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Legal Responsibility in Smart Contracts in Blockchain Transactions

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Abstract**:** *The development of blockchain technology has given rise to smart contracts as a self-executing, decentralized, code-based contractual mechanism. Their presence poses conceptual and normative challenges in the Indonesian contract law system, particularly regarding the legal standing and construction of the parties' responsibilities amidst a normative vacuum. This study aims to analyze the legal status of smart contracts from the perspective of Indonesian civil law and to formulate a relevant legal liability model for blockchain-based transactions. The research method used is normative legal research with statutory, conceptual, and analytical approaches. Primary legal materials include the Civil Code, the Electronic Transactions and Transactions Law, and regulations related to electronic transactions, while secondary legal materials include doctrine, liability theory, and literature on blockchain. The results show that smart contracts can be qualified as agreements as long as they meet the valid requirements of an agreement as stipulated in Article 1320 of the Civil Code. However, their immutable and automated nature creates tensions with the principles of freedom of contract and good faith. The identification of legal subjects in the blockchain ecosystem includes users, developers, validators, and platforms, with liability models that can be based on fault liability or the possibility of strict liability under certain conditions. The absence of norms has the potential to give rise to disparities in interpretation and legal uncertainty, so that a normative reconstruction is needed that is adaptive to the character of decentralization to ensure legal certainty, justice, and benefits.*

Keywords: Smart Contracts, Blockchain, Legal Responsibility, Contract Law.

INTRODUCTION

The digital transformation of the 21st century has shifted the paradigm of economic interaction from a centralized system to a distributed system based on cryptographic technology. Blockchain is a concrete manifestation of this development, namely as a decentralized, transparent, and immutable digital recording technology. Conceptually, blockchain is not merely a technical infrastructure, but rather a trust architecture that replaces central authority with an algorithmic consensus mechanism. Modern legal system theory demands that law be responsive to social change, as proposed by Nonet and Selznick. Therefore, blockchain

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development cannot be separated from the need for the reconstruction of legal norms.[1] In a state based on law (rechtstaat), every change in the structure of economic transactions must be followed by adaptation of normative instruments to ensure legal certainty.[2] Such massive digital transformation makes blockchain not just a technical innovation, but a legal phenomenon that demands systemic regulation.

Empirically, blockchain adoption has shown significant growth across various jurisdictions. Reports from global research institutions indicate that the market capitalization of crypto assets has reached trillions of US dollars in recent years, with millions of daily transactions recorded on the global network.[3] In Indonesia, data from the Commodity Futures Trading Regulatory Agency shows that the number of crypto asset investors surpassed 18 million users in 2024, a figure that even surpasses the number of conventional capital market investors.[4] This fact confirms that blockchain-based transactions have become an economic reality that cannot be ignored by lawmakers. From a sociological perspective, this social fact constitutes living law developing in a digital society.[5] Therefore, positive law is required to integrate these empirical developments into an adaptive and progressive regulatory framework.

Blockchain's expansion is no longer limited to crypto asset trading, but has also penetrated decentralized finance (DeFi), supply chain logistics, digital health, and even e-government-based governance. The characteristics of decentralization enable reduced transaction costs, as analyzed in Douglass North's institutional economic theory.[6] Blockchain minimizes the need for intermediaries, thus creating efficiencies as well as new challenges in terms of legal accountability.[7] The transparency principle inherent in distributed ledgers aligns with the transparency principle of good governance. However, the anonymity and pseudonymity of blockchain users have the potential to raise legal liability issues. This situation demonstrates the dialectic between technological efficiency and legal certainty.

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In this landscape, smart contracts emerge as a further innovation that revolutionizes the concept of contracts. First introduced by Nick Szabo, the concept views contracts not as mere normative texts but as computer protocols that execute themselves based on programmed conditions.[8] Their widespread implementation on the Ethereum platform demonstrates that smart contracts can perform escrow functions, lending and borrowing, digital asset exchange, and even decentralized autonomous organization (DAO) governance. Theoretically, smart contracts combine the legal aspects of contracts with software engineering.[9] The advantages of self-execution and irreversibility create efficiency, but also create rigidity. From the perspective of will theory (Wilsleer), the question arises whether the parties' expressed will is still relevant when execution is controlled by code.

