritage Objects. *Journal of Law, Politic and Humanities*, 5(3), 2216-2227. <https://doi.org/10.38035/jlph.v5i3.1198>
- De Filippi, P., & Wright, A. (2018). *Blockchain and the law: The rule of code*. Harvard University Press.
- Fikrina, A., Deswari, M. P., Sucia, Y., & Putri, A. S. (2025). Adapting Contract Law to the Digital Era: The Indonesian Context. *Melayunesia Law*, 9(1), 1-15. <https://doi.org/10.30652/cwnhf292>
- Government Regulation of the Republic of Indonesia Number 71 of 2019 concerning the Implementation of Electronic Systems and Transactions.
- Halaburda, H., Levina, N., & Min, S. (2024). Digitization of transaction terms within TCE: Strong smart contract as a new mode of transaction governance. *MIS Quarterly*, 48(2), 825-846. <https://doi.org/10.25300/MISQ/2023/17818>
- Harianja, S. A. H., & Satya, A. M. (2026). Smart Contract Integration In Indonesian Law: Legal Certainty And Data Protection In The Digital Age: Integrasi Kontrak Cerdas dalam Hukum Indonesia: Kepastian Hukum dan Perlindungan Data di Era Digital. *Perspektif Hukum*, 33-65. <https://doi.org/10.30649/ph.v26i1.446>
- Hassanah, H., Wahyudi, W., & Aziz, N. A. (2023). Standard Clause Problems in E-Commerce Based on Indonesian Civil Law. *Jurnal Wawasan Yuridika*, 7(2), 221-238. <https://doi.org/10.25072/jwy.v7i2.4226>
- Hsiao, T. C., Chen, T. L., Chang, S. C., & Chang, T. P. (2025). Research on smart contracts for Omnipresent AI in commercial health insurance. *Enterprise Information Systems*, 19(3-4), 2442405. <https://doi.org/10.1080/17517575.2024.2442405>
- Indonesian Civil Code [Kitab Undang-Undang Hukum Perdata].
- Law of the Republic of Indonesia Number 1 of 2024 concerning the Second Amendment to Law Number 11 of 2008 on Electronic Information and Transactions.
- Law of the Republic of Indonesia Number 4 of 2023 concerning Financial Sector Development and Strengthening.
- Manimuthu, A., Venkatesh, V. G., Shi, Y., Sreedharan, V. R., & Koh, S. L. (2022). Design and development of automobile assembly model using federated artificial intelligence with smart contract. *International Journal of Production Research*, 60(1), 111-135. <https://doi.org/10.1080/00207543.2021.1988750>
- Marditia, P. P. R., & Yanto, A. (2025, February). Regulation model implementing smart contract (terminable contract) in commercial contracts in Indonesia. In *2nd International Conference*

- Changing of Business Law (ICOCLB 2024)* (pp. 355-382). Atlantis Press.
https://doi.org/10.2991/978-2-38476-356-6_40
- Putranti, D., & Putri, U. T. (2024). Enforcement of Copyright Law on Non-Fungible Token (NFT) Through Smart Contracts. *Kosmik Hukum*, 24(1), 40-51.
<https://doi.org/10.30595/kosmikhukum.v24i1.18476>
- Rahman, I., Muhtar, M. H., Mongdong, N. M., Setiawan, R., Setiawan, B., & Siburian, H. K. (2024). Harmonization of Digital laws and Adaptation Strategies in Indonesia focusing on E-Commerce and Digital transactions. *Innovative: Journal Of Social Science Research*, 4(1), 4314-4327. <https://doi.org/10.31004/innovative.v4i1.8240>
- Rusakova, E. P., & Frolova, E. E. (2022). Digital disputes in the new legal reality. *RUDN Journal of law*, 26(3), 695-704. <https://doi.org/10.22363/2313-2337-2022-26-3-695-704>
- Saputri, F. A. (2024). Regulating the use of smart contract in Indonesia. *Jurnal Hukum dan Keadilan*, 1(2), 42-50. <https://doi.org/10.61942/jhk.v1i2.84>
- Simran, S., & Adam, R. (2023). Legal Analysis Of Cbdc's Role As A Digital Payment Instrument Regulatory System In Indonesia. *Asian Journal of Management, Entrepreneurship and Social Science*, 3(03), 270-286. <https://doi.org/10.63922/ajmesc.v3i03.297>
- Singh, K. K. (2022). Application of blockchain smart contracts in e-commerce and government. *arXiv preprint arXiv:2208.01350*. <https://doi.org/10.48550/arXiv.2208.01350>
- Sudarto, S. (2025). Smart contracts from a civil law perspective: Validity and implementation in Indonesia. *Jurnal Ilmiah Hukum Dirgantara*, 15(2). <https://doi.org/10.35968/jihd.v15i2.1444>
- Warianto, W., Amboro, F. Y. P., & Sudirman, L. (2024). Pragmatism of smart contracts in legal perspective: A comparative analysis between Indonesia and the United States. *Jurnal Mediasas: Media Ilmu Syari'ah dan Ahwal Al-Syakhsyiyah*, 7(1), 13-38.
<https://doi.org/10.58824/mediasas.v7i1.42>