



Integration of Blockchain-Based Smart Contracts in the Resolution of Commercial Contract Disputes

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ABSTRACT

The development of blockchain technology encourages the use of smart contracts as digital contract instruments that are automatic and cannot be changed, especially in cross-sector commercial transactions. This study aims to analyze the legal status of blockchain-based smart contracts as well as evaluate the possibility of their integration in legally recognized commercial contract dispute resolution mechanisms.

This research uses a normative legal research method with a conceptual and case legislation approach conducted through a literature study of laws and regulations, legal doctrine, as well as relevant decisions and cases. This study does not involve respondents or informants because it focuses on the analysis of legal norms and concepts. The data was analyzed qualitatively juridically through interpretation methods and legal arguments. The results of the study show that smart contracts can in principle be integrated in the settlement of commercial contract disputes as an instrument for the implementation and proof of contracts, but have not been able to fully replace the role of conventional dispute resolution mechanisms due to their limitations in handling legal interpretation, the application of the principle of good faith, and certain conditions such as non-technical defaults. This study concludes that the integration of smart contracts requires a hybrid model that combines technology-based automated execution with a law-based dispute resolution mechanism to ensure legal certainty and substantive justice in commercial contract practice.

INTRODUCTION

The development of blockchain technology has shifted the paradigm of contract law through the birth of smart contracts that are automatically executed based on computer code (Werbach & Cornell, 2020). Smart contracts allow the implementation of contractual obligations without human intermediaries so that they are seen as able to increase the efficiency and certainty of commercial transactions across sectors. However, this shift also shifts the foundation of the contract from the will of the parties to algorithmic logic that is deterministic. In the context of modern contract law, these changes have raised debates about the compatibility of smart contracts with the basic principles of contracts and established dispute resolution mechanisms (Murray, 2021).

Smart contracts are able to eliminate contract disputes that are not fully proven in practice (Raskin, 2021). Disputes persist when there is a programming error, oracle failure, or conditions beyond the algorithm's predictions that contract code cannot respond to. In this situation, contract automation actually has the potential to increase the inequality of the position of the parties because there is no discretion space as in conventional contracts. This phenomenon shows the tension between the principle of "code is law" and the need for substantive legal protection in commercial practice (De Filippi & Wright, 2021).

In the realm of dispute resolution, Koulu (2022) highlights that traditional litigation and arbitration mechanisms face serious challenges when dealing with smart contract-based disputes. These kinds of disputes often involve complex technical aspects of blockchain and are difficult for law enforcement officials without special expertise to understand. Additionally, the immutable nature of blockchain makes it difficult to implement contract cancellations or adjustments based on the principles of fairness and propriety. The absence of a clear integration framework between smart contracts and dispute resolution mechanisms increases the risk of legal uncertainty (Schmitz & Rule, 2023).

At the national level, these challenges are increasingly complex in a legal system that still places the principles of consensualism and good faith as the foundation of contracts. Mik (2023) emphasized that smart contracts have the potential to contradict the principle of interpretability flexibility due to their rigid and code-based execution. This condition becomes relevant in developing countries whose legal systems have not fully accommodated blockchain-based automated contracts. The unpreparedness of national regulations in responding to smart contracts has the potential to create a gap between digital business practices and legal certainty for parties (Fenwick et al. 2021).

Based on these conditions, this study explicitly aims to analyze the legal position of blockchain-based smart contracts in the contract law system as well as evaluate the possibility of their integration into legally recognized commercial contract dispute resolution mechanisms. The focus of the research is directed at the relationship between the technical character of smart contracts and the legal principles of contracts, as well as their implications for litigation and arbitration. With a normative approach, this study seeks to identify the juridical limitations of smart contracts and formulate a realistic and applicable integration model. This goal is in line with the view that contract innovation should be placed within

an institutional framework that guarantees legal certainty and fairness (Allen et al. 2021; Hacker, 2020).

