



Digital Asset Insolvency in the Blockchain Era: A Framework for Bankruptcy Law

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Article Info :

Article history:

Received: July 9, 2026

Revised: August 26, 2026

Accepted: August 27, 2026

Available Online: August 31, 2026

Keywords:

Bankruptcy Law; Blockchain
Technology; Digital Assets



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Abstract

Background: Blockchain-based assets increasingly operate as investment and commercial property, yet their decentralized architecture, pseudonymous control, volatility, and cross-border transferability challenge conventional bankruptcy mechanisms.

Objective: This study examines how digital assets may be treated under insolvency law, identifies legal and operational obstacles to their administration, and develops a Digital Asset Insolvency Framework for Indonesia.

Methods: Using normative legal research, the study combines statutory, conceptual, comparative, and case approaches. Indonesia is assessed against developments in the United Kingdom, Singapore, and the United States across property status, disclosure, control, valuation, liquidation, distribution, and institutional capacity.

Results: Digital assets may be recognized as property and included in a bankruptcy estate where applicable legal doctrine supports their economic value, transferability, identifiability, and effective control. The analysis nevertheless identifies persistent gaps in wallet disclosure, private-key access, ownership verification, valuation timing, liquidation security, and cross-border recovery. The study's novelty lies in an integrated five-pillar framework linking disclosure-based transparency, access-based control, adaptive valuation, secure liquidation and distribution, and institutional capacity. This framework translates comparative legal developments into operational guidance for Indonesian insolvency governance.

Conclusion: A technology-responsive insolvency regime should combine legal recognition with enforceable access, valuation, liquidation, and institutional mechanisms so that digital assets can be administered transparently while protecting creditor equality and asset value.

To cite this article: Valid., Triana, Y., Harahan, I., Pratiwi, R., Syazali, E.A., (2026). Digital Asset Insolvency in the Blockchain Era: A Framework for Bankruptcy Law. *Journal of Law & Social Politics*, 4 (4), 556-575.
<https://doi.org/10.59261/jlsp.v4i4.173>

INTRODUCTION

The development of information and communication technology has brought fundamental changes to the ways in which society creates, stores, transfers, and utilizes wealth. The massive digital transformation that has occurred over the past two decades has generated new forms of economic activity that were previously unknown within traditional legal systems. Amid these developments, various forms of wealth whose existence depends on digital technology have

556 | Journal of Law & Social Politics

emerged, one of which is the category of digital assets. The existence of digital assets demonstrates that the concept of wealth in modern society is no longer limited to physically tangible objects but also encompasses various rights and economic values existing within electronic systems ([Green, 2019](#); [MAYDANYK, 2025](#)).

For bankruptcy law, the significance of blockchain lies not in the technology itself but in the way it separates legal entitlement from practical control. A debtor may hold economically valuable cryptoassets while access depends on a private key, a custody arrangement, or an exchange account; this immediately raises questions concerning inclusion in the bankruptcy estate, proof of ownership, control by the insolvency administrator, valuation, and liquidation.

The development of digital assets has also occurred significantly in Indonesia. State recognition of cryptoassets as commodities that may be traded through futures exchanges has contributed to the substantial growth of digital asset investors in recent years. Policies issued by the Commodity Futures Trading Supervisory Agency (Bappebti) indicate that the Indonesian government has, in principle, recognized cryptoassets as objects possessing economic value and capable of forming part of national commercial activities ([Komoditi, 2024](#)). The increasing number of cryptoasset users in Indonesia, which has reached tens of millions, demonstrates that digital assets have become an integral component of economic life and can no longer be regarded as a marginal phenomenon. At the same time, the legal materials reviewed do not provide a consolidated official dataset identifying Indonesian bankruptcy proceedings in which cryptoassets were administered as estate property. This evidentiary gap is itself relevant to legal reform because it limits consistency in judicial and professional practice.

These developments have simultaneously generated various new legal issues. One issue receiving considerable attention in many jurisdictions concerns the position of digital assets within property law and bankruptcy law. This issue has become increasingly important because a growing number of individuals and business entities allocate portions of their wealth in the form of digital assets. When such legal subjects experience financial distress and are declared bankrupt, questions arise as to whether their digital assets may be classified as part of the bankruptcy estate and utilized to satisfy creditors' claims.

Within the Indonesian legal system, the fundamental principle of bankruptcy law places all of a debtor's assets as general security for the fulfillment of obligations owed to creditors. This principle is embodied in Article 1131 of the Indonesian Civil Code, which provides that all present and future assets belonging to the debtor constitute security for all obligations. The same principle is reaffirmed in Article 21 of Law Number 37 of 2004 concerning Bankruptcy and Suspension of Debt Payment Obligations, which stipulates that bankruptcy encompasses all assets owned by the debtor at the time the bankruptcy declaration is rendered, together with all assets acquired during the bankruptcy process ([Law Number 37 of 2004 Concerning Bankruptcy and Suspension of Debt Payment Obligations, 2004](#); [Ramadhania, 2023](#)). In practical terms, Article 21 does not answer how a curator should obtain effective control of a self-custody wallet, establish that a pseudonymous blockchain address is beneficially owned or controlled by the debtor, or determine when a highly volatile asset should be valued and liquidated. A workable insolvency regime therefore requires rules that connect the broad concept of the bankruptcy estate with disclosure duties, access orders, documentary and on-chain evidence, custody safeguards, and a documented valuation and disposal strategy.

Nevertheless, neither the Indonesian Civil Code nor Law Number 37 of 2004 explicitly regulates digital assets. This regulatory gap creates legal uncertainty, particularly concerning the status of digital assets as components of the bankruptcy estate, the authority of curators to control digital assets, valuation mechanisms, and procedures for administering digital assets within bankruptcy proceedings.

The issue becomes even more complex because digital assets possess characteristics different from those of conventional assets. Control over digital assets is not necessarily determined by physical possession but rather depends on access to private keys that enable holders to exercise control over such assets. The Law Commission of England and Wales ([2023](#)) explains that these characteristics render digital assets unique and require distinct legal approaches ([L. C. of E. and Wales, 2023](#)). Their decentralized nature, pseudonymous features, price volatility, and cross-border characteristics create new challenges for the application of conventional bankruptcy principles.

In the development of international law, several jurisdictions have begun recognizing digital assets as objects of proprietary rights. The UK Jurisdiction Taskforce, through its Legal Statement on

Cryptoassets and Smart Contracts, concluded that cryptoassets may, in principle, be categorized as property because they possess characteristics enabling them to be owned, controlled, and transferred (Maydanyk, 2024; Taskforce, 2019). A similar position has been adopted by the Law Commission of England and Wales (2023), which proposes that digital assets should be regarded as a distinct category of personal property requiring the development of new legal concepts (L. C. of E. and Wales, 2023).