The self-executing nature of smart contracts has serious implications for the doctrine of breach of contract and cancellation of agreement. In conventional contracts, breach of contract can be tested through judicial mechanisms to determine whether there is a breach of contract. Smart contracts, on the other hand, execute automatically without considering force majeure or good faith in the substantive sense.[10] The principle of freedom of contract as recognized in Article 1338 of the Civil Code presupposes the existence of room for interpretation and renegotiation.[11] Smart contracts actually lock agreements into code that is difficult to change. This creates a tension between the flexibility of civil law and algorithmic rigidity.

In the Indonesian legal system, the normative basis of contract law still rests on the Civil Code, specifically Article 1320, which establishes four conditions for a valid contract. The elements of agreement and capacity presuppose a legal subject who consciously expresses their will. Smart contracts challenge how this agreement is proven when interactions occur through anonymous private keys and wallet addresses.[12] The recognition of electronic documents in the Electronic Information and Transactions Law does open up space for legitimacy, but it does not explicitly regulate autonomous code-based contracts. Existing norms are still general and do not address the technical dimensions and distribution of responsibilities within decentralized networks. Thus, there is a lack of synchronization between technological developments and normative construction. The issue of a legal vacuum (rechtsvacuum) becomes increasingly apparent when code failures or security vulnerabilities are exploited. In several global cases, smart contract hacks have caused billions of dollars in losses without an effective cancellation mechanism. Civil law recognizes the concept of unlawful acts (onrechtmatige daad), but its application in the context of anonymous global networks

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raises evidentiary and jurisdictional issues.[13] The principle of territoriality in national law conflicts with the borderless nature of blockchain. This legal vacuum creates uncertainty in determining who should be held responsible: developers, validators, users, or the network community. This situation has the potential to undermine the principle of legal certainty (rechtssicherheit).

From a liability theory perspective, liability can be based on fault liability or strict liability. Smart contracts raise the question of whether coding errors can be equated with developer negligence. In a product liability regime, manufacturers can be held liable for losses resulting from product defects. This analogy is appealing, but not entirely accurate, given the open-source and decentralized nature of blockchain. Determining legal subjects in anonymous networks is complex. This normative vacuum demands legal reform based on an interdisciplinary approach. Within the principle of justice, Gustav Radbruch's theory places legal certainty, fairness, and utility as three fundamental values.[14] Smart contracts tend to emphasize algorithmic certainty, but they potentially neglect the dimension of substantive justice. Automated execution without room for correction can lead to injustice when technical errors occur. Law as a tool of social engineering, as argued by Roscoe Pound, must be able to control technology for the benefit of society.[15] Without regulation, technology can become a determinant that shifts the rule of law. Therefore, the state cannot afford to remain passive.

The urgency of regulating legal liability becomes even more pressing given the irreversible nature of blockchain. Unlike conventional banking systems, which allow transaction cancellation through a central authority, blockchains lack a rollback mechanism except through rare extraordinary consensus. This situation poses a systemic risk to consumer and investor protection. The principle of legal protection requires the state to provide transaction security guarantees.[16] Adaptive regulations must bridge innovation with accountability. Without them, a normative vacuum will create a dangerous gray area. Comparatively, several countries have begun formulating legal frameworks related to crypto assets and smart contracts, both through digital securities regulations and the recognition of blockchain-based electronic contracts. Indonesia is still at a limited regulatory stage, specifically regulating crypto asset trading as a commodity. This sectoral approach fails to comprehensively address the civil law and contractual liability dimensions. Regulatory harmonization is urgently needed to prevent normative fragmentation. Regulation must adhere to the principles of lex certa and lex scripta to avoid multiple interpretations.

Based on the overall description, it can be emphasized that digital transformation through blockchain and smart contracts has created a new paradigm in contract law. The lack of norms regarding legal status and

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[14] Firdaus, M. B. (2025). Dialektika Keadilan, Kepastian, Kemanfaatan Hukum dalam Perspektif Gustav Radbruch pada Hukum Indonesia. *Jurnal Kajian Hukum Dan Kebijakan Publik| E-ISSN: 3031-8882*, *3*(1), 357-367. https://doi.org/10.62379/qy4b6z80

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responsibilities in smart contracts creates uncertainty that can potentially harm the parties. National laws are required to conceptually reformulate classical principles, theories, and doctrines to make them relevant to algorithm-based contracts.[17] The fundamental issue that arises is how to construct legal responsibility in smart contract transactions on a blockchain system to align with the principles of legal certainty, justice, and expediency in the Indonesian legal system. This question is the central focus of the scientific study in this article.