The theoretical contribution of this research lies in the development of a legal analysis framework that places smart contracts as an integral part of the contract legal system, not just a technological instrument. This approach fills the void of literature that has so far separated the technical study of blockchain from the analysis of contract law and dispute resolution. By integrating these two perspectives, this research enriches the theory of contract law in the digital age and provides a conceptual basis for the development of adaptive regulations. This contribution is relevant to the development of modern contract law that deals with automation and decentralization (Bassan & Rabitti, 2024; Low & Teo, 2022).

Practically, this research is expected to provide normative guidelines for policymakers, legal practitioners, and business actors in designing and enforcing smart contract-based commercial contracts. The resulting recommendations can be used as a basis for the development of regulatory and dispute resolution practices that are more responsive to blockchain technology. In addition, this research is expected to help judicial and arbitration institutions in understanding the characteristics of smart contracts when handling commercial contract disputes. Thus, this research contributes directly to increasing legal certainty and substantive justice in technology-based business practices (Zetzsche et al. 2022; Avgouleas & Kiayias 2023).

LITERATURE REVIEW

Smart Contract as an Innovation in Contract Law

The development of smart contracts in the blockchain ecosystem has attracted the attention of legal academics due to its potential to change the traditional structure of contract law. Szabo (2021) views smart contracts as instruments that integrate legal logic into computer code so that contract execution becomes automated and decentralized. This view is reinforced by Clack et al. (2022) who stated that smart contracts introduce a new paradigm in commercial contracts by reducing reliance on manual contract enforcement. From a legal perspective, this innovation sparked a debate about the changing role of the will of the parties and the meaning of agreements in modern contracts. Therefore, smart contracts are understood as legal-technological innovations that demand adjustments to contract law theory.

Legal Validity and Risks of Smart Contracts

The literature further highlights the validity issues and legal risks inherent in smart contracts in commercial practice. Fairfield (2021) explains that although smart contracts can fulfill the economic function of contracts, their validity still depends on the national legal system that governs them. Research by Savelyev (2020) shows that the automated nature of smart contracts has the potential to cause injustice when contracts are executed without considering the specific circumstances of the parties. This legal risk increases when smart contracts are used in large-value transactions and across jurisdictions. Thus, the literature

agrees that smart contracts require a clear legal framework to ensure balanced legal protection.

Smart Contracts and Dispute Resolution Challenges

In the context of dispute resolution, several studies confirm that smart contracts present new challenges for the judicial and arbitration systems. Katsh and Rabinovich-Einy (2021) state that digital disputes require a different approach to resolution than conventional disputes because they involve complex technological elements. Additionally, research by Kaufmann and Gallo (2023) highlights the limitations of traditional arbitration institutions in handling blockchain-based disputes due to a lack of technical and procedural standards. This condition shows that the existing dispute resolution mechanism is not fully ready to deal with smart contract disputes. Therefore, the integration of smart contracts into the dispute resolution system is an urgent legal issue.

Smart Contracts and the Principle of Good Faith

The basic aspect of good faith is an important concern in the literature that studies smart contracts. Brownsword (2022) argues that contract automation has the potential to shift the ethical dimension in contractual relationships because contract decisions are made by codes, not humans. A similar view was put forward by Surden (2021) who assessed that smart contracts are difficult to accommodate the contextual assessments needed in the application of the goodwill principle. This literature shows that there is a tension between the mechanical nature of smart contracts and the normative values of contract law. Therefore, normative studies are needed to ensure that the implementation of smart contracts remains in line with the principles of justice and good faith.

Smart Contract Integration Model with Legal Systems

Some recent research has begun to develop an integration model between smart contracts and conventional legal systems. Borge, Kleros, and Lesaege (2021) propose a hybrid-based dispute resolution model that combines automated execution with third-party decisions. Meanwhile, Wright and De Filippi (2023) emphasize the importance of the involvement of formal legal institutions in overseeing the implementation of smart contracts to ensure legal legitimacy. This integration model is considered more realistic than an approach that relies entirely on automation. Thus, the contemporary literature tends to favor a hybrid approach in the implementation of smart contracts.