From the perspective of bankruptcy law, Low and Teo conclude that cryptocurrency may constitute part of the bankruptcy estate because it possesses economic value and can be utilized to satisfy debtors' obligations toward creditors (Haynes, 2022). Meanwhile, Parry and Olivares-Caminal explain that the development of digital assets has generated new challenges for modern insolvency regimes, particularly concerning asset identification, transaction tracing, valuation mechanisms, and control over private keys (Parry & Olivares-Caminal, 2022).

Accordingly, the principal issue in the relationship between digital assets and bankruptcy law no longer concerns whether digital assets possess economic value, but rather whether legal systems are capable of accommodating the unique characteristics inherent in digital assets.

Studies on digital assets have developed significantly in recent years alongside the increasing use of blockchain technology in global economic activities. Most early studies focused on the legal status of cryptoassets as a new form of property within modern legal systems. Fox and Green (2019) explain that the development of cryptoassets has challenged traditional property law concepts because the characteristics of digital assets cannot be fully explained through the categories of tangible property or choses in action recognized under classical property law (Fox & Green, 2019; Haynes, 2022). According to them, such developments require a reconstruction of ownership concepts within modern private law.

Consistent with this perspective, Fairfield introduced the concept of BitProperty, which positions digital assets as objects of property rights possessing characteristics similar to other forms of wealth despite lacking physical existence (Fairfield, 2015; Hamza & Pradana, 2022). The study demonstrates that exclusive control over economic value constitutes the primary element determining the existence of property rights, rather than the physical existence of the owned object itself.

Another study was conducted by Castellucci, who analyzed the legal status of cryptoassets from a comparative law perspective. His findings indicate that various jurisdictions have gradually moved toward recognizing digital assets as objects of property rights, although the regulatory approaches adopted remain diverse (Castellucci, 2020; Low & Hara, 2024). While this study contributes significantly to the development of property law theory, it does not specifically discuss the implications of digital assets within bankruptcy regimes.

In the field of insolvency law, Low and Teo examined the relationship between cryptocurrency and bankruptcy law in Singapore. Their study concluded that cryptocurrency may, in principle, be included in the bankruptcy estate because it possesses economic value and can be used to satisfy obligations owed by debtors to creditors (Low & Teo, 2020; Schwartz et al., 2024). However, the study focuses primarily on the Singaporean legal system and does not address issues concerning trustees' control over digital assets or asset administration mechanisms in developing countries.

A more specific study concerning the relationship between digital assets and insolvency was conducted by Parry and Olivares-Caminal, who examined the treatment of cryptocurrencies in insolvency proceedings. They found that the principal issues in digital asset insolvency do not concern legal recognition itself, but rather ownership identification, transaction tracing, control over private keys, and valuation mechanisms for highly volatile assets (Parry & Olivares-Caminal, 2022). These findings demonstrate that the development of digital assets has generated new challenges that conventional insolvency regimes have not yet fully addressed.

Studies conducted in Indonesia generally focus on consumer protection and the regulation of cryptoasset trading. Research by Yuspin and Wicaksono shows that the development of cryptoasset investment requires stronger legal protection for consumers in order to ensure legal certainty in digital transactions (Yuspin & Wicaksono, 2023). Meanwhile, Aswadi and Mudiparwanto examined cryptoassets as objects of secured transactions and concluded that cryptoassets possess the

characteristics of intangible movable property, making them suitable objects of proprietary legal relations (Aswadi & Mudiparwanto, 2024).

Several previous studies have discussed various aspects related to digital assets and bankruptcy law. Parry and Olivares-Caminal examined the treatment of cryptocurrencies in insolvency proceedings and the various issues emerging in modern bankruptcy practice (Parry & Olivares-Caminal, 2022). Meanwhile, Low and Teo highlighted the relationship between cryptocurrency and bankruptcy law in Singapore by emphasizing issues concerning the recognition and control of digital assets (Schwartz et al., 2024).

From the perspective of property law, Fox and Green (2019) explain how the emergence of cryptoassets challenges traditional classifications in property law and encourages the development of new approaches to modern ownership concepts (Fox & Green, 2019; Haynes, 2022). Similarly, Mik argues that the characteristics of digital assets have shifted the concept of ownership from an object-based approach toward a control-based ownership model (Low & Hara, 2024; Mik, 2020).

Recent research on digital assets has advanced in property law and financial regulation, yet existing studies remain fragmented, focusing mainly on cryptoassets as property, investor protection, or jurisdiction-specific insolvency practices without integrating property theory, bankruptcy law, and comparative legal approaches. This gap is particularly significant in Indonesia, where rapid digital asset ownership has outpaced bankruptcy regulation, while decentralization, private-key control, and price volatility create legal challenges that cannot be adequately addressed through conventional interpretations of existing law.

Based on these gaps, this study offers both theoretical and normative contributions through the development of a Digital Asset Insolvency Framework, a legal reconstruction model that not only positions digital assets as part of the bankruptcy estate but also integrates disclosure, control, valuation, and asset administration within a systematic framework. Unlike previous studies, which tend to be descriptive or confined to specific jurisdictions, this study develops an integrative approach linking modern property theory, the principle of the universal bankruptcy estate, and comparative legal practices as the basis for constructing a regulatory model that is adaptive to the digital economy.

Accordingly, the primary contribution of this study lies in shifting the focus from merely recognizing the legal status of digital assets toward formulating implementable mechanisms within bankruptcy law, an area that remains relatively underexplored in legal scholarship, particularly in the Indonesian context. Read together, the prior literature reveals a progression from property recognition (Fairfield; Fox and Green; Mik), to jurisdiction-specific insolvency treatment (Low and Teo), and then to operational problems of tracing, control, and valuation (Parry & Olivares-Caminal, 2022). The unresolved issue is not another abstract classification of cryptoassets, but an integrated model that links these strands to the powers and duties of Indonesian insolvency actors.

The novelty of this study lies in integrating Responsive Law Theory, Modern Property Theory, and the Universal Bankruptcy Estate through a comparative legal approach to develop a five-pillar Digital Asset Insolvency Framework covering disclosure, control and access, valuation, liquidation and distribution, and institutional capacity. The framework addresses the distinctive characteristics of digital assets, including concealability, private-key dependence, technological complexity, and price volatility, while emphasizing debtor disclosure obligations, curator access, flexible valuation, secure liquidation, and stronger institutional capacity. Accordingly, the study positions bankruptcy law as an adaptive mechanism for managing digital assets within insolvency proceedings and responding to developments in the digital economy.

As the grand theory, this study adopts Responsive Law Theory, developed by Nonet and Selznick. According to Nonet and Selznick, law must possess the capacity to adapt to social change and societal development in order to continue fulfilling its functions of protection, justice, and legal certainty (Bora, 2026; Nonet & Selznick, 1978). The concept of responsive law views law not as a static system but as an instrument that continuously evolves in accordance with the needs of society. In the context of the digital economy, this theory provides a foundation for understanding that the emergence of digital assets as a new form of wealth requires the bankruptcy system to adapt in order to remain relevant to technological developments.