METHODOLOGY

The research method used in this article is doctrinal legal research, which focuses on the study of positive legal norms, legal principles, and doctrines developed in academic literature. According to Soerjono Soekanto, normative legal research is research conducted by examining library materials or secondary data as primary sources, including laws and regulations, court decisions, and the opinions of legal scholars.[18] The approaches used include a statutory approach, a conceptual approach, and a comparative approach to analyze the construction of legal responsibility in smart contracts in blockchain transactions. Primary legal materials, in the form of provisions in the Civil Code and the Electronic Information and Transactions Law, are systematically analyzed, while secondary legal materials, in the form of scientific journals, textbooks, and previous research results, are used to enrich the theoretical framework. The analysis is conducted prescriptively by assessing the compatibility between applicable norms and developments in blockchain technology and formulating solution-oriented legal arguments.

Methodologically, this research also adopts a conceptual approach based on legal theory to examine the normative vacuum (rechtsvacuum) in smart contract regulations. Peter Mahmud Marzuki emphasized that normative legal research aims to identify legal rules, legal principles, and legal doctrines to address the legal issues at hand, thus its orientation is argumentative and prescriptive.[19] Therefore, this research not only describes existing norms but also critically analyzes them through legal certainty theory, liability theory, and general principles of contract law. The legal material was collected through library research, while the analysis employed grammatical, systematic, and teleological interpretation methods to obtain comprehensive meaning. Therefore, this research method is aimed at producing a legal construction capable of providing certainty, justice, and benefit in regulating the legal responsibility of smart contracts in Indonesia.

RESULTS AND DISCUSSION

Normative Analysis of the Position of Smart Contracts in the Indonesian Contract Law System

Conceptualizing smart contracts from a contract law perspective must begin with an ontological determination of whether they constitute a "contract" in the legal sense or merely a technical instrument for

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implementing an obligation. Doctrinally, contracts in the civil law tradition are rooted in the mutual will of the parties, which gives rise to a legal relationship and certain legal consequences.[20] Smart contracts, on the other hand, are defined as computer programs that store and execute certain conditions automatically on a blockchain network.[21] Within the conceptual framework, it is necessary to distinguish between norms as expressions of will and code as a representation of algorithmic logic. Smart contracts do not possess will, nor do they understand the moral intentions of the parties, but merely execute instructions based on "if/then" conditions. Therefore, conceptually, they are more appropriately positioned as automatic enforcement mechanisms, unless the code is the sole manifestation of the parties' agreement without an underlying agreement in natural language.

The fundamental difference between traditional contracts and smart contracts lies in their epistemological basis. Traditional contracts are based on a meeting of minds, interpreted through language, context, and the principle of good faith. Judges in civil disputes have the interpretive latitude to explore the parties' intentions, consider force majeure, and assess the balance of rights and obligations.[22] Smart contracts operate within a deterministic system that defies teleological interpretation. The code simply executes the programmed syntax, so even a small error in the command line can have significant legal consequences. In this context, the adage "code is law" cannot be accepted as an absolute in a legal system that upholds substantive justice.[23] Law should not be reduced to a mere rigid algorithm without considering normative values.

A conceptual approach to the classical doctrine of contractual obligations suggests that smart contracts can be tested within the parameters of Article 1320 of the Civil Code. The element of agreement in traditional contracts is understood as a correspondence of wills free from defects of will. In blockchain transactions, agreement is manifested through the use of private keys to sign digital transactions.[24] This technical action can be functionally viewed as an electronic expression of offer and acceptance. However, problems arise when the private key is misused or stolen, as the blockchain system still considers the transaction technically valid. This is where the distinction between technical validity and legal validity becomes apparent, which doesn't always perfectly align.

