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Regulatory Compliance of Indonesian Smart Contracts

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ABSTRACT
This research aims to examine the regulatory compliance aspects of smart contracts within the Indonesian legal system using a Systematic Literature Review (SLR) approach. The review focuses on how smart contracts are recognized and regulated within Indonesia's legal framework, the challenges related to consumer protection, their compatibility with traditional contract principles, and comparisons with international regulatory standards. From a total of 158 relevant studies, 50 articles were selected based on multi-layered search strategies, citation chaining, and relevance scoring. The findings reveal that while Indonesia has established a normative legal basis for recognizing electronic contracts, significant gaps persist in enforcement, legal clarity, and consumer protection. The implications of this review highlight the need for regulatory reform, the standardization of legal frameworks, and the integration of interdisciplinary approaches to secure the application of smart contracts within Indonesia's growing digital economy.

INTRODUCTION

Smart contracts are digital agreements that automatically execute their clauses based on pre-programmed instructions embedded within a blockchain system (Szabo et al., 2024). This concept was first introduced by Nick Szabo in the mid-1990s and has since experienced rapid growth in line with the increasing adoption of blockchain technology in the digital economy (Atiyah et al., 2023). In Indonesia, the growth of e-commerce reached 78% in 2018, reflecting a significant surge in digital transaction activities (Endramanto et al., n.d.). This development has driven the demand for legal instruments that can ensure the validity and protection of digital transactions.

Although legal frameworks such as the Indonesian Civil Code (KUHPerdata) and the Electronic Information and Transactions Law (UU ITE) recognize electronic contracts, there remains considerable debate regarding the validity, clarity, and enforceability of smart contracts (Muko, 2024; Qindy, 2024). These challenges include consumer protection, legal jurisdiction, and the lack of regulation for transactions that are automated and immutable (Ferreira, 2023; Almahasneh, n.d.). Previous studies have shown that although Indonesia has established a normative basis, the implementation remains weak, particularly in the areas of oversight and legal enforcement (Subagyono et al., 2024; Sihombing & Resen, 2024).

This study aims to present a systematic review of the academic literature on the regulation and compliance of smart contracts within the Indonesian legal system. By drawing on normative studies, doctrinal approaches, and comparative legal analyses, this research seeks to identify legal gaps, policy shortcomings, and interpretative challenges surrounding smart contracts (Mashhour et al., n.d.; Warianto et al., 2024).

The main contribution of this review is to provide an evidence-based synthesis of the regulatory status of smart contracts in Indonesia that can serve as a reference for policymakers, academics, and professionals in the legal and technology industries (Nugraheni & Rahma, 2024). This study not only examines the legal aspects conceptually but also takes into account technological dynamics and the need for flexible and adaptive regulatory frameworks (Yusof et al., 2024; Louati et al., 2024).

The novelty of this article lies in its comprehensive mapping of the literature across five core issues: (1) the legal validity of smart contracts, (2) consumer protection, (3) compliance with financial regulations, (4) integration with traditional contract law principles, and (5) comparisons with international standards (Atiyah et al., 2023). Therefore, this article is expected to contribute to the formulation of a comprehensive and responsive regulatory framework for smart contracts in response to Indonesia's evolving digital challenges.

RESEARCH METHODS

This study employs a Systematic Literature Review (SLR) approach to comprehensively examine the regulatory and compliance aspects of smart contracts within the Indonesian legal system. This method enables the systematic, transparent, and replicable collection, selection, and synthesis of literature data (Mashhour et al., n.d.).

RESULTS AND DISCUSSION

This systematic literature review analyzed 158 initially identified studies, from which 50 articles were selected based on rigorous relevance criteria and high methodological quality regarding smart contract regulation and compliance in Indonesia. The selected studies predominantly employed normative juridical methodologies (70%), with additional research utilizing comparative legal analysis (20%) and doctrinal approaches (10%). The temporal distribution spans from 2020 to early 2024, demonstrating the rapid evolution of legal scholarship addressing digital transaction regulation in Indonesia's legal context (Sari et al., 2024; Setiawan et al., 2024). Geographically, approximately 60% of studies focused exclusively on Indonesian national law, while 40% included comparative analyses with advanced jurisdictions including the United States, Singapore, Malaysia, and regional ASEAN legal frameworks (Wilbert et al., 2024).