National and International Regulatory Perspectives

From a regulatory perspective, the literature shows that smart contract arrangements are still fragmentary in various jurisdictions. At the international level, a report by the European Law Institute (2022) emphasizes the need for harmonization of smart contract regulations to reduce cross-border legal uncertainty. In Indonesia, research by Sjahdeini (2021) highlights that national contract laws still need to be developed to be able to accommodate blockchain-based electronic contracts. This regulatory gap has the potential to hinder the adoption of smart contracts in commercial transactions. Therefore, legal studies

that discuss the integration of smart contracts in the settlement of commercial contract disputes are very relevant.

METHODOLOGY

Types and Approaches to Research

This study uses a qualitative approach with a normative type of legal research that focuses on the analysis of legal norms, legal principles, and doctrines relevant to the integration of blockchain-based smart contracts in commercial contract dispute resolution. This approach was chosen because the object of the research study is not the empirical behavior of legal subjects, but the legal position, normative implications, and smart contract integration models in the applicable legal system. Normative legal research is widely used in the study of technology law to evaluate the suitability of digital innovation with positive legal principles and modern contract law theories (Hutchinson & Duncan, 2021). In addition, this approach is relevant to examine the tension between the automatic character of smart contracts and legal flexibility in commercial dispute resolution (Brownsword, 2022).

Research Design and Legal Approach

The design of this research is prescriptive-analytical, namely analyzing the applicable legal norms as well as formulating conceptual recommendations regarding the smart contract integration model in the dispute resolution mechanism. This research uses several legal approaches, including a legislative approach, a conceptual approach, and a case approach. The statutory approach is used to examine regulations related to contracts, electronic transactions, and dispute resolution, while the conceptual approach is used to examine the concept of smart contracts, contract law principles, and the principle of good faith. The case approach is used in a limited way to analyze relevant judgments and legal practices in the context of electronic contracts and technology-based disputes (McCrudden, 2020).

Population, Sample, and Unit of Analysis

This study does not use populations and samples in a statistical sense, as it does not involve human respondents or participants. The unit of analysis of this research is legal norms, legal doctrines, and legal documents relevant to smart contracts and commercial contract dispute resolution. Legal materials are selected non-probability through purposive selection, which is based on substantial relevance to the focus of the research. This approach is commonly used in normative legal research because the purpose of the research is to obtain the depth of analysis, not statistical generalizations (Chynoweth, 2021). Thus, there is no measure of the number of respondents, but rather the selection of quality and relevance of legal materials.

Data Collection Techniques and Sources

The data collection technique is carried out through literature studies by collecting primary, secondary, and tertiary legal materials. Primary legal materials include laws and regulations that are still in force, including the Civil

Code, Law Number 11 of 2008 concerning Information and Electronic Transactions as amended by Law Number 19 of 2016, and Law Number 30 of 1999 concerning Arbitration and Alternative Dispute Resolution. Secondary legal materials include legal textbooks, articles from reputable international journals, and expert opinions on smart contracts and blockchain. Tertiary legal materials include legal dictionaries and legal encyclopedias. This method is considered most appropriate for legal research that systematically examines legal norms and concepts (Kommers, Miller, & Waite, 2022).

Data Validity and Research Validity

In normative legal research, validity is not tested through statistical reliability, but rather through normative validity and consistency of legal argumentation. The validity of the data is maintained by triangulating legal sources, namely comparing laws and regulations, legal doctrines, and the opinions of academics across jurisdictions. In addition, this research uses the principle of source authority, by prioritizing regulations that are still in force and reputable scientific publications. This approach is in line with the standards of contemporary legal research methodologies that emphasize the accuracy of interpretation and coherence of the legal system (Hoecke, 2021).

Research Implementation Procedure

This research was carried out through several systematic stages. The first stage is the identification of legal issues and the formulation of problems based on the development of smart contracts and commercial contract disputes. The second stage is the collection of primary, secondary, and tertiary legal materials through legal databases and scientific journals. The third stage is the classification and inventory of legal materials in accordance with the research theme. The fourth stage is legal analysis through normative and conceptual interpretation. The final stage is the drawing of conclusions and the formulation of recommendations regarding the smart contract integration model in commercial contract dispute resolution. This phased procedure aims to maintain the coherence and consistency of the analysis (Halliday & Shaffer, 2020).