The capacity element in Article 1320 of the Civil Code also faces serious challenges in the pseudonymous and cross-jurisdictional nature of blockchain systems. Civil law requires that parties must be adults and not

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[23] Wirayudha, M. D. (2025). Diskresi Penegak Hukum Dalam Sistem Peradilan Pidana: Harmonisasi Keadilan Prosedural dan Substantif. *HARISA: Jurnal Hukum, Syariah, dan Sosial*, *2*(1)), 170-185. https://ejournal.eddhuhacenter.com/index.php/harisa/article/view/70

[24] Chic, S. A., & Bilqisthi, M. F. (2024). Tantangan dan Peluang Blockchain di Era Digital dalam Bidang Keamanan Data dan Transaksi Digital. *Journal of Comprehensive Science (JCS)*, *3*(11). 10.59188/jcs.v3i11.2887

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be in a state that precludes their capacity to act.[25] Blockchain doesn't recognize real identities, only wallet addresses as cryptographic representations. This makes it difficult to verify whether a legal subject is competent under specific national laws. Borderless transactions also raise legal conflict issues, particularly in determining which law applies in the event of a dispute. Therefore, the element of competence in the context of smart contracts requires additional mechanisms such as KYC on registered exchanges to bridge this normative gap.

From a specific object perspective, smart contracts have the advantage of ensuring the determination of obligations. Computer code explicitly defines the asset type, token quantity, and execution conditions, which are verified in the blockchain ledger. In Indonesia, crypto assets are recognized as tradable commodities, thus meeting the criteria for a specific object as long as their type and value can be determined.[26] However, technical certainty does not necessarily guarantee legal certainty if the object in question is found to have originated from a criminal act or is used for an unlawful purpose. Here, the element of lawful cause becomes crucial. Agreements that conflict with law or public order remain null and void even if they are perfectly executed by the code.

The implications of the failure to fulfill the subjective element in smart contracts raise serious problems. In classical doctrine, an agreement containing a flawed will is voidable. However, the immutable nature of blockchains allows execution to proceed even if the agreement is legally flawed. Cancellation can only be achieved through a court decision, which practically cannot erase transactions on a public ledger. This situation creates a gap between the theory of contract cancellation and the technical reality of smart contracts. Therefore, a reinterpretation of the cancellation doctrine is necessary to address the challenges of decentralized technology.

If the objective elements are not met, for example, an illegal object or an unlawful cause, the agreement is null and void. In smart contracts, the code still executes the transaction without verifying its substantial legality.[27] Blockchain systems lack the normative capacity to assess the morality or legality of transactions. Consequently, legally void agreements can still have factual consequences that are difficult to reverse. This demonstrates that legal validity and technical finality are two domains that do not always run parallel. This tension demands regulatory intervention to maintain the supremacy of law over technology.

Overall, the conceptualization of smart contracts in Indonesia's contract law system demonstrates that they are not entirely new entities, but neither are they merely digital replicas of conventional contracts. Smart contracts can function as valid electronic contracts as long as they meet the elements of Article 1320 of the Civil Code, but they are also technical execution instruments that operate outside of traditional corrective mechanisms. The distinction between a meeting of minds and algorithmic code poses doctrinal challenges that require adjustments to legal interpretation. Without conceptual updates, contract law risks being left

[25] Ganda, C. M., & Huda, M. (2024). Batasan Perbuatan Hukum Orang Dewasa Yang Berada Dalam Pengampuan. *UNES Law Review*, *7*(1), 156-159. https://doi.org/10.31933/unesrev.v7i1.2240

[26] Anggadinata, R. G. (2025). ASET TAK BERWUJUD DAN KONSEP HARTA DALAM FIKIH KONTEMPORER: ANALISIS KEHALALAN KRIPTO BERDASARKAN KAJIAN PLATFORM "CRYPTOSHARIA". *At-Tadhmin: Journal of Islamic Financial Management*, *1*(1), 13-26. https://jurnal.iaipigarut.ac.id/JIFM/article/view/116

[27] Rukman, J. A., Rahardiansah, T., & Notoprayitno, M. I. (2025). Legalitas dan Pemanfaatan Teknologi Blockchain Terhadap Smart Contract pada Perjanjian Bisnis di Indonesia. *RIGGS: Journal of Artificial Intelligence and Digital Business*, *4*(2), 6914-6925. https://doi.org/10.31004/riggs.v4i2.1311

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behind by exponential technological developments. Therefore, normative analysis of the status of smart contracts must be directed at harmonizing classical contract principles with the decentralized nature of blockchain to ensure legal certainty, fairness, and utility.