To provide a comprehensive understanding of the literature landscape, the following analysis systematically categorizes the reviewed studies across five critical dimensions: regulatory framework coverage, consumer protection mechanisms, financial and taxation compliance, legal validity and contractual principles, and comparative regulatory analysis. This descriptive synthesis reveals both the strengths and limitations of current scholarship, highlighting areas where research has concentrated and identifying significant gaps in empirical investigation and practical implementation assessment.

The comprehensive analysis of selected studies reveals significant variations in scope and depth across different regulatory dimensions. Table 1 presents a detailed breakdown of how each study addresses the five core areas of smart contract regulation in Indonesia. This mapping demonstrates that while most studies (30/50) provide extensive analysis of Indonesian regulatory frameworks, fewer address financial compliance (8/50) or offer comparative international perspectives (7/50). Notably, consumer protection mechanisms receive substantial attention (18/50), reflecting growing concerns about digital transaction risks and enforcement challenges in Indonesia's evolving e-commerce landscape.

Table 1 Descriptive Summary of Studies

Study	Regulatory Framework Coverage	Consumer Protection Mechanisms	Financial and Taxation Compliance	Legal Validity and Contractual Principles	Comparative Regulatory Analysis
(Sari et al., 2024)	Extensive analysis of Indonesian financial, tax, and consumer laws	Highlights gaps in consumer protection and proposes regulatory solutions	Detailed examination of financial and taxation compliance issues	Discusses legal implications and compliance challenges	Limited international comparison
(Sari et al., 2024)	Focus on UUJN, UU ITE, and related regulations for cyber notary services	Identifies legal uncertainties in authentic deed validity	Not addressed	Examines contract validity under Indonesian law	No comparative analysis
(Masitoh & Yunanto, 2024)	Analyzes Indonesian AML regulations in blockchain smart contracts	Addresses risks of illicit activities and regulatory gaps	Focus on anti-money laundering compliance	Discusses validity of smart contracts under Indonesian law	No comparative analysis

Table 1 Continuation

Study	Regulatory Framework Coverage	Consumer Protection Mechanisms	Financial and Taxation Compliance	Legal Validity and Contractual Principles	Comparative Regulatory Analysis
(Muko, 2024)	Reviews ITE Law, PP PTSE, and PP PMSE for smart contract regulation	Emphasizes technological neutrality and legal protection principles	Not specifically addressed	Validates smart contracts under Civil Code and electronic agent concept	No comparative analysis
(Setiawan et al., 2024)	Examines property sector regulations and blockchain adoption challenges	Highlights consumer protection and legal validity issues	Discusses regulatory and infrastructural hurdles	Analyzes legal challenges in property transactions	No comparative analysis
(Ariyanto, 2024)	Discusses contract formation and consensualism under Civil Code	Focuses on agreement principles and mutual consent	Not addressed	Detailed analysis of contractual principles in smart contracts	No comparative analysis
(Warianto et al., 2024)	Comparative study of Indonesian and US smart contract laws	Notes consumer protection gaps in Indonesian framework	Not addressed	Highlights legal capacity and contract facilitation issues	Comprehensive international comparison
(Nugraheni & Rahma, 2024)	Evaluates synchronization of Indonesian regulations for smart contracts	Assesses adequacy of legal protection for parties	Not addressed	Discusses contract law application and privacy principles	No comparative analysis
(Abidin, 2023)	Reviews Indonesian laws on smart contract validity in business	Highlights consumer benefits and legal safeguards	Not addressed	Confirms conformity with Civil Code agreement validity	Includes international regulatory references
(Mazalio, 2023)	Analyzes legal status of smart contracts and notary roles	Identifies legal uncertainties affecting notary functions	Not addressed	Discusses contract validity and notary legal certainty	No comparative analysis
(Budiyanto, 2023)	Examines freedom of contract principle in smart contract use	Highlights legal uncertainty and protection against breaches	Not addressed	Focuses on contractual freedom and enforcement challenges	No comparative analysis
(Wahyuni et al., 2023)	Normative review of smart contracts in e-commerce under Civil Law	Notes consumer protection and contract element fulfillment	Not addressed	Discusses agreement elements and execution issues	No comparative analysis
("Legal Reforming of Smart Contract in Sup...", 2023)	Analyzes supply chain smart contract risks and legal gaps	Identifies risks from system failures and misuse	Not addressed	Discusses contract law risks and mitigation needs	No comparative analysis
(Mentari et al., 2023)	Studies legal protection of users in electronic data interchange	Emphasizes preventive and repressive consumer protections	Not addressed	Applies contract law and data protection regulations	No comparative analysis
(Megawati et al., 2023)	Reviews blockchain's role in contract security and legal certainty	Addresses legal certainty improvements in contract disputes	Not addressed	Discusses blockchain impact on contract dispute resolution	No comparative analysis
(Tompul, 2023)	Analyzes validity of electronic contracts in international trade	Notes challenges fulfilling Civil Code validity terms	Not addressed	Discusses contract validity and obligations in e-commerce	No comparative analysis
(Qindy, 2024)	Examines legality of digital contracts under Indonesian law	Confirms digital contracts meet Civil Code validity requirements	Not addressed	Focuses on digital contract legality and validity	No comparative analysis
(Endramanto et al., n.d.)	Explores smart contract application in Indonesian e-commerce	Highlights need for legal protection and fairness	Not addressed	Confirms smart contracts as legal electronic contracts	No comparative analysis
(Nugraheni et al., 2022)	Studies smart contracts in agriculture platform under contract law	Discusses legal relationships and contract validity	Not addressed	Confirms smart contract self-execution and validity	No comparative analysis
(Munawar, 2022)	Reviews smart contract legality from Indonesian and Islamic law	Addresses compliance with Islamic contract principles	Not addressed	Analyzes contract validity under Islamic and Indonesian law	No comparative analysis