As the middle theory, this study employs Modern Property Theory. Technological advancement has generated various forms of wealth that are no longer dependent upon physical existence. Fairfield argues that economic value, exclusivity of control, and transferability constitute

the principal elements determining the existence of property rights, regardless of whether the object possesses physical form (Fairfield, 2015; Hamza & Pradana, 2022). Consistent with this view, Mik maintains that the emergence of digital assets has shifted the understanding of ownership from an object-based approach toward control-based ownership, in which control over access to an asset becomes more important than physical possession as traditionally recognized in classical property law (Low & Hara, 2024; Mik, 2020). Consequently, digital assets may, in principle, be understood as part of modern property rights.

As the applied theory, this study utilizes the concept of Universal Bankruptcy Estate, which has developed within modern bankruptcy law. Warren and Westbrook (2014) argue that the principal objective of bankruptcy law is to consolidate all assets belonging to the debtor into a collective proceeding in order to ensure equitable distribution among creditors (Rahardja et al., 2026; Warren et al., 2014). Accordingly, the scope of the bankruptcy estate is determined not by the physical nature of an asset but by the existence of economic value attached to that asset. Based on this approach, digital assets possessing economic value may, in principle, be regarded as part of the bankruptcy estate.

METHOD

This study employed a normative legal research approach aimed at analyzing the legal position of digital assets as part of the bankruptcy estate, identifying legal issues arising from insolvency proceedings involving digital assets, and formulating a model for reconstructing Indonesian bankruptcy law in response to developments in the digital economy. Normative legal research was adopted because the focus of the study lay on legal norms, legal principles, legal doctrines, and various concepts developed within property law and bankruptcy law. According to Marzuki, normative legal research is conducted to identify legal rules, legal principles, and legal doctrines in order to address legal issues encountered in society (Marzuki, 2021; Mustafa, 2024). This was exclusively a normative and documentary study; it did not involve an empirical research location, human participants, or research subjects. The objects of analysis were statutes, legal doctrines, judicial decisions, regulatory materials, and scholarly literature.

This study applied several approaches. First, the statutory approach was employed by examining various laws and regulations relevant to the subject matter, including the Indonesian Civil Code, Law Number 37 of 2004 concerning Bankruptcy and Suspension of Debt Payment Obligations, and regulations governing digital assets and cryptoasset trading in Indonesia.

Second, the conceptual approach was used to analyze legal concepts relating to digital assets, property rights, property law, and legal theories associated with bankruptcy and insolvency. This approach was particularly important because the emergence of digital assets had created new forms of wealth that could not yet be fully explained through traditional property law concepts (Hutchinson, 2018; Roselle et al., 2025).

Third, the comparative approach was adopted by comparing the development of digital asset regulation in Indonesia with jurisdictions that had more advanced legal frameworks concerning digital assets and insolvency, particularly the United Kingdom, Singapore, and the United States. Comparative analysis was intended to identify best practices that could serve as references for national legal reform (Husa, 2023; Samuel, 2014). The United Kingdom, Singapore, and the United States were selected because the materials examined showed comparatively developed judicial, doctrinal, or insolvency responses to digital assets and provided distinct models for evaluating property recognition, court-led adaptation, and estate administration. Their treatment was used functionally rather than as a basis for direct legal transplantation.

Fourth, the case approach was employed through the examination of legal developments and judicial decisions relating to the recognition of digital assets as objects of property rights and as components of insolvency estates in several jurisdictions. This approach enabled an understanding of how legal norms were applied in practice and how legal systems responded to technological developments (Marzuki, 2021; Mustafa, 2024). Judicial decisions were selected when they directly addressed at least one issue material to the research questions, including proprietary status, custody or control, estate ownership, creditor entitlement, asset recovery, or insolvency administration involving digital assets.

This study employed primary, secondary, and tertiary legal materials, including legislation,

international legal instruments, books, journal articles, research findings, legal dictionaries, and other relevant academic sources. The materials were collected through library research in printed and electronic forms and organized using a legal-document analysis matrix to identify applicable norms, legal characterizations of digital assets, regulatory or judicial reasoning, operational insolvency issues, and relevant lessons for Indonesia. The materials were analyzed qualitatively through legal interpretation, legal argumentation, deductive reasoning, and comparative analysis by examining Indonesian bankruptcy rules, comparing foreign legal mechanisms across key dimensions such as asset status, disclosure, control, valuation, liquidation, cross-border cooperation, and institutional capacity, and assessing their compatibility with Indonesian bankruptcy law. This approach was used to formulate a comprehensive legal framework for recognizing and administering digital assets within the bankruptcy estate and to propose regulatory reforms responsive to developments in the digital economy.

RESULTS AND DISCUSSION

Results

Reconceptualizing Digital Assets as Objects of Modern Property Rights: From Abstract Objects to Insolvency Assets

The development of blockchain technology has transformed the concept of wealth within modern legal systems. Traditionally, property law has been closely associated with objects possessing physical existence and capable of being directly controlled by their owners. However, the emergence of digital assets demonstrates that economic value is no longer exclusively attached to tangible objects. Digital assets represent a new form of wealth that exists within electronic systems and derives its value from the ability to be controlled, transferred, and utilized in economic transactions.

The emergence of blockchain technology has fundamentally altered conventional notions of ownership and control. According to De Filippi and Wright, blockchain technology ultimately creates a new governance structure that enables the distribution of trust without dependence on centralized institutions (De Filippi et al., 2024; De Filippi & Wright, 2018). Consequently, ownership relationships in blockchain-based systems are determined not solely by institutional recognition but also by technological control over digital assets.

From the perspective of property law, these developments challenge traditional classifications that distinguish property according to physical characteristics. Fairfield argues that the essence of property rights lies not in the material existence of an object but in the existence of economic value, exclusivity, and transferability. Therefore, digital assets may theoretically satisfy the requirements necessary to qualify as objects of property rights despite lacking physical form (Fairfield, 2015; Hamza & Pradana, 2022).

Similarly, Fox and Green explain that cryptoassets have characteristics enabling them to function as proprietary objects because they may be controlled, transferred, and possess economic value. In their view, technological developments have necessitated the expansion of property law concepts beyond the traditional categories that have historically dominated common law systems (Fox & Green, 2019; Haynes, 2022).

The same view is expressed by Mik, who argues that digital assets have shifted the concept of ownership from an object-based model toward a control-based model (Low & Hara, 2024; Mik, 2020). In the context of blockchain systems, effective control over an asset is generally exercised through possession of the relevant private keys. Accordingly, practical control over digital assets is determined more by the ability to access and control the asset than by physical possession as recognized in conventional property law.

Giancaspro further explains that blockchain technology has generated a new form of digital scarcity that enables digital assets to acquire exclusivity characteristics similar to those associated with conventional property rights. Through cryptographic mechanisms and consensus protocols, blockchain technology prevents double-spending and enables digital assets to maintain distinct records of ownership and transfer, thereby allowing such assets to possess characteristics of uniqueness and economic value comparable, in certain respects, to those of tangible assets (Giancaspro, 2017; Pronina & Buyanov, 2023).