The principle of freedom of contract, as stipulated in Article 1338 of the Civil Code, affirms that all legally entered into agreements are valid as law for the parties making them. This principle is rooted in the classical liberal view that places individual will as the primary source of the creation of obligations. In self-executing and immutable smart contracts, the relevance of Article 1338 becomes problematic because the validity of "as law" is no longer merely metaphorical but is manifested literally through code that executes itself without room for correction. Freedom of contract in the blockchain ecosystem appears to have reached its extreme, where parties are free to program legal consequences that will run automatically.[28] However, this freedom has the potential to eliminate the corrective dimension traditionally inherent in judges' authority to assess the fairness and balance of contracts. Therefore, Article 1338 needs to be interpreted progressively to avoid being interpreted as absolute legitimacy for algorithmic rigidity that could undermine substantive justice.

The tension between freedom of contract and protection of the vulnerable becomes even sharper in blockchain-based transactions. In modern contract theory, freedom of contract is no longer understood as unlimited freedom, but is limited by the principles of balance, propriety and protection for parties who are in an unequal bargaining position.[29] Smart contracts are often written by developers or entities with advanced technical capabilities, while users can simply accept (take it or leave it) without understanding the complexity of the underlying code. This situation resembles a standard contract, potentially leading to unfairness. In a decentralized system, there is no renegotiation mechanism once the code is deployed to the blockchain. Therefore, freedom of contract in the blockchain ecosystem must be interpreted in conjunction with the principles of consumer protection and proportionality to prevent the emergence of hidden domination through technology.

The principle of good faith, which in civil law doctrine has subjective and objective dimensions, also faces conceptual challenges in smart contracts. Good faith requires honesty, openness, and propriety in the execution of agreements. Algorithmic code lacks moral consciousness and therefore cannot be "in good faith" in the ethical sense. Automatic execution based on binary logic ignores the social context and coercive circumstances that might affect the execution of an agreement. In the event of a programming error or exploitation of a loophole, the system continues to operate without considering the parties' original intentions. This situation demonstrates that the principle of good faith cannot be reduced to mere compliance with the code but must remain a parameter of legal evaluation outside the blockchain system.

From a legal and evidentiary perspective, the recognition of electronic documents and information as valid evidence under the Electronic Information and Transactions Law provides a normative basis for digital transactions. This recognition affirms that electronic data has evidentiary force as long as it meets the requirements for electronic system reliability. Smart contracts, as code stored on a blockchain, can qualify

[28] Wibowo, K. T., & SH, M. (2025). *Aspek Hukum dalam Dunia Digital*. Sada Kurnia Pustaka.

[29] Budi, G. S. (2025). Perkembangan Asas Kebebasan Berkontrak dalam Praktik Hukum Perdata di Indonesia. *Jurnal Kajian Hukum Dan Kebijakan Publik| E-ISSN: 3031-8882*, *3*(1), 139-148. https://doi.org/10.62379/wnaj8r67

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as electronic information because they contain data and instructions that can be accessed and verified.[30] However, the decentralized and distributed nature of the ledger raises questions about who is responsible for the system's integrity. The ITE Law assumes the existence of an electronic system administrator who can be held accountable, while blockchain is permissionless and lacks a single authority. This discrepancy highlights a normative gap in the electronic evidence framework.

A further question is whether smart contracts can be fully equated with electronic documents or whether they possess sui generis characteristics. Electronic documents are typically digital representations of textual documents that can be read and understood by humans. Smart contracts, on the other hand, are strings of code that require technical expertise to interpret.[31] The code is not always easily understood by laypeople, creating information asymmetry. In disputes, judges must interpret lines of code to understand the parties' rights and obligations. This necessitates the use of technology experts as witnesses or expert testimony. Thus, smart contracts possess a hybrid character between electronic documents and technical instruments, requiring a specialized interpretive approach.

The issue of authentication and identification of legal subjects in decentralized systems is a crucial issue in proving the value of a wallet. A wallet address does not directly reveal the real identity of its owner. While the use of a private key does demonstrate control over an address, it does not necessarily prove the identity of the person behind it.[32] In civil disputes, proving who acted as a party to an agreement is essential. When identities cannot be verified, legal liability becomes difficult to enforce. Therefore, additional mechanisms such as Know Your Customer procedures on registered exchanges bridge the gap between technical anonymity and legal identification requirements.

Regarding the status of smart contracts, there is debate as to whether they constitute a standalone agreement or merely a means of implementing the underlying agreement. Normatively, if the entire agreement between the parties is contained in code and there are no other accompanying documents, then a smart contract can be considered a complete electronic agreement. However, in practice, natural language contracts often describe rights and obligations narratively, while the code only serves to enforce certain provisions. This dualism creates potential disharmony when there is a difference between the text and the code. In such circumstances, the question arises: which should be prioritized as a representation of the parties' intentions? Without clear regulations, interpretations can vary from judge to judge.