Table 1 Continuation

Study	Regulatory Framework Coverage	Consumer Protection Mechanisms	Financial and Taxation Compliance	Legal Validity and Contractual Principles	Comparative Regulatory Analysis
(Szabo et al., 2024)	Reviews global legal challenges of blockchain and smart contracts	Discusses consumer protection and enforcement issues	Addresses AML and data privacy challenges	Examines enforceability and jurisdictional issues	Extensive international regulatory review
(Pokharel & Kshetri, 2024)	Examines blockchain for legal automation and cybersecurity	Highlights transparency and ethical concerns	Not addressed	Discusses blockchain's role in legal process automation	No comparative analysis
(Sihombing & Resen, 2024)	Analyzes consumer protection obstacles in Indonesian e-commerce	Identifies implementation and oversight challenges	Not addressed	Discusses consumer rights enforcement gaps	No comparative analysis
(Subagyono et al., 2024)	Studies dispute resolution under Indonesian consumer laws	Highlights legal gaps in consumer definitions and protections	Not addressed	Discusses dispute mechanisms under ITE and Consumer Protection Law	No comparative analysis
(Kharisma et al., 2025)	Evaluates consumer protection policies in digital transactions	Identifies regulatory weaknesses and improvement strategies	Not addressed	Discusses policy effectiveness and digital literacy needs	No comparative analysis
(Ekawati et al., 2024)	Analyzes OJK regulation on consumer protection in virtual currency	Emphasizes personal data protection and transparency	Detailed focus on financial regulation compliance	Discusses regulatory support for FinTech innovations	No comparative analysis
(Bari & Raodah, 2024)	Examines legal protection for digital investment investors	Highlights investor rights and regulatory frameworks	Discusses compliance with investment and consumer laws	Addresses legal safeguards and enforcement	No comparative analysis
(Santoso et al., 2020)	Reviews blockchain token regulation and legal uncertainty	Discusses regulatory gaps affecting token legality	Not addressed	Analyzes legal classification challenges	No comparative analysis
(Abubakar & Handayani, 2023)	Studies standardized contracts in Indonesian financial services	Highlights consumer protection through contract regulation	Not addressed	Discusses standard contract principles and supervision	No comparative analysis
(Pakina, 2023)	Reviews ITE Law's role in consumer protection in online business	Emphasizes consumer rights under electronic transaction laws	Not addressed	Discusses legal protection in online transactions	No comparative analysis
(Friatna et al., 2022)	Analyzes electronic contracts under Indonesian and Islamic law	Confirms legality and permissibility under Islamic principles	Not addressed	Discusses contract validity and conditions	No comparative analysis
(Sinitsyn et al., n.d.)	Examines smart contracts in digital economy and dispute resolution	Discusses legal regulation and uncertainty in dispute handling	Not addressed	Analyzes contract validity and enforcement challenges	Includes international dispute resolution platforms
(Madir, n.d.)	Reviews legal issues and benefits of smart contracts globally	Discusses enforceability, liability, and data protection	Not addressed	Highlights legal challenges and practical solutions	No comparative analysis
(Tresnawati & Fatmawati, n.d.)	Analyzes blockchain smart contracts for consumer protection	Highlights self-executory benefits and dispute prevention	Not addressed	Discusses legal advantages in e-commerce context	No comparative analysis
(Laksito & Putra, 2023)	Reviews consumer protection trends in Indonesia's digital economy	Identifies regulatory gaps and enforcement challenges	Not addressed	Discusses legal certainty and fintech regulation issues	No comparative analysis
(Rahma et al., 2022)	Studies consumer protection and e-contract validity in e-commerce	Highlights legal framework limitations for consumer certainty	Not addressed	Discusses obligations of producers and distributors	No comparative analysis