From a broader perspective, Reed emphasizes that technological developments have gradually expanded the legal concept of property beyond physical objects. According to Reed,

modern legal systems increasingly recognize that property rights are essentially legal relationships concerning value and control rather than relationships limited to tangible things (Reed, 2012; Spinello, 2026).

These theoretical developments have also influenced legal practice in several jurisdictions. In the United Kingdom, the UK Jurisdiction Taskforce issued the Legal Statement on Cryptoassets and Smart Contracts, which concluded that cryptoassets may, in principle, be treated as objects of property rights (L. C. of E. and Wales, 2023). According to the report, cryptoassets possess the characteristics necessary to constitute property because they are identifiable, capable of being controlled, and transferable.

Subsequently, the Law Commission of England and Wales introduced a more progressive approach by proposing digital assets as a third category of personal property, distinct from the traditional classifications of things in possession and things in action. This approach demonstrates that digital assets should not necessarily be forced into conventional legal categories but instead may require the development of new conceptual frameworks compatible with technological developments.

The recognition of digital assets as objects of property rights has significant implications for bankruptcy law. In modern insolvency systems, the scope of the bankruptcy estate is fundamentally determined by the existence of economic value and the debtor's legal or proprietary interest in an asset rather than by the physical characteristics of the asset (Maydanyk, 2024; Taskforce, 2019). Therefore, once digital assets are recognized as objects of property rights, they may theoretically become part of the debtor's assets and consequently fall within the scope of the bankruptcy estate.

This approach is consistent with developments in modern property law, which increasingly emphasize economic value and effective control rather than physical existence. Accordingly, the intangible nature of digital assets should not constitute grounds for excluding such assets from the scope of the bankruptcy estate.

Thus, the transformation of property law concepts resulting from technological developments demonstrates that digital assets have evolved from abstract technological constructs into legally recognized economic assets. Consequently, the recognition of digital assets as part of the bankruptcy estate represents a logical extension of the evolution of modern property law and the principle of universality that underlies contemporary insolvency systems.

The Status of Digital Assets as Part of the Bankruptcy Estate under Indonesian Law

Bankruptcy law is fundamentally built upon the principle that all assets belonging to the debtor constitute the general security for the satisfaction of creditors' claims. This principle has long been recognized within the Indonesian civil law system through Article 1131 of the Indonesian Civil Code, which provides that all property owned by the debtor, whether movable or immovable, whether existing at present or to be acquired in the future, constitutes security for all of the debtor's personal obligations. This provision reflects Indonesia's adoption of the principle of universality of assets (general security principle), whereby the entirety of a debtor's assets serves as the source for the repayment of debts owed to creditors (Setyomurni, 2026; Subekti, 1999).

This principle is further elaborated under Law Number 37 of 2004 concerning Bankruptcy and Suspension of Debt Payment Obligations. Article 21 of the Bankruptcy Law expressly stipulates that the bankruptcy estate comprises all assets owned by the debtor at the time the bankruptcy declaration is rendered, together with all assets acquired during the course of the bankruptcy proceedings. The wording of this provision demonstrates that the legislature adopted a broad approach in defining the scope of the bankruptcy estate. Consequently, Indonesian positive law does not, in principle, restrict particular categories of assets from being included as part of the bankruptcy estate (Deviana & Gunadi, 2025; Law Number 37 of 2004 Concerning Bankruptcy and Suspension of Debt Payment Obligations, 2004).

The notion that all of the debtor's assets should form part of the bankruptcy estate is consistent with the development of modern insolvency law. According to Warren and Westbrook, one of the principal objectives of bankruptcy law is to consolidate all of the debtor's assets within a single collective mechanism to ensure an equitable distribution among creditors (Rahardja et al., 2026; Warren et al., 2014). Accordingly, the scope of the bankruptcy estate is not determined by the physical form of an asset, but rather by the economic value inherent in that asset.

From a doctrinal perspective, Sutan Remy Sjahdeini explains that the essence of bankruptcy lies in the imposition of a general attachment over all assets belonging to the debtor, the administration and liquidation of which are carried out by a curator (insolvency administrator) under the supervision of the supervisory judge (Sjahdeni, 2011; Umaternate & Lie, 2026). Accordingly, the primary objective of bankruptcy is not to punish the debtor, but rather to ensure the fair distribution of the debtor's assets among creditors based on the principle of *paritas creditorum*.

The principle of *paritas creditorum* constitutes one of the fundamental principles of bankruptcy law, placing all creditors in an equal legal position with respect to the debtor's assets unless otherwise provided by law. According to Goode, this principle represents one of the defining characteristics of modern insolvency law because it guarantees the proportional distribution of the debtor's assets while preventing unilateral actions by individual creditors (Goode, 2018; Steffek, 2026). Accordingly, any asset possessing economic value should, as a matter of principle, not be excluded from the bankruptcy estate where such exclusion would prejudice the interests of other creditors.

In the development of modern insolvency law, the concept of the universal bankruptcy estate occupies a central position. Warren and Westbrook explain that the primary objective of bankruptcy law is to consolidate all the debtor's assets into a single collective proceeding to ensure an equitable distribution among creditors (Rahardja et al., 2026; Warren et al., 2014). Accordingly, the scope of the bankruptcy estate is determined not by the physical nature of an asset, but by the economic value inherent in that asset.

The expansion of the digital economy has resulted in the emergence of various forms of intangible assets possessing significant economic value. Modern legal systems have long recognized that different forms of intangible property may constitute part of a debtor's estate in insolvency proceedings. Fletcher observes that the concept of property within insolvency law has evolved dynamically in response to economic development and is no longer confined to assets having a tangible physical existence. (Fletcher, 2017; Poon et al., 2022) Likewise, Goode argues that the modern concept of property has expanded alongside the emergence of new economic instruments that do not necessarily possess a physical form (Baskind & Osborne, 2025; Goode, 2016). Consequently, the intangible nature of digital assets should not constitute a valid legal basis for excluding such assets from the scope of the bankruptcy estate.

This view is consistent with developments in international insolvency law. Parry and Olivares-Caminal observe that an increasing number of jurisdictions have begun recognizing cryptoassets as part of the insolvency estate because such assets possess economic value and are capable of being transferred to other parties (Parry & Olivares-Caminal, 2022). According to these authors, the principal challenge in digital asset insolvency no longer concerns the legal recognition of digital assets as property, but rather the mechanisms for their identification, control, and administration during insolvency proceedings.

Parry and Olivares-Caminal further contend that the contemporary legal issues surrounding digital asset insolvency are no longer centered on whether such assets possess economic value, but instead on how they can be effectively identified, controlled, and distributed within insolvency proceedings (Parry & Olivares-Caminal, 2022).

Within the Indonesian legal framework, the phrase "all assets of the debtor," as stipulated in Article 21 of the Bankruptcy Law, provides a sufficiently broad basis for interpreting digital assets as forming part of the bankruptcy estate. Such an interpretation is also consistent with the evolution of modern property law, which places greater emphasis on the economic value of an asset and its transferability rather than on the physical existence of the object itself.