The implications of the lack of norms regarding the definition and legal status of smart contracts have the potential to undermine legal certainty (rechtssicherheit). The absence of specific regulations governing the nature, responsibilities, and correction mechanisms for blockchain-based transactions creates room for disparate interpretations in judicial practice. The principle of lex certa requires clear, unambiguous norms, while the phenomenon of smart contracts remains in a normative gray area. Under such conditions, judges are forced to construct law through analogy or extensive interpretation, which risks inconsistency. This

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uncertainty can ultimately erode public trust in the legal system. Therefore, the establishment of firm and systematic norms is urgently needed to ensure that technological innovation remains within the corridors of legal certainty, justice, and benefit.

Construction of Legal Responsibility of Parties in Smart Contract-Based Blockchain Transactions Amidst a Normative Void

Identifying legal subjects in the blockchain ecosystem is a fundamental starting point in constructing accountability, as without a clear definition of the subject, the liability regime lacks a normative address. From a classical civil law perspective, legal subjects consist of natural persons and legal persons, each of which has the capacity to bear rights and obligations.[33] In the blockchain ecosystem, parties potentially qualified as legal subjects include users, developers, validators or miners, and platforms such as crypto exchanges or marketplaces. Users are directly involved in transactions and are therefore most easily qualified as conventional legal subjects. However, developers who design and deploy smart contracts also play a causal role in creating risks, and therefore cannot be separated from the possibility of attribution of responsibility. Meanwhile, validators or miners are often positioned as neutral parties who merely verify transactions, but in certain systems they receive economic incentives, raising questions about whether they are truly merely technical intermediaries or part of the chain of responsibility.

The problem becomes more complex when considering the anonymity and pseudonymity inherent in blockchain. Wallet addresses do not inherently reveal personal identity, creating a distinction between technical and legal identity. In civil law, liability requires a concretely identifiable subject to be held liable for fulfillment of obligations or compensation.[34] When an identity is merely a string of cryptographic characters, the process of attributing responsibility is hampered. Pseudonymity does not necessarily mean absolute anonymity, but it does require digital forensics and often the involvement of cross-border authorities. This situation creates structural challenges to the principle of accountability that underpins private law. Therefore, the theory of legal subjects needs to be interpreted adaptively, recognizing that digital entities do not replace humans or legal entities as subjects, but rather merely represent a medium that must be traced to its effective control holder.

In the fault-based liability model, the provisions of Article 1365 of the Civil Code concerning unlawful acts open up scope for application to losses resulting from bugs or code exploitation in smart contracts. This norm requires an unlawful act, fault (schuld), loss (schade), and a causal relationship (causal verband). A bug in the code can be considered a form of negligence if it is proven that the developer failed to apply reasonable care in the audit or testing process. However, not every loss resulting from exploitation automatically meets the elements of fault, especially if the exploitation exploits a loophole technically "permitted" by the code. This is where the tension between the principle of "code is law" and the concept of fault in civil law arises. Normatively, the law should not be subject to technical logic but must instead

[33] Rahadiyan Veda Mahardika, S. H., Bhim Prakoso, S. H., MM, S. N., & Iswi Hariyani, S. H. (2022). *Kedudukan Subyek Hukum Ditinjau Dari Hak Keperdataan: Refleksi: Terjadinya Tumpang Tindih Lahan Hak Guna Usaha*. UM Jember Press.

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assess whether there has been a violation of the standards of decency prevailing within the relevant professional community.[35]

Testing the element of fault requires proving that the perpetrator is objectively and subjectively culpable. For smart contract developers, the relevant standard is whether they acted as a reasonably prudent and competent developer would. The element of loss is relatively easy to prove when there is an economically measurable loss of crypto assets. However, proving causality is often problematic because blockchain ecosystems involve numerous nodes and algorithmic interactions. Did the loss arise solely from a code flaw, or from the actions of a third party actively exploiting the system? This question requires in-depth technical analysis that goes beyond conventional evidentiary capacity. Therefore, the application of Article 1365 of the Civil Code remains possible, but requires a more progressive, digitally-skilled evidentiary approach. The issue of proof becomes increasingly complex in decentralized, cross-jurisdictional networks. Transactions can involve parties located in multiple countries without a clear forum. The principle of territoriality of national law faces limitations when nodes are dispersed globally. In disputes, plaintiffs must prove the identity of the defendant, the location of the act, and the applicable law. Without an explicit choice of law or forum mechanism, the litigation process has the potential to be hampered by jurisdictional conflicts. This condition shows that the fault liability model in the blockchain context requires harmonization of international law so that it does not stop at a purely theoretical level.