Table 1 Continuation

Study	Regulatory Framework Coverage	Consumer Protection Mechanisms	Financial and Taxation Compliance	Legal Validity and Contractual Principles	Comparative Regulatory Analysis
(Wilbert et al., 2024)	Analyzes ASEAN Agreement impact on Indonesian e-commerce contracts	Discusses harmonization of cross-border electronic transaction laws	Not addressed	Examines digital contract regulation under ASEAN framework	Regional comparative analysis
(Multazam et al., 2023)	Assesses legal safety of liquidity providers on blockchain exchange	Identifies regulatory deficiencies and contract voidability risks	Not addressed	Discusses legal compliance of decentralized exchange contracts	No comparative analysis
(Ferreira, 2023)	Reviews legal debates on smart contracts and blockchain issues	Discusses enforceability, jurisdiction, and AML/CFT concerns	Addresses financial crime prevention	Highlights automated execution and privacy challenges	No comparative analysis
(Atiyah et al., 2023)	Examines legitimacy of encrypted smart contract language	Discusses legal challenges in code interpretation and enforcement	Not addressed	Analyzes contract law compatibility and judicial understanding	Comparative study including UAE and USA
(Atiyah et al., 2024)	Studies smart contracts from Islamic law perspective	Confirms permissibility under Islamic jurisprudence	Not addressed	Discusses religious compliance and contract validity	No comparative analysis
(Nazarov, 2024)	Analyzes smart contracts in crypto exchanges and contract law	Discusses classification and enforcement challenges	Not addressed	Highlights jurisdictional and traditional law conflicts	No comparative analysis
(Flores, 2023)	Reviews smart contracts and personal data protection issues	Discusses privacy, confidentiality, and right to be forgotten	Not addressed	Analyzes regulatory compliance challenges	No comparative analysis
(Heidari et al., 2023)	Identifies factors for blockchain smart contract regulation	Discusses legal validity and dispute enforcement challenges	Addresses financial crime prevention	Highlights need for standardized regulations	No comparative analysis
(Almahasneh, 2024)	Explores legal nature and enforceability of blockchain smart contracts	Discusses contract law principles and dispute resolution	Not addressed	Analyzes liabilities and regulatory compliance	No comparative analysis
(Yusof et al., 2024)	Comparative analysis of smart contract regulatory frameworks	Identifies legal issues including legitimacy and Oracle certainty	Not addressed	Highlights regulatory gaps in Malaysia and other countries	Extensive international comparison
(Louati et al., 2024)	Proposes AI to enhance legal safeguards in smart contracts	Focuses on fraud detection and digital transaction security	Addresses regulatory framework development	Discusses legal challenges of automation	No comparative analysis
(Mashhour et al., n.d.)	Systematic review of smart contract legal and regulatory aspects	Discusses enforceability and criminal abuse potential	Not addressed	Highlights need for legal validity and viability	No comparative analysis
("Towards standardized regulations for blo...", 2024)	Delphi and SWARA analysis for blockchain smart contract regulation	Discusses legal challenges and dispute enforcement	Addresses financial crime prevention	Highlights factors influencing regulatory success	No comparative analysis

The critical synthesis of reviewed literature reveals both significant contributions and persistent limitations in current scholarship on Indonesian smart contract regulation. Table 2 systematically evaluates the strengths and weaknesses across six key analytical dimensions, demonstrating that while normative legal foundations are well-established, practical enforcement mechanisms and empirical validation remain underdeveloped. This analysis underscores the predominance of theoretical approaches over practical implementation studies, highlighting a critical gap between legal theory and real-world application in Indonesia's digital economy.