In addition to the principle of universality of assets, modern insolvency law also embraces the concept of collective proceedings, namely, a debt-resolution mechanism whereby all of the debtor's assets are consolidated into a single bankruptcy estate for collective administration. According to Fletcher, this approach is intended to prevent individual enforcement actions by creditors that could undermine the principle of fairness in the distribution of the debtor's assets. (Fletcher, 2017; Poon et al., 2022) Accordingly, the bankruptcy estate serves not only as an instrument for satisfying creditors' claims but also as a mechanism for ensuring the equitable and proportional distribution of the debtor's assets.

Within the United States legal system, this principle is reflected in Section 541 of the United States Bankruptcy Code, which provides that the property of the estate includes all legal or equitable

interests held by the debtor at the commencement of the bankruptcy case ([Feibelman, 2022](#); [United States Bankruptcy Code, 11 U.S.C. § 541 \(Property of the Estate\), 1978](#)).

This provision demonstrates that modern bankruptcy law does not limit the bankruptcy estate solely to tangible property but also encompasses various forms of intangible assets possessing economic value.

Furthermore, United States bankruptcy law recognizes the doctrine of after-acquired property, whereby, under specified circumstances, assets acquired by the debtor after the commencement of bankruptcy proceedings may also become part of the bankruptcy estate. According to Warren and Westbrook, this doctrine reflects the fundamental objective of bankruptcy law, namely, to maximize the value of the assets available for distribution among creditors ([Rahardja et al., 2026](#); [Warren et al., 2014](#)). Consequently, the concept of the universal bankruptcy estate continues to evolve in response to the changing dynamics of modern economic activities.

A similar development can be observed in the United Kingdom. In its *Digital Assets: Final Report* (2023), the Law Commission of England and Wales concluded that digital assets possess characteristics that enable them to be recognized as objects of property rights and, therefore, to constitute part of a person's property ([L. C. of E. and Wales, 2023](#)). This recognition carries significant implications for insolvency law because, as a matter of principle, all proprietary rights belonging to the debtor may be included within the insolvency estate.

Singapore has likewise adopted a progressive approach toward the legal recognition of digital assets. The decision in *B2C2 Ltd v Quoine Pte Ltd* (2019) SGCA(I) 03 illustrates the willingness of Singaporean courts to recognize digital assets as property possessing economic value and capable of forming the subject matter of legal rights and obligations ([Cassar, 2023](#); *B2C2 Ltd v Quoine Pte Ltd*, 2019). Although the case did not directly concern bankruptcy proceedings, judicial recognition of the legal status of digital assets provides an important legal foundation for their potential inclusion within the bankruptcy estate.

The foregoing comparative analysis demonstrates that international legal developments generally favor an expanded interpretation of the insolvency estate in response to the emergence of new forms of wealth. Accordingly, the approach adopted under Article 21 of Law Number 37 of 2004 concerning Bankruptcy and Suspension of Debt Payment Obligations is, in fact, sufficiently flexible to accommodate digital assets without requiring any alteration to the fundamental principles of Indonesian bankruptcy law.

Accordingly, developments in international insolvency law demonstrate that the fundamental issue is no longer whether digital assets should be recognized as part of a debtor's estate, but rather whether the legal system is capable of providing effective mechanisms for administering such assets throughout bankruptcy proceedings. This development indicates that Article 21 of Law Number 37 of 2004 concerning Bankruptcy and Suspension of Debt Payment Obligations may, as a matter of legal interpretation, accommodate digital assets as part of the bankruptcy estate.

Nevertheless, although Indonesian positive law adopts a broad approach to defining the scope of the bankruptcy estate under Article 21 of the Bankruptcy Law, the practical application of this provision to digital assets continues to encounter a number of structural challenges.

First, the identification of digital assets reveals a fundamental gap between a registration-based legal system and the pseudonymous architecture of blockchain technology. Low and Teo observe that one of the principal challenges in cryptocurrency insolvency lies in the difficulty of linking blockchain addresses to the legal identity of their owners ([Low & Teo, 2020](#); [Schwartz et al., 2024](#)). This situation demonstrates that conventional identification mechanisms employed in bankruptcy proceedings are no longer sufficient to capture assets existing within decentralized technological environments.

Second, the administration of digital assets reflects a fundamental shift from a possession-based system to an access-based system. Within this framework, the private key functions as the primary instrument of control, effectively replacing the traditional notion of physical possession. Fox and Green argue that control over a private key constitutes the decisive form of factual control determining the effective exercise of proprietary rights over cryptoassets ([Fox & Green, 2019](#); [Haynes, 2022](#)). Consequently, where an insolvency administrator fails to obtain access to the relevant

private key, the digital asset cannot, in practical terms, be effectively controlled or realized, notwithstanding that it legally forms part of the bankruptcy estate.

Third, the extreme price volatility of digital assets creates considerable uncertainty in valuation processes. Parry and Olivares-Caminal explain that substantial fluctuations in cryptocurrency prices may significantly affect the level of recovery available to creditors depending upon the timing of valuation (Parry & Olivares-Caminal, 2022). Accordingly, this circumstance necessitates a valuation methodology that is not rigid but sufficiently adaptive to reflect the dynamic conditions of digital asset markets.

Fourth, the inherently cross-border nature of digital assets complicates the application of the traditional principle of territoriality in insolvency law. Fletcher argues that economic globalization has created an increasing need for cross-border coordination in contemporary insolvency proceedings. (Fletcher, 2017; Poon et al., 2022) In the context of digital assets, this challenge becomes even more complex because the location of such assets cannot necessarily be determined by reference to any physical jurisdiction.

These four structural challenges demonstrate the existence of an inherent tension between conventional bankruptcy rules and the technology-driven characteristics of digital assets. Accordingly, a reconstructive legal approach is required one that not only expands the interpretation of existing bankruptcy norms but also develops practical implementation mechanisms specifically designed to accommodate the distinctive characteristics of digital assets within contemporary insolvency proceedings.

Challenges Faced by Insolvency Administrators in the Control and Administration of Digital Assets in Bankruptcy Proceedings

The recognition of digital assets as part of the bankruptcy estate does not, in itself, resolve all the practical issues arising in bankruptcy proceedings. Unlike conventional assets, which generally possess a physical existence or are recorded within established administrative systems, digital assets exhibit distinctive characteristics that render their identification, control, and administration considerably more complex. Consequently, the emergence of digital assets presents new challenges for insolvency administrators, who bear responsibility for the administration and liquidation of the bankruptcy estate (Deviana & Gunadi, 2025; Law Number 37 of 2004 Concerning Bankruptcy and Suspension of Debt Payment Obligations, 2004).

The first challenge concerns the identification of digital assets owned by the debtor. In conventional bankruptcy proceedings, an insolvency administrator may trace bank accounts, land certificates, motor vehicles, and other assets through official documentation or competent authorities. Digital assets recorded on blockchain networks, however, cannot always be readily identified because their existence does not depend upon any centralized institution. The pseudonymous nature of blockchain transactions further complicates the identification process in comparison with conventional assets. Low and Teo observe that one of the principal challenges in cryptocurrency insolvency lies in the difficulty of linking blockchain addresses to the true legal identity of their owners (Low & Teo, 2020; Schwartz et al., 2024). This circumstance may significantly hinder the effective collection of the bankruptcy estate by the insolvency administrator.