Beyond the fault-based model, the possibility of implementing strict liability or product liability arises through the analogy of smart contracts as digital products. Under a product liability regime, manufacturers can be held liable for product defects without the need to prove fault, as long as the defect and the resulting harm are proven. Widely designed, marketed, and used smart contracts resemble software products. If the code contains a design flaw that causes systemic harm, there is a normative argument that the developer should bear objective responsibility. This approach aims to provide stronger protection for users who lack the technical capacity to assess the code's security. However, the application of strict liability must be formulated carefully to avoid stifling technological innovation.

Normative arguments regarding developer liability for code defects rest on the principles of due professional care and risk distribution. Developers are best positioned to prevent risks through security audits, testing, and code transparency. Therefore, in terms of distributive justice, the burden of risk is more appropriately assigned to those with the greatest control and technical capacity. However, not all smart contracts are developed within a commercial framework; many are open-source and collaborative. In this context, it is difficult to determine who is the sole “producer.” Without a clear organizational structure, the attribution of responsibility becomes blurred and potentially creates new inequities.

Limiting liability in open-source and decentralized systems requires the formulation of proportional normative criteria. It would be unfair to automatically hold every code contributor responsible for all losses incurred. On the other hand, exempting all developers from liability would create moral hazard and weaken legal protection. Therefore, a distinction is needed between core developers with substantive control and minor contributors whose roles are limited. This approach aligns with the principles of proportionality and justice in civil law. Therefore, the construction of liability in the blockchain ecosystem must be layered, integrating legal subject theory, fault liability models, and the possibility of strict liability selectively and adaptively to the decentralized nature of the technology.

[35] Alfayum, A., & Alamsyah, M. A. (2025). Hubungan Profesi Dan Profesional Hukum Dalam Menjaga Integritas. *JURNAL ILMIAH NUSANTARA*, *2*(3), 728-738. https://doi.org/10.61722/jinu.v2i3.4602

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In a hybrid system between technological decentralization and service centralization, platforms such as crypto exchanges or marketplaces occupy a strategic position that cannot be viewed as merely neutral facilitators.[36] Although transactions at the blockchain level occur peer-to-peer, access to the crypto ecosystem is practically dependent on platform providers, who provide custodial services, account recording, and the conversion of digital assets to fiat currency. In this context, platforms act as intermediaries, having actual control over user funds and data. Doctrinally, this position creates higher legal obligations than ordinary users, due to the fiduciary-like relationship between the platform and consumers. Therefore, the argument that decentralization eliminates intermediary responsibility is not entirely acceptable in a hybrid system. Precisely because platforms derive economic benefits from these activities, the attribution of responsibility becomes more rational and proportionate.

Platform liability can be tested through the duty of care principle, which has developed in modern civil law. This principle requires every party engaging in risky activities to act with reasonable care to prevent harm to others. In crypto exchanges, the duty of care includes maintaining system security, implementing cybersecurity standards, conducting identity verification (KYC), and providing transparent information regarding transaction risks.[37] If a platform fails to anticipate a hack or fails to patch a known system vulnerability, the element of negligence may be met. In some circumstances, systemic failures can even be interpreted as a breach of professional duty. Thus, a duty of care-based approach provides a strong normative basis for assessing platform liability without denying the inherent nature of blockchain technology.

The link to consumer protection principles further emphasizes the urgency of platform responsibility. Crypto users generally face information asymmetry, both in terms of technical aspects and investment risks. Under consumer protection law, businesses are obligated to provide accurate, clear, and honest information, as well as to guarantee the security of the products or services they offer.[38] Crypto platforms marketing digital investment services cannot escape these obligations by claiming that transactions take place on a decentralized network. Normatively, a consumer protection approach places a greater burden of risk on professional business actors. Therefore, a hybrid system requires integration of civil liability principles and consumer protection regimes to achieve a balance between innovation and user security.