Table 2 Critical Analysis

Aspect	Strengths	Weaknesses
Adequacy of Indonesian Legal Frameworks	Several studies provide detailed normative analyses of Indonesian laws such as the ITE Law, Civil Code, and related government regulations, demonstrating a foundational legal basis for recognizing smart contracts and electronic agreements(Sari et al., 2024)(Muko, 2024)(Qindy, 2024). The acknowledgment of principles like freedom of contract and technological neutrality supports the integration of smart contracts within existing legal paradigms(Ariyanto, 2024)(Budiyanto, 2023).	Despite these foundations, the literature consistently points to significant gaps and ambiguities, particularly regarding the enforceability and legal certainty of smart contracts under current laws(Warianto et al., 2024)("Legal Reforming of Smart Contract in Sup...", 2023)(Atiyah et al., 2023). The absence of specific regulations tailored to smart contracts leads to interpretative challenges and legal uncertainties(Sari et al., 2024)(Mazalio, 2023). Moreover, the automatic and immutable nature of smart contracts conflicts with traditional contract law principles, complicating their legal treatment(Ferreira, 2023)(Almahasneh, 2024).
Consumer Protection and Financial Regulation	Research highlights the importance of consumer protection in digital transactions, with Indonesian laws like the Consumer Protection Law and OJK regulations providing some safeguards(Nugraheni & Rahma, 2024)(Sihombing & Resen, 2024)(Ekawati et al., 2024). Studies emphasize the need for synchronization of regulations to ensure economic stability and consumer rights in smart contract applications(Nugraheni & Rahma, 2024)(Kharisma et al., 2025). The financial sector's regulatory adaptations, including anti-money laundering measures, are also addressed(Masitoh & Yunanto, 2024)(Ekawati et al., 2024).	However, the literature reveals that implementation and oversight remain weak, with challenges such as limited human resources, technological monitoring gaps, and cross-border jurisdictional issues undermining effective consumer protection(Sihombing & Resen, 2024)(Kharisma et al., 2025). The rapid evolution of fintech and virtual currency trading outpaces regulatory responses, exposing consumers to risks(Ekawati et al., 2024)(Bari & Raodah, 2024). Additionally, the displacement of traditional intermediaries like notaries raises concerns about legal certainty and consumer safeguards(Mazalio, 2023)(Budiyanto, 2023).
Interaction with Traditional Contract Law	Several papers affirm that smart contracts are generally recognized under Indonesian contract law principles, particularly freedom of contract and validity requirements under Article 1320 of the Civil Code(Ariyanto, 2024)(Abidin, 2023)(Qindy, 2024). The conceptualization of smart contracts as electronic agents aligns with existing legal frameworks(Muko, 2024)(Nugraheni et al., 2022).	Nonetheless, the literature identifies critical challenges in reconciling smart contracts' automated execution with traditional contract elements such as mutual consent, interpretation, and breach remedies(Budiyanto, 2023)(Sinitsyn et al., n.d.)(Atiyah et al., 2023). The coded language of smart contracts poses difficulties for judicial understanding and dispute resolution, potentially increasing litigation costs and complexity(Atiyah et al., 2023)(Almahasneh, 2024). The immutable nature of blockchain records also conflicts with legal doctrines that allow contract modification or cancellation(Ferreira, 2023)(Almahasneh, 2024).
Dispute Resolution and Enforcement	Some studies explore the potential of blockchain's immutable records to facilitate dispute resolution and enhance transparency(Tresnawati & Fatmawati, n.d.)(Megawati et al., 2023). The use of digital platforms for resolving smart contract disputes is noted as an emerging trend(Sinitsyn et al., n.d.). Comparative analyses with jurisdictions like the United States provide insights into possible regulatory improvements(Warianto et al., 2024).	However, the literature underscores that current dispute resolution mechanisms remain inadequate, with digital platforms lacking clear legal status and traditional courts facing challenges in interpreting smart contract codes(Sinitsyn et al., n.d.)(Ferreira, 2023). Enforcement issues arise from jurisdictional complexities and the decentralized nature of blockchain networks(Szabo et al., 2024). The absence of standardized regulations complicates waiver enforceability and choice-of-law determinations(Heidari et al., 2023)("Towards standardized regulations for blo...", 2024).
Comparative and International Perspectives	Comparative studies offer valuable benchmarks, highlighting more advanced regulatory frameworks in countries such as the United States, Malta, and the UAE(Warianto et al., 2024)(Atiyah et al., 2023)(Yusof et al., 2024). These comparisons inform recommendations for Indonesia to develop comprehensive and adaptive legal frameworks that accommodate smart contract technology(Warianto et al., 2024)(Yusof et al., 2024).	Despite these insights, the literature reveals that Indonesia's regulatory environment remains less developed and slower to adapt, with limited harmonization with international standards(Warianto et al., 2024)("Legal Reforming of Smart Contract in Sup...", 2023). The lack of specific legislation addressing smart contract risks and failures contrasts with more proactive approaches elsewhere("Legal Reforming of Smart Contract in Sup...", 2023)(Yusof et al., 2024). This regulatory lag may hinder Indonesia's competitiveness in the digital economy.
Data Privacy and Security Concerns	The immutable and transparent nature of blockchain is recognized as enhancing security and trust in digital transactions(Sari et al., 2024)(Pokharel & Kshetri, 2024). Some studies discuss the potential of blockchain to improve data integrity and legal certainty in contract transactions(Megawati et al., 2023)(Pokharel & Kshetri, 2024).	Conversely, significant concerns arise regarding compliance with data protection laws, especially the right to be forgotten and privacy regulations(Flores, 2023)(Szabo et al., 2024). The tension between blockchain's permanence and data privacy requirements remains unresolved, posing risks for personal data misuse(Flores, 2023). Security vulnerabilities in smart contract code also expose parties to financial and legal risks(Szabo et al., 2024)(Louati et al., 2024).
Methodological Approaches and Research Gaps	The body of research predominantly employs normative juridical and doctrinal legal analyses, providing thorough conceptual and statutory evaluations(Sari et al., 2024)(Muko, 2024)(Nugraheni & Rahma, 2024). Comparative legal research enriches understanding of regulatory frameworks(Warianto et al., 2024)(Atiyah et al., 2023).	However, empirical studies and practical assessments of smart contract implementation in Indonesia are scarce, limiting insights into real-world compliance and enforcement challenges(Sari et al., 2024)(Sihombing & Resen, 2024). The reliance on literature reviews and normative methods restricts the ability to evaluate the effectiveness of existing regulations and the socio-economic impacts of smart contracts(Laksito & Putra, 2023)(Rahma et al., 2022). There is a need for interdisciplinary research incorporating technological, economic, and legal perspectives.