Furthermore, access to digital assets is generally determined by control over the private key. Within blockchain systems, the loss of a private key may result in the permanent loss of access to the asset, notwithstanding that the economic ownership of the asset remains vested in the debtor. Fox and Green explain that control over the private key performs a function that is, in practical terms, equivalent to physical possession under the traditional law of property (Fox & Green, 2019; Haynes, 2022). Accordingly, the administration of digital assets in bankruptcy is concerned not merely with the legal recognition of ownership rights, but equally with the technical capability to obtain effective access to the relevant assets.

In the context of digital assets, control over the private key effectively replaces the conventional notion of physical possession. As Fox and Green further observe, the ability to access a digital asset ultimately determines the practical effectiveness of the proprietary rights associated with that asset. Consequently, the loss of access to the private key may render the liquidation of a digital asset impossible, even though the debtor's legal ownership remains intact.

Another significant issue concerns the proof of ownership. Not all digital assets are held through cryptocurrency exchanges or custodial service providers capable of verifying the identity of

their owners. A considerable proportion of digital assets are maintained in self-custody wallets, where proof of control and ownership depends largely upon the electronic data and credentials possessed by the debtor. According to Mik, this characteristic demonstrates that legal relationships concerning digital assets are fundamentally based on control over access, rather than physical possession as traditionally recognized under property law (Low & Hara, 2024; Mik, 2020).

In addition to the challenges of identification and control, the extreme price volatility of digital assets presents a further obstacle in the administration and liquidation of the bankruptcy estate. Unlike conventional assets, whose market values tend to remain relatively stable, the value of digital assets may fluctuate dramatically within a very short period. Parry and Olivares-Caminal observe that such volatility makes the determination of the appropriate valuation date one of the most critical issues in insolvency proceedings involving digital assets (Parry & Olivares-Caminal, 2022). Different valuation dates may produce substantially different values for the bankruptcy estate, thereby directly affecting the level of recovery available to creditors.

Furthermore, the absence of comprehensive technical guidelines governing the valuation of digital assets creates additional legal uncertainty in practice. Under certain circumstances, extreme market fluctuations may generate conflicting interests among the debtor, the insolvency administrator, and creditors regarding the most appropriate timing for the liquidation of digital assets.

The administration of digital assets is further complicated by the decentralized architecture of blockchain technology. Unlike conventional financial systems, which rely upon intermediary institutions, blockchain networks generally operate without a single central authority capable of unilaterally controlling or freezing transactions. Paech explains that the governance structure of blockchain networks is founded upon distributed consensus mechanisms, with no central entity exercising authority comparable to that found within traditional financial systems (Paech, 2017; Wu et al., 2024). Consequently, many of the methods conventionally employed in the administration of tangible assets cannot be effectively applied to digital assets.

Beyond the issue of decentralization, insolvency administrators also encounter significant challenges in tracing and verifying digital asset transactions. Although transactions recorded on a blockchain may be publicly and immutably recorded, the identities of the parties involved are not always directly ascertainable. Arner, Barberis, and Buckley argue that developments in financial technology have transformed regulatory paradigms from institution-based supervision toward data-driven regulation (Arner et al., 2017; Casey, 2026). Accordingly, the effective administration of digital assets in bankruptcy proceedings increasingly depends upon the availability of digital forensic technologies capable of linking blockchain transaction data with the legal identities of the relevant parties.

In international practice, blockchain analytics has emerged as an important tool for tracing digital assets. Such technology enables the identification of transaction patterns, relationships between blockchain addresses, and potential transfers of assets undertaken prior to the commencement of bankruptcy proceedings. The growing use of blockchain analytics demonstrates that the effective administration of the bankruptcy estate in the digital era depends not only upon the quality of legal rules but also upon the institutional capacity to utilize advanced technological tools in insolvency administration.

Another significant challenge arises from the cross-border nature of digital asset transactions. Fletcher explains that globalization has increasingly caused modern insolvency proceedings to involve multiple jurisdictions, making cross-border coordination an unavoidable necessity. (Briggs, 2023; Fletcher, 2005) In the context of digital assets, this issue becomes considerably more complex because the physical location of such assets is often impossible to determine with certainty.

The cross-border characteristics of digital assets consequently enhance the relevance of the cross-border insolvency regime. Through the *Model Law on Cross-Border Insolvency*, UNCITRAL emphasizes the importance of cooperation among competent authorities and the mutual recognition of insolvency proceedings across jurisdictions (Law, 2014; UNITED, 2023). Although the Model Law does not specifically regulate digital assets, its underlying principles provide an important normative foundation for the future development of legal mechanisms governing digital asset insolvency.

In addition, the existence of Digital Asset Service Providers (DASPs) including cryptocurrency exchanges, digital custodians, and electronic trading platforms plays a crucial role in assisting insolvency administrators in identifying digital assets belonging to debtors. Accordingly, a more structured framework for cooperation between insolvency administrators and digital asset service providers is required to ensure the effective protection of creditors' interests.

Zetzsche, Buckley, Arner, and Barberis argue that the rapid evolution of financial technology ultimately requires a transformation of regulatory systems through the adoption of RegTech and SupTech as supporting regulatory instruments (Yan, 2025; Zetzsche et al., 2018). This approach demonstrates that the effectiveness of law in the digital era depends not only upon the existence of legal rules, but also upon the institutional capacity to utilize technology efficiently and effectively.

The continuing evolution of financial technology further illustrates that regulatory effectiveness in the digital economy is determined not merely by the quality of legal norms but also by the ability of regulatory institutions to harness technological innovation. According to Zetzsche, Buckley, Arner, and Barberis, the transformation of supervisory systems through the implementation of RegTech and SupTech represents one of the inevitable consequences of the emergence of the data-driven economy (Yan, 2025; Zetzsche et al., 2018).

Discussion

Accordingly, the challenges encountered by insolvency administrators in administering and liquidating digital assets extend beyond purely legal issues. They encompass technological capability, institutional preparedness, and international cooperation. Strengthening the professional capacity of insolvency administrators while simultaneously establishing effective mechanisms for inter-agency and cross-border coordination therefore constitutes an essential prerequisite for ensuring the effectiveness of bankruptcy law in the digital economy.

Comparative Regulation of Digital Assets under the Insolvency Laws of the United Kingdom, Singapore, and the United States

The rapid development of digital assets has prompted numerous jurisdictions to adapt their legal systems, including their insolvency regimes. Although no uniform regulatory model has yet emerged, several countries have demonstrated a clear tendency to recognize digital assets as a form of property capable of becoming the subject of insolvency proceedings. The United Kingdom and Singapore are among the jurisdictions that have responded most progressively to these developments.