The problem becomes more complex when considering the irreversible nature of blockchain, which technically makes transaction rollback virtually impossible. The immutable nature of the ledger makes every validated transaction permanent and cannot be unilaterally reversed. In conventional contract law, cancellation or rescission is possible in the event of a defect in will, breach of contract, or unlawful act.[39] Restitution mechanisms in traditional systems allow parties to be restored to their original state (restitutio

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in integrum). However, in blockchain, restitution cannot be achieved through system-level transaction cancellations but must instead be achieved through a separate compensation mechanism. This creates a tension between technical certainty and substantive justice in civil law.

A comparison with conventional contract cancellation mechanisms demonstrates the lack of corrective instruments in smart contracts. In traditional systems, judges have the authority to cancel or adjust agreements to maintain balance. In contrast, smart contracts execute automatically without any room for intervention. Therefore, a normative need arises to develop smart contract-based escrow or dispute resolution mechanisms that allow for a "stop point" before final execution. These mechanisms can be designed with multi-signature clauses or digital arbitration integrated into the code. In this way, technological innovation maintains the legal flexibility essential for protecting the rights of the parties.

In both forums and jurisdictions, smart contract disputes face serious challenges to the principle of territoriality of national law. Blockchain is global and not tied to any particular sovereign territory, while positive law remains based on national territorial boundaries.[40] When parties are located in different countries and nodes are spread across multiple jurisdictions, questions arise about which law applies and which court has jurisdiction. Without explicit choice of law and choice of forum clauses, disputes can potentially become entangled in international legal conflicts. This demonstrates that technological decentralization does not eliminate the need for jurisdictional certainty. On the contrary, the more global a system becomes, the more pressing the need for cross-border harmonization of norms becomes.

The potential application of choice of law and choice of forum in smart contracts could be a preventative solution to jurisdictional conflicts. Such clauses could be included in the natural language contract underlying the code, or even integrated into smart contract metadata. However, their effectiveness depends on the recognition and enforcement of judgments in other countries. Therefore, an approach to harmonizing international law, whether through model laws, conventions, or soft law, is relevant to bridging differences in legal systems. Without global coordination, blockchain disputes risk fragmentation and inconsistent rulings. Therefore, the transnational dimension of smart contracts demands a normative response that goes beyond merely national legal frameworks. In conclusion, normative reconstruction is urgently needed to address the normative vacuum in the regulation of smart contracts and blockchain transactions. Prescriptively, legislators can consider special regulations or limited amendments to civil law to recognize the unique characteristics of this technology. The integration of the principles of legal certainty, justice, and utility, as formulated in Radbruch's theory, should be the philosophical foundation of legal reform. Legal certainty is necessary to guarantee the predictability of digital transactions, justice to protect the vulnerable, and utility to support technological innovation. The norms established must be adaptive to decentralization, without sacrificing the principle of accountability. With this approach, the law will not be left behind by technological developments, but rather serve as a guiding instrument, ensuring that digital transformation proceeds within the framework of the fundamental values of the legal system.

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CONCLUSIONS

The lack of norms regarding smart contracts in the Indonesian legal system poses serious problems for legal certainty, particularly in determining the legal standing and constructing the parties' responsibilities in blockchain-based transactions. Conceptually, smart contracts can be positioned as a form of agreement as long as they meet the requirements for a valid agreement under the Civil Code. However, their self-executing, immutable, and decentralized nature creates deviations from the classical construction of contract law, particularly regarding the principles of freedom of contract, good faith, cancellation, and restitution mechanisms. Identification of legal subjects in the blockchain ecosystem reveals the complexity of liability involving users, developers, validators, and platforms across a spectrum of fault-based and potentially strict liability. Anonymity and pseudonymity complicate the proof of fault and causality. Furthermore, the recognition of electronic evidence in the positive legal regime has not explicitly regulated the sui generis character of smart contracts, potentially leading to disparities in judicial interpretation and inconsistent decisions. The challenges of cross-border jurisdiction and the irreversibility of transactions further emphasize that conventional legal instruments have not yet fully adapted to decentralized technology. Therefore, normative reconstruction through the formation of special regulations or limited amendments that integrate the principles of legal certainty, justice, and benefit is an urgent need to ensure that the law is not left behind by technological developments, while also being able to provide proportional protection and guarantee accountability in the blockchain-based digital transaction ecosystem.

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