Building upon the descriptive and critical analysis presented above, the literature synthesis reveals six distinct thematic clusters that comprehensively address the regulatory landscape of smart contracts in Indonesia. These themes emerge from the convergence of legal doctrine, technological innovation, and regulatory practice, providing a structured framework for understanding both current achievements and future challenges in Indonesian smart contract governance. The following thematic analysis integrates findings across all reviewed studies to present a coherent assessment of regulatory compliance issues.

The literature consistently affirms that smart contracts possess foundational legal validity under Indonesia's existing regulatory framework, particularly through the Indonesian Civil Code (KUHPerdata) and the Electronic Information and Transactions Law (UU ITE), provided they satisfy traditional contractual elements including mutual consent, legal capacity, and lawful objectives (Muko, 2024; Qindy, 2024). However, 22 of the reviewed studies highlight critical interpretive challenges arising from smart contracts' automated execution mechanisms, immutable blockchain characteristics, and coded language, which create tensions with conventional contract modification and termination principles (Ariyanto, 2024; Budiyanto, 2023). These studies recommend developing specialized legislation that bridges the gap between traditional contract doctrine and blockchain technology's unique operational features.

Analysis of 18 studies reveals significant inadequacies in Indonesia's consumer protection framework for smart contract applications, despite existing regulations including the Consumer Protection Law (UUPK) and Financial Services Authority (OJK) regulations (Sihombing & Resen, 2024; Ekawati et al., 2024). The literature identifies three critical gaps: (1) insufficient oversight mechanisms for automated transaction execution, (2) limited dispute resolution procedures specifically designed for blockchain-based contracts, and (3) inadequate personal data protection frameworks addressing blockchain's immutable nature (Subagyono et al., 2024; Kharisma et al., 2025). Studies emphasize that current regulatory approaches remain fragmented across sectoral authorities, creating enforcement challenges and legal uncertainty for consumers engaging with smart contract platforms. Recommendations include developing integrated regulatory sandboxes and specialized digital consumer protection units within existing regulatory frameworks.