United Kingdom

Within the United Kingdom legal system, the recognition of digital assets has largely been driven by judicial developments and the evolution of legal doctrine rather than by the enactment of new legislation. One of the most significant milestones was the publication of the Legal Statement on Cryptoassets and Smart Contracts by the UK Jurisdiction Taskforce in 2019, which concluded that cryptoassets are, in principle, capable of being recognized as objects of property rights (Maydanyk, 2024; Taskforce, 2019).

This position was subsequently reinforced in *AA v Persons Unknown* (2019) EWHC 3556 (Comm), in which the High Court of England and Wales recognized that Bitcoin constitutes a form of property entitled to legal protection (*AA v Persons Unknown & Ors, Re Bitcoin*, 2019). The decision illustrates the evolutionary approach adopted by the English legal system, whereby traditional legal concepts are progressively adapted to accommodate technological innovation.

A more significant development occurred with the publication of Digital Assets: Final Report by the Law Commission of England and Wales in 2023. The Report concludes that digital assets are capable of being objects of personal property rights and may fall within a third category of personal property, existing outside the traditional classifications of things in possession and things in action (L. C. of E. and Wales, 2023). This approach demonstrates that English law no longer attempts to force digital assets into existing legal categories but instead develops a conceptual framework that more accurately reflects the distinctive characteristics of digital technology. This doctrinal trajectory is also reflected in litigation concerning control and duties in blockchain networks, including *Tulip Trading Ltd v Bitcoin Association* (2023) EWCA Civ 83.

In light of this recognition, digital assets owned by a debtor may, in principle, form part of the insolvency estate, provided that they satisfy the applicable legal requirements for property rights and possess identifiable economic value.

Singapore

Unlike the United Kingdom, which places greater emphasis on the development of property law doctrine, Singapore has adopted a pragmatic approach that relies in part upon the active role of the judiciary in addressing emerging legal issues and legislative gaps. One of the landmark decisions is *B2C2 Ltd v Quoine Pte Ltd* (2019) SGCA(I) 03, in which the Singapore courts acknowledged the legal significance of digital assets within commercial legal relationships (Cassar, 2023; *B2C2 Ltd v Quoine Pte Ltd*, 2019).

Furthermore, in *CLM v CLN and Others* (2022) SGHC 46, the Singapore High Court held that cryptoassets are capable of constituting property and may therefore be protected through a proprietary injunction (*CLM v CLN and Others*, 2022). This decision demonstrates that Singaporean courts have accepted the proposition that digital assets possess proprietary characteristics notwithstanding their lack of physical form.

The foregoing decision demonstrates that Singaporean courts have accepted the proposition that digital assets possess proprietary characteristics notwithstanding their lack of physical form. According to Low and Teo, these judicial developments provide a strong legal foundation for the inclusion of digital assets within the bankruptcy estate under Singaporean insolvency law (Low & Teo, 2020; Schwartz et al., 2024).

Although Singapore has not yet enacted specific legislation governing the insolvency of digital assets, the flexibility inherent in the common law system enables courts to adapt established legal principles to technological developments. The Singaporean approach illustrates that legal certainty does not necessarily require the enactment of new legislation; rather, it may evolve through progressive judicial decisions that respond adaptively to social and technological change. The broader corporate and insolvency context also operates alongside Singapore's Companies Act 1967, although the digital asset issues discussed here have developed primarily through judicial interpretation (Dignam & Lowry, 2022; Companies Act 1967, 1967).

United States

Compared with the United Kingdom and Singapore, which have primarily developed the legal recognition of digital assets through judicial decisions and legal doctrine, the United States adopts a more pragmatic approach grounded in its well-established bankruptcy system. The principal legal basis is found in Section 541 of the United States Bankruptcy Code, which provides that the property of the estate includes all legal or equitable interests of the debtor in property as of the commencement of the bankruptcy case (Feibelman, 2022; United States Bankruptcy Code, 11 U.S.C. § 541 (Property of the Estate), 1978).

The broad wording of this provision enables a wide range of intangible assets to be included within the bankruptcy estate. Warren and Westbrook explain that the concept of property of the estate under the United States bankruptcy system is designed to maximize the value of the debtor's assets for the collective benefit of creditors through a unified insolvency process (Rahardja et al., 2026; Warren et al., 2014). Accordingly, the intangible nature of an asset does not, in itself, constitute a legal basis for excluding it from the bankruptcy estate.

Developments within the United States digital asset industry further demonstrate that this principle has also been applied to cryptoassets. One of the most significant examples is the bankruptcy of FTX Trading Ltd. in 2022, which became one of the largest insolvency cases in the history of the digital asset industry. In those proceedings, digital assets held by the debtor and claims concerning customer assets constituted central components of the identification, recovery, and administration of the bankruptcy estate (*In re FTX Trading Ltd.*, 2022).

In addition to FTX, the bankruptcy of Celsius Network LLC illustrates the complexity encountered by courts in determining the legal status of digital assets held through cryptocurrency service platforms. In its decision, the United States Bankruptcy Court for the Southern District of New York held that certain digital assets deposited in the Earn Program formed part of the company's bankruptcy estate pursuant to the contractual terms agreed upon by the parties (*In re Celsius*

Network LLC, 2023). The decision demonstrates that contractual arrangements can play a decisive role in determining the legal status of digital assets in insolvency proceedings.

The Voyager Digital Holdings Inc. bankruptcy proceedings further demonstrate that fluctuations in the value of digital assets may significantly influence both corporate restructuring and the distribution of assets to creditors. In practice, United States bankruptcy courts have adopted a flexible approach aimed at safeguarding creditors' interests while simultaneously preserving the economic value of the debtor's digital assets (*In re Voyager Digital Holdings, Inc., 2022*).

According to Parry and Olivares-Caminal, these developments indicate that the principal issue in digital asset insolvency no longer concerns the legal recognition of digital assets as property. Rather, the central challenge lies in establishing effective mechanisms for the administration, valuation, and distribution of digital assets within insolvency proceedings (Parry & Olivares-Caminal, 2022). In other words, contemporary insolvency law has evolved beyond the stage of conceptual recognition toward the practical implementation and administration of digital assets.

The United States approach demonstrates that the flexibility of a legal system plays a crucial role in responding to technological innovation. Although no specific legislation governing digital asset insolvency has yet been enacted, the existing bankruptcy framework has proven sufficiently adaptable to accommodate emerging forms of digital property through progressive judicial interpretation and a creditor-oriented approach.

Implications of the Comparative Analysis for Indonesia

The comparative analysis of the legal frameworks of the United Kingdom, Singapore, and the United States demonstrates that the development of digital asset law does not necessarily depend upon the enactment of entirely new legislation. These jurisdictions illustrate that existing legal systems remain capable of accommodating new forms of property through adaptive interpretation, the evolution of legal doctrine, and the active role of judicial institutions (Fox & Green, 2019; Haynes, 2022).

From the perspective of comparative law, the primary objective of comparative legal analysis is not merely to identify differences among jurisdictions, but rather to understand how different legal systems resolve similar legal issues through distinct legal approaches. According to Michaels, the comparative method serves to identify solutions that are most appropriate for the legal, social, and institutional conditions of each jurisdiction, rather than encouraging the mechanical transplantation of foreign legal rules (De Cruz, 2024; Michaels, 2006). Accordingly, the reform of Indonesian bankruptcy law should not consist of replicating foreign legal models in their entirety.

The experience of the United Kingdom demonstrates the importance of developing property law concepts capable of accommodating the unique characteristics of digital assets. Singapore illustrates how judicial flexibility may effectively fill legislative gaps without waiting for statutory reform. Meanwhile, the United States provides valuable lessons regarding the importance of practical implementation mechanisms and robust protection of creditors' interests in insolvency proceedings involving digital assets. In comparative terms, the United Kingdom contributes doctrinal clarification of digital property, Singapore demonstrates judicial adaptation through proprietary remedies, and the United States illustrates the operational administration of digital assets within a broad statutory estate. The proposed Indonesian framework differs from these jurisdiction-specific responses by integrating these functions into a single sequence of disclosure, control, valuation, liquidation and distribution, and institutional capacity-building, while retaining Article 21 as the domestic normative entry point.

A common feature emerging from these three jurisdictions is that the principal challenge in digital asset insolvency no longer concerns the legal recognition of digital assets as property, but rather the practical implementation of insolvency law. International legal developments generally indicate that digital assets have increasingly been accepted as a form of property, while the principal legal challenges concern their identification, control, valuation, and distribution throughout insolvency proceedings (Parry & Olivares-Caminal, 2022).

For Indonesia, these comparative developments demonstrate that Law Number 37 of 2004 concerning Bankruptcy and Suspension of Debt Payment Obligations retains sufficient flexibility to accommodate digital assets through the phrase "all assets of the debtor" contained in Article 21. Accordingly, the most pressing need is not the wholesale replacement of the existing bankruptcy

regime, but rather the development of legal mechanisms capable of addressing the distinctive characteristics of digital assets.

Moreover, direct legal transplantation from foreign jurisdictions must be approached with caution. Watson explains that the success of any legal transplant depends largely upon the compatibility of the transplanted legal norms with the social, economic, and institutional conditions of the receiving jurisdiction (Siems, 2026; Watson, 1993). Consequently, future reform of Indonesian bankruptcy law should take into account the characteristics of the national legal system, the professional capacity of insolvency administrators, the institutional readiness of the judiciary, and the continuing development of Indonesia's digital asset ecosystem.

Based on the foregoing comparative analysis, this study argues that Indonesia requires a model of legal reconstruction that extends beyond substantive legal reform to encompass institutional capacity and technical implementation mechanisms. It is within this context that the Digital Asset Insolvency Framework proposed in this study acquires its significance as a model for the modernization of Indonesian bankruptcy law in the era of the digital economy. The following section elaborates on the proposed framework by integrating the comparative findings discussed above into a coherent normative model for the administration of digital assets in insolvency proceedings. The framework also has a socioeconomic and public policy dimension. Unclear recovery rules can shift losses from debtors to unsecured creditors, increase administration costs, and reduce confidence in digital asset markets. Conversely, predictable disclosure, custody, and valuation rules can strengthen creditor equality, market accountability, and public trust. For policymakers, this requires coordinated governance among legislators, commercial courts, insolvency administrators, financial and digital asset regulators, law enforcement bodies, and regulated service providers rather than a bankruptcy law response operating in isolation.

Accordingly, comparative legal analysis serves not merely to explain legal developments in different jurisdictions, but also to provide a normative foundation for formulating a legal model that is better suited to the needs and characteristics of the Indonesian legal system.

Digital Asset Insolvency Framework as a Model for the Reconstruction of Indonesian Bankruptcy Law

The development of digital assets has demonstrated that conventional bankruptcy law faces new challenges that cannot be fully addressed through the mechanisms currently in place. The distinctive characteristics of digital assets being intangible, decentralized, pseudonymous, and dependent upon control of private keys render the traditional bankruptcy framework insufficient to ensure the effective protection of creditors' interests. Accordingly, legal reconstruction is required that not only recognizes digital assets as part of the bankruptcy estate, but also accommodates the unique characteristics inherent in such assets.

Based on the normative analysis and comparative legal study conducted in this research, this article proposes a reconstruction model referred to as the Digital Asset Insolvency Framework. The framework is designed to integrate the fundamental principles of bankruptcy law with the development of the digital economy through five principal components: (i) disclosure of digital assets; (ii) control of digital assets; (iii) valuation of digital assets; (iv) liquidation of digital assets; and (v) institutional capacity-building. Conceptually, the framework operates as an ordered governance chain: debtor disclosure and traceability -> legally enforceable access and custody -> transparent valuation -> secure liquidation and creditor distribution -> institutional and cross-border support. Each component addresses a distinct failure point identified in the comparative analysis, while the components remain interdependent in practice.

Disclosure Obligation of Digital Assets by the Debtor

The principle of full disclosure constitutes one of the fundamental principles of modern bankruptcy law. In conventional bankruptcy proceedings, the debtor is under a legal obligation to disclose all of his or her assets to the insolvency administrator. However, because digital assets can be easily concealed and are not necessarily recorded within formal administrative systems, conventional disclosure mechanisms are no longer adequate.

Accordingly, bankruptcy law should expressly require debtors to disclose all digital assets they own, together with information concerning their storage arrangements and the means of

accessing those assets. Such an obligation is essential to prevent the concealment of assets that may prejudice creditors and to preserve the integrity of bankruptcy proceedings (Parry & Olivares-Caminal, 2022).

Authority of the Insolvency Administrator over Digital Assets

The principal issue in digital asset insolvency does not lie in the legal status of digital assets themselves, but rather in the ability of the insolvency administrator to obtain effective control over those assets. Accordingly, bankruptcy legislation should provide a clear legal basis authorizing the insolvency administrator to take control of digital assets as part of the bankruptcy estate.

Such authority may include:

1. requiring the debtor to surrender or otherwise provide lawful access to the private keys;
2. obtaining access to cryptocurrency trading accounts;
3. cooperating with virtual asset service providers (VASPs) or other regulated digital asset service providers; and
4. requesting assistance from law enforcement authorities where there are indications that digital assets have been concealed.

This approach is consistent with the fundamental objective of bankruptcy law, namely, to ensure the equitable distribution of the debtor's assets among all creditors.²

Digital Asset Valuation Mechanism

Price volatility constitutes one of the principal challenges in digital asset insolvency. Accordingly, a valuation mechanism that is more flexible than that applied to conventional assets is required. This study proposes the use of three valuation approaches:

1. Market Value Approach, based on the market price prevailing at the time the bankruptcy order is issued;
2. Average Price Approach, based on the average market price over a specified period; and
3. Expert Valuation Approach, based on an assessment conducted by an independent expert possessing professional expertise in digital assets.

These approaches are intended to reduce the risk of losses resulting from extreme price fluctuations