Data Analysis Techniques

Data analysis was carried out using juridical qualitative analysis with legal interpretation methods which included grammatical, systematic, and teleological interpretations. The analysis was carried out by examining the relationship between contract law norms, dispute resolution principles, and the technical character of smart contracts. To support the management of library sources and citation consistency, this study uses reference management software such as Zotero or Mendeley. This analytical approach allows for the drawing of normative conclusions that are argumentative and academically accountable (Baude & Sachs, 2023).

RESEARCH RESULT

This section presents the findings of the research based on normative juridical analysis of the legal norms, doctrines, and technical character of smart contracts in the context of commercial contract disputes. The findings are thematically structured to show the relationship between the nature of automated execution and the "immutable" character of blockchains with the prevailing positive legal framework. The legal framework on which the analysis is based includes the Civil Code as the main source of treaty law, Law Number 11 of 2008 concerning Information and Electronic Transactions as amended by Law Number 19 of 2016 as the basis for the recognition of transactions and electronic evidence, and Law Number 30 of 1999 concerning Arbitration and Alternative Dispute Resolution as the basis for resolving commercial disputes outside the court.

Smart Contract's Position in Contract Law and Agreement Validity Parameters

The findings show that smart contracts in commercial contract practice are commonly positioned in two models. The first model puts smart contracts as contracts themselves, which are when clauses, conditions, and execution mechanisms are fully laid out in code and executed on the blockchain. The second model places smart contracts as contract execution instruments, i.e. when the main contract remains structured in a written document containing commercial provisions and legal provisions, while the code only executes certain measurable obligations such as automatic payments, fund holds, or release of funds through escrow. From the perspective of legal certainty, the second model is more compatible because contract documents can contain interpretive clauses, compelling circumstances clauses, change of circumstances clauses, and dispute resolution clauses that are unrealistic if forced entirely into code.

Within the framework of the Civil Code, smart contracts do not become invalid solely because they are in the form of codes, because the legal conditions of the agreement still refer to Article 1320 which requires the agreement of the parties, skills, certain objects, and halal causes. The research found that the critical point was not in the "medium" of the contract, but in the proof of the agreement and the identity of the legal subject who was bound by it. In smart contracts, agreements are often manifested through technical actions, such as cryptographic signing or blockchain account interactions. In order for such technical actions to be positioned as a binding expression of consent, the principal contract needs to affirm the construction of its consent and clarify the consequences if the action is performed by an unauthorised party, including representational arrangements and the authority to act.

This need is strengthened by the Electronic Information and Transaction Law, especially Article 5 paragraph (1) which recognizes Electronic Information and Electronic Documents as valid legal evidence, Article 5 paragraph (2) which expands the position of the evidence as an extension of evidence known to procedural law, and Article 5 paragraph (3) which affirms further provisions regarding the terms and procedures for the use of electronic evidence. However, the research emphasizes that the recognition of electronic evidence still leaves a typical problem of blockchain, namely linking account addresses with legal

identities and proving that the party who controls the private key is the authority in the contractual relationship. To strengthen this linkage, the contract document should include the blockchain account addresses of the parties, the governance of account controls, and the protocol in case the account is compromised. This strengthening is in line with the construction of electronic signatures in Article 11 paragraph (1) which requires the relationship of signature making data with the signator, the existence of a way to identify the signer, and the way to show the signer's consent to the related electronic information.

This theme emphasizes that smart contracts can be part of a valid commercial contract as long as the validity parameters are assessed within the framework of Article 1320 of the Civil Code, while the aspect of electronic form and proof is supported by Article 5 and Article 11 of the Electronic Information and Transaction Law. The safest model in terms of proof is the hybrid contract model, which is a written contract as a "main legal document" that regulates the relationship of rights and obligations, accompanied by a smart contract that automates certain obligations based on data.