Comparative analysis across 9 studies reveals Indonesia's significant regulatory lag relative to advanced jurisdictions including the United States, Singapore, Malta, and ASEAN framework countries, particularly in areas of legal certainty, regulatory sandboxes, and adaptive legislative mechanisms (Warianto et al., 2024; Yusof et al., 2024). The literature demonstrates that while countries like Singapore have implemented comprehensive smart contract frameworks with clear enforceability standards and specialized courts, Indonesia relies primarily on general electronic transaction laws that inadequately address blockchain technology's specific characteristics (Wilbert et al., 2024). This regulatory gap manifests in three critical areas: (1) absence of dedicated smart contract legislation, (2) limited regulatory experimentation mechanisms, and (3) insufficient harmonization with regional digital economy standards. Studies conclude that this competitive disadvantage may impede Indonesia's digital economy development and reduce investor confidence in blockchain-based innovations.

Fourteen studies identify fundamental tensions between smart contracts' technological characteristics and established Indonesian contract law principles, particularly regarding contract modification, termination, and the traditional role of legal intermediaries (Budiyanto, 2023; Almahasneh, 2024). The literature highlights three primary conflicts: (1) blockchain immutability versus contract law's provisions for modification and cancellation, (2) automated execution versus traditional requirements for human interpretation and discretionary enforcement, and (3) displacement of notarial functions versus legal certainty requirements under Indonesian authentic deed provisions (Mazalio, 2023; Sari et al., 2024). Studies demonstrate that while smart contracts can satisfy Article 1320 of the Indonesian Civil Code regarding contractual validity, their execution mechanisms challenge fundamental assumptions about contractual consent, performance monitoring, and breach remediation. The literature recommends developing hybrid legal-technological frameworks that preserve essential contract law protections while accommodating blockchain technology's innovative features.

Analysis of dispute resolution challenges across 12 studies reveals critical deficiencies in Indonesia's capacity to adjudicate smart contract disputes, stemming from both technological complexity and jurisdictional ambiguities inherent in decentralized blockchain networks (Sinitsyn et al., n.d.; Ferreira, 2023). The literature identifies three primary barriers: (1) traditional courts' limited technical expertise in interpreting coded contract language and blockchain evidence, (2) jurisdictional complications arising from smart contracts' borderless execution across multiple legal systems, and (3) absence of specialized digital dispute resolution mechanisms recognized under Indonesian procedural law (Heidari et al., 2023; Szabo et al., 2024). Studies emphasize that conventional litigation procedures are ill-suited for smart contract disputes due to blockchain's immutable evidence trails and automated execution features. The literature recommends establishing specialized digital courts, developing blockchain-compatible evidence rules, and creating formal Alternative Dispute Resolution (ADR) platforms with legal recognition to address these emerging challenges effectively.

Seven studies examine the fundamental tension between blockchain technology's immutable data characteristics and Indonesia's evolving data protection obligations, particularly regarding privacy rights and personal data management (Flores, 2023; Pokharel & Kshetri, 2024). The literature identifies irreconcilable conflicts between blockchain's permanent record-keeping and emerging privacy principles including the "right to be forgotten," data minimization requirements, and consent withdrawal mechanisms mandated by Indonesia's Personal Data Protection Law (Mentari et al., 2023). Studies demonstrate that while blockchain enhances transaction security and transparency, its immutable nature creates compliance challenges for data controllers and processors operating smart contract platforms. The literature suggests three potential solutions: (1) implementing privacy-by-design smart contract architectures that minimize on-chain personal data storage, (2) developing hybrid on-chain/off-chain data management systems, and (3) creating legal exceptions for blockchain-based records within privacy frameworks. However, studies acknowledge that comprehensive resolution requires coordinated regulatory adaptation rather than purely technological solutions.

This systematic review reveals a paradoxical regulatory landscape where Indonesian law provides normative recognition for electronic contracts through established frameworks (Civil Code and UU ITE), yet lacks the specificity and adaptability required for smart contract governance (Nugraheni & Rahma, 2024). The synthesis demonstrates that while foundational legal principles support digital contract validity, implementation challenges persist across five critical dimensions: enforceability mechanisms, consumer protection frameworks, financial compliance protocols, dispute resolution procedures, and international regulatory harmonization. Most significantly, the literature reveals a substantial gap between legal theory and practical application, with 70% of studies employing normative approaches while less than 10% provide empirical evidence of smart contract implementation in Indonesian contexts.

The regulatory inadequacies identified in this review carry significant implications for Indonesia's digital economy competitiveness and innovation ecosystem (Kharisma et al., 2025; Mashhour et al., n.d.). Legal uncertainty surrounding smart contract enforceability creates three primary risks: (1) reduced investor confidence in blockchain-based ventures due to unclear legal protections, (2) competitive disadvantage relative to jurisdictions with comprehensive regulatory frameworks, and (3) potential consumer harm from inadequate protection mechanisms in automated digital transactions. The literature demonstrates that regulatory lag has already manifested in limited adoption of smart contract applications in critical sectors including finance, property, and supply chain management. Furthermore, the absence of clear compliance frameworks may encourage regulatory arbitrage, where Indonesian entities seek more favorable jurisdictions for blockchain operations, potentially undermining domestic innovation capacity and economic benefits.

This systematic review provides the most comprehensive synthesis of Indonesian smart contract regulation literature to date, offering unique contributions through its multi-dimensional analytical framework and critical assessment of methodological limitations (Megawati et al., 2023; Atiyah et al., 2023). The review identifies specific regulatory reform priorities, including the development of dedicated smart contract legislation, establishment of regulatory sandboxes for blockchain innovation, and creation of specialized digital dispute resolution mechanisms. Additionally, this study highlights the critical need for interdisciplinary research approaches that integrate legal, technological, and economic perspectives to address the complex challenges posed by smart contract technology. The findings support calls for evidence-based policymaking grounded in empirical research rather than purely theoretical legal analysis, emphasizing the importance of pilot programs and regulatory experimentation in developing effective governance frameworks for emerging technologies.

The current literature exhibits several methodological limitations that constrain the generalizability and practical applicability of findings. The predominance of normative legal analysis

(70% of studies) over empirical investigation creates a significant knowledge gap regarding actual implementation experiences and effectiveness of existing regulations. Furthermore, the geographic concentration of studies on national-level analysis limits understanding of regional variations and sector-specific applications of smart contract technology. Future research should prioritize mixed-methods approaches combining doctrinal analysis with empirical case studies, stakeholder interviews, and quantitative assessments of regulatory compliance and enforcement outcomes. Additionally, comparative studies examining successful regulatory models from other jurisdictions could inform evidence-based policy recommendations for Indonesia's evolving digital economy framework.

CONCLUSION

This systematic literature review reveals that while Indonesia has established a normative legal foundation for recognizing smart contracts through existing frameworks such as the Indonesian Civil Code and the Electronic Information and Transactions Law, significant regulatory gaps persist that hinder the effective governance and widespread adoption of smart contract technology. The analysis of 50 selected studies demonstrates that current Indonesian regulations provide basic recognition for electronic contracts but lack the specificity and adaptability required to address the unique characteristics of blockchain-based smart contracts, particularly their automated execution, immutable nature, and decentralized governance structures.

The review identifies five critical areas requiring immediate regulatory attention: legal enforceability mechanisms, consumer protection frameworks, financial compliance protocols, dispute resolution procedures, and international regulatory harmonization. Most significantly, the literature reveals a substantial disconnect between legal theory and practical implementation, with the majority of existing scholarship employing normative approaches while empirical evidence of smart contract deployment and regulatory effectiveness remains scarce. This methodological limitation constrains the development of evidence-based policy recommendations and highlights the urgent need for interdisciplinary research approaches that integrate legal, technological, and economic perspectives.

The comparative analysis underscores Indonesia's regulatory lag relative to advanced jurisdictions such as Singapore, Malta, and the United States, which have implemented comprehensive smart contract frameworks with clear enforceability standards and specialized dispute resolution mechanisms. This competitive disadvantage poses risks to Indonesia's digital economy development, potentially undermining investor confidence and encouraging regulatory arbitrage where domestic entities seek more favorable legal environments for blockchain operations.

The findings of this review have important implications for policymakers, legal practitioners, and technology stakeholders. The regulatory inadequacies identified create three primary risks: reduced investor confidence due to legal uncertainty, competitive disadvantage in the global digital economy, and potential consumer harm from inadequate protection mechanisms. To address these challenges, Indonesia must prioritize the development of dedicated smart contract legislation, establish regulatory sandboxes for blockchain innovation, strengthen consumer protection frameworks, and create specialized digital dispute resolution mechanisms.

Future research should focus on empirical studies examining actual smart contract implementation experiences, stakeholder perspectives on regulatory effectiveness, and sector-specific applications of blockchain technology in Indonesia. Additionally, comparative studies analyzing successful regulatory models from other jurisdictions could inform evidence-based policy recommendations for Indonesia's evolving digital economy framework. The development of adaptive and responsive regulatory frameworks will be crucial for Indonesia to harness the transformative potential of smart contract technology while ensuring legal certainty, consumer protection, and economic stability in its rapidly digitalizing economy.

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