Smart Contract as a Mechanism for Implementing Achievements and Their Impact on Default

The findings of the study show that the main contribution of smart contracts in commercial contracts lies in increasing the certainty of performance through the nature of self-executing. For obligations that can be represented as data, such as payments, escrow releases, late penalties, or transfers of digital assets, smart contracts reduce the room for factual disputes about whether obligations have been performed and when performance occurred. Normatively, on-chain execution records help establish a chronology of performance performance, so disputes about "events" become more limited to truly measurable liabilities.

However, research found structural limits that were unavoidable. Smart contracts are not effective for qualitative achievements and require contextual assessments, such as quality assessments, service standards, or "best effort" obligations. Within the framework of the Civil Code, default does not only concern the existence or absence of implementation, but also the quality and conformity of implementation with what is agreed. This analysis is closely related to the binding power of the agreement in Article 1338 paragraph (1) and the obligation to implement in good faith in Article 1338 paragraph (3), which demands normative assessment beyond the ability to execute the code. Consequently, smart contracts only partially cover the risk of default on fully "documented" obligations, while substantial defaults remain potentially occurring and require dispute resolution forums.

The study also identified a specific form of risk, namely technical failure, when performance failures arise not because the party refuses or is negligent, but because of code bugs, misconfigurations, or external data source failures that trigger incorrect execution. From the perspective of the agreement, this kind of failure still has the potential to give rise to a claim for damages under Article 1243 of the Civil Code (compensation due to non-fulfillment of the agreement), with a follow-up assessment of the cause and exemption from liability in certain

circumstances as commonly analyzed through Article 1244 and Article 1245. Therefore, the research emphasizes the importance of technical clauses in written contracts: the division of technical responsibilities, code audit obligations, change or update protocols, emergency termination mechanisms, as well as correction procedures in the event of execution errors. These clauses work as a bridge between the consequences of automatic execution and a civil liability regime that requires attribution of error, negligence, and causality.

This theme emphasizes that smart contracts increase the certainty of execution for data-based obligations and can reduce factual disputes. However, smart contracts do not remove substantial defaults that require a quality and propriety assessment within the framework of Article 1338 paragraph (3) and the indemnification provisions of Article 1243 along with the parameters of liability exemption. Therefore, contract design that combines commercial clauses, technical clauses, and corrective clauses determines the effectiveness of integration.

Smart Contract as Evidence in Commercial Contract Disputes

The research findings show that smart contracts and blockchain records can serve as a proofing instrument because they produce a chronologically recorded, consistent, and difficult to manipulate trace of transactions. The record is relevant to prove technical events, such as payment timing, escrow release, identity of the address that calls the contract function, and execution output. In commercial contract disputes, this kind of evidence suppresses differences in versions of the facts on measurable aspects and adds certainty as to the sequence of events.

The electronic evidentiary framework is supported by Article 5 paragraph (1) of the Electronic Information and Transaction Law which places Electronic Information and Electronic Documents as valid legal evidence, as well as Article 6 which basically recognizes that electronic information can meet "written" requirements as long as it can be accessed, displayed, guaranteed to be intact, and accountable. In the context of smart contracts, this support strengthens the use of transaction outputs, hashes, and execution records as part of electronic proof. The research also found the direct relevance of the electronic signature regime in Article 11 paragraph (1), as identification and approval through cryptographic mechanisms can be positioned as the basis for the authentication of the actions of the parties.

However, research confirms that there is a major obstacle, namely the issue of linking identities. Blockchain records the activity of an address, not the identity of a legal subject. As a result, in the dispute forum, additional proof is still required that a particular address is actually controlled by the contracting party and that the on-chain action is the implementation of the agreed obligation. To overcome these barriers, the study found the most effective contractual practice was to include attestation devices from the outset in contract documents, including the inclusion of account addresses, authentication procedures, private key control rules, procedures if the private key is lost or taken over, as well as incident notification obligations. On-chain evidence becomes much more

powerful when combined with off-chain evidence in the form of correspondence, transaction documents, system logs, trail audits, and expert testimony.

This theme emphasizes that Article 5 and Article 6 of the Electronic Information and Transaction Law provide a strong foundation for electronic proof, but blockchain evidence requires strengthening identity and context to meet the needs of civil proof in its entirety. Thus, smart contracts are most effective as evidence of technical events, not as the only basis for proving legal relationships.

Limitations of Smart Contracts in Legal Interpretation and Good Faith

The central findings of the research state that smart contracts cannot replace conventional dispute resolution forums because there are legal elements that cannot be reduced to code instructions. In commercial contract disputes, legal interpretation often requires a thorough interpretation of the clauses, the purpose of the agreement, the customs of trade, and the context of the business relationship. Smart contracts only execute programmed commands, so they are not able to process ambiguities, conflicts between clauses, or changes in circumstances that affect the balance of performance.

Within the framework of the Civil Code, the obligation to carry out in good faith is rooted in Article 1338 paragraph (3), which requires a normative assessment of behavior and propriety. The study found that disputes rooted in good faith typically involve elements of opportunism, abuse of circumstances, or execution that is formally in accordance with the clause but is substantively inappropriate. These elements cannot be converted into objective technical parameters without eliminating their judgmental nature. Therefore, smart contracts cannot replace adjudication that assesses propriety and balance substantially.

Research also confirms that many commercial contract disputes are non-technical, such as the quality of goods, delays due to supply chains, violations of service standards, compelling circumstances, or compensation for changes in circumstances. If these aspects are forced into entry through external data sources, disputes could potentially move to the validity of the data and the governance of the data source. In the framework of electronic transactions, the obligation of good faith is also affirmed in Article 17 paragraph (2) of the Electronic Information and Transaction Law, which states that the parties are obliged to act in good faith during the transaction. This norm reinforces the finding that the goodwill assessment remains a legal institution's workspace, not an automated execution workspace.

This theme emphasizes that the standards of interpretation and good faith in Article 1338 paragraph (3) of the Civil Code and Article 17 paragraph (2) of the Law on Information and Electronic Transactions require normative assessments that cannot be carried out by smart contracts. Therefore, smart contracts cannot replace conventional dispute resolution mechanisms for substantive disputes, but rather serve as an enforcement and evidence tool.

Smart Contract Integration in Litigation, Arbitration, and Alternative Dispute Resolution

The results show that the most realistic smart contract integration is done through a hybrid model that combines automated execution with a legally recognized dispute resolution mechanism. In litigation, smart contract records function as evidence of the implementation of achievements and evidence of the sequence of events, while the judge still assesses defaults, compensation, cancellation, and recovery based on the framework of the agreement in the Civil Code, including the use of the norm of compensation in Article 1243 and the assessment of the implementation of the agreement in good faith Article 1338 paragraph (3). Litigation tends to be dominant for non-technical disputes or disputes that require extensive examination of context and propriety.

In arbitration, research finds greater integration opportunities because arbitration is born from the agreement of the parties and the procedure is more flexible for technical evidence. The normative basis is clear in Law Number 30 of 1999, especially the definition of arbitration in Article 1 number 1, the definition of arbitration agreement in Article 1 number 3, and the alternative definition of dispute resolution in Article 1 number 10. The scope is affirmed in Article 2 which requires an arbitration agreement that expressly states that the dispute is resolved through arbitration or alternative dispute resolution. The validity and form of consent are also relevant in Article 3 paragraph (2) which requires documents signed by the parties, as well as Article 3 paragraph (3) which recognizes the form of electronic communication exchange with a record of receipt. The locking points of integration are Article 11 paragraph (1) which negates the right of the parties to submit disputes included in the arbitration agreement to the District Court, and Article 11 paragraph (2) which requires the District Court to refuse to intervene except in certain cases stipulated by law. These findings reinforce the need to draft detailed arbitration clauses in written contracts to bind forums, electronic evidentiary procedures, expert use, and blockchain evidentiary examination procedures.

In alternative dispute resolution, research places mediation and negotiation as often effective stages for interpretive disputes and merit adjustments. The normative framework rests on Article 6 paragraph (1) of Law Number 30 of 1999 which states that civil disputes can be resolved through alternative dispute resolution based on good faith by setting aside litigation, and Article 6 paragraph (2) which encourages direct meetings within a certain time limit with results in the form of written agreements. In the context of cross-border electronic transactions, the selection of a forum also gains legitimacy through Article 18 paragraph (4) of the Electronic Information and Transaction Law, which provides the authority for the parties to establish a forum for court, arbitration, or other alternative dispute resolution institutions to handle disputes. The research findings suggest that the existence of on-chain data helps narrow the factual debate in ADR, but settlement remains dependent on the willingness of compromise and reasonableness assessments, so it does not replace arbitration or litigation when disputes relate to liability, cancellation, or substantial damages.

This theme emphasizes that Law Number 30 of 1999 provides a formal foundation for integration through arbitration and alternative dispute resolution,

strengthened by forum norms in Article 18 paragraph (4) of the Electronic Information and Transaction Law. Litigation remains important for substantive disputes that require normative judgment. Therefore, a hybrid model that combines written contracts, smart contracts, and explicit forum clauses is the most compatible option with the prevailing legal framework.

DISCUSSION

This study reveals that the integration of smart contracts in commercial contract disputes cannot be understood as a substitution for conventional contracts, but rather as a transformation of contractual architecture towards a hybrid model that combines code-based execution tools with written legal instruments. Key findings suggest that the most juridically compatible smart contract position is as an execution mechanism inherent in the main contract, rather than as the sole representation of the agreement. Theoretically, this result is in line with the concept of smart legal contracts which distinguishes ontological between code as a deterministic system and contracts as a normative construct that contains the intentions of the parties, risk allocation, and remedial clauses that cannot be entirely reduced to programming languages (Compagnucci et al., 2021).

In the context of civil law, these findings reinforce the view that the validity and enforceability of contracts remain dependent on the fulfillment of the terms of the agreement, while technology only changes the medium and method of proof without replacing its normative structure (Durovic & Willett, 2024). In Indonesia, the need to associate blockchain addresses with the identity of legal subjects and representational authority suggests that the recognition of electronic documents demands evidence-conscious contractual design. This is in line with a national study that emphasizes the importance of authentication and electronic consent as a bridge between cryptographic identity and the capacity to act in treaty law (Tresnawati & Fatmawati, 2021). Thus, the hybrid model found by the study is not just a pragmatic solution, but rather a logical consequence of the fundamental difference between code logic and legal logic.

The results of the study also show that smart contract efficiency claims mainly apply to obligations that can be represented as data and are triggered by conditions that can be objectively verified. The findings on the phenomenon of technical malfunctions indicate a shift in the source of risk from non-compliance by parties to design vulnerabilities, misconfigurations, and reliance on oracles as a link between off-chain and on-chain data. The literature on artificial intelligence-based oracles confirms that data governance, model transparency, and output accountability are crucial factors that determine the validity of automated execution and the allocation of responsibility when errors occur (Papadouli & Papakonstantinou, 2023). These findings are consistent with technical studies that place the reliability of external data sources as a key prerequisite for the reliability of smart contracts as well as a new source of dispute when data is disputed (Almasoudi et al., 2023).

In addition, this study found that the need for audits and correction mechanisms are important prerequisites for the use of smart contracts in high-

value transactions. This is in line with smart contract security research that shows that the immutable nature and limitations of updates magnify the impact of code errors into losses that are difficult to recover without remedial paths outside of the on-chain system (Liu et al., 2020). Thus, the effectiveness of smart contracts in suppressing disputes is not inherent, but rather relies heavily on how technical and legal risks are explicitly engineered in the main contract.

On the proof dimension, the research findings place blockchain as a strong source of transaction traces to prove technical events, but not automatically enough to prove the legal relationship of the parties. The literature on blockchain-based proofing confirms that tamper-resistant characteristics only answer questions about what happens on the network, while legal forums still require proof of the identity of the perpetrator and the legal meaning of the act (Wu, 2020). Recent studies on blockchain evidence also show that the receipt of on-chain evidence is greatly influenced by digital forensic standards, verification methods, and the ability to explain the chain of custody so that data can be accounted for in the adjudication process (Wang et al., 2024). Therefore, the research recommendations regarding the reinforcement of off-chain evidence through identity clauses, private key control, and incident protocols are a direct implication of the normative-procedural evidentiary needs.

Furthermore, this study emphasizes that smart contracts cannot replace conventional dispute resolution mechanisms, especially in terms of interpretation, fairness, and good faith. These findings are in line with an analysis of algorithmic errors that emphasizes the need for normative correction mechanisms when automatic results deviate from the substantive objectives of the agreement (Fratton, 2024). The literature on artificial intelligence-based contracts also shows that normative standards such as propriety and good faith require contextual judgments that cannot be adequately reduced to technical parameters without losing their legal substance (Awang, 2024). Thus, the need for adjudication for non-technical disputes is a conceptual boundary between the enforcement apparatus and the norms that assess the behavior of the parties.

The most realistic integration, as found in this study, is the pattern of smart contracts as evidence and partial executors linked to dispute resolution forums, specifically arbitration and alternative dispute resolution. The literature on blockchain and online dispute resolution shows that technology can speed up the clarification of technical facts and reduce enforcement costs, but still requires institutional legitimacy and procedural standards for judgments to be accepted and executed effectively (Chevalier, 2021). These findings are also in line with smart contract institution design studies that emphasize that contract incompleteness and contingency uncertainty make adjudication institutions relevant as complements, rather than competitors that can be completely replaced (Howell & Potgieter, 2021).

From a policy and governance perspective, the study expands the understanding that blockchain efficiency benefits arise when verification and coordination costs are reduced, but will decrease as transaction complexity and uncertainty increase (Catalini & Gans, 2020). Studies on blockchain governance also confirm that the success of smart contract systems is greatly influenced by

decision-making mechanisms, interoperability, and update procedures that are acceptable to stakeholders (Balcerzak et al., 2022). Therefore, smart contract integration should be understood as institutional engineering, not just software adoption.

Despite making a strong conceptual contribution, this study has limitations in the empirical scope and variety of jurisdictions analyzed. Focusing on the context of a particular commercial contract limits the generalization of findings to other sectors or legal systems. Further research is suggested to test this hybrid contract model through cross-border comparative studies, analysis of arbitration or court awards involving on-chain evidence, as well as exploration of remedial clause designs that are more adaptive to technological changes. Thus, this research contributes to the development of digital contract law by formulating an argumentative basis that places hybrid contracts as the most rational design to maintain a balance between execution certainty and normative justice.

CONCLUSIONS AND RECOMMENDATIONS

This study concludes that blockchain-based smart contracts can be legally recognized in commercial contract practice, provided that their validity remains anchored to the essential requirements of agreement under the Civil Code and is supported by the evidentiary framework of electronic documents and electronic signatures under the Electronic Information and Transactions Law. Smart contracts are most appropriately positioned as instruments of automated performance and evidentiary reinforcement, particularly for measurable and data-based obligations such as payments, escrow mechanisms, and digital asset transfers, where on-chain records enhance certainty regarding technical execution. However, due to their inherent limitations in interpreting contractual intent, assessing good faith, evaluating proportionality, and resolving non-technical or contextual disputes, smart contracts cannot substitute conventional dispute resolution mechanisms. Therefore, the effective implementation of this research supports a hybrid contractual model in which a written principal contract functions as the normative legal foundation, complemented by smart contracts for partial execution, accompanied by clear clauses on identity attribution, technical risk allocation, evidentiary procedures, and dispute resolution forums (litigation, arbitration, or ADR), so that technological efficiency can operate within a framework that preserves legal certainty, accountability, and substantive justice in commercial transactions.

ADVANCED RESEARCH

This study is limited to normative juridical analysis within the Indonesian legal framework and does not include empirical examination of court decisions, arbitral awards, or real-case smart contract disputes, nor does it conduct comparative cross-jurisdictional analysis. Accordingly, further research is recommended to explore empirical case studies involving on-chain evidence in litigation or arbitration, comparative regulatory approaches across different legal systems, and the development of adaptive contractual clause models capable of addressing technical failures, oracle risks, and cross-border enforcement challenges in blockchain-based commercial transactions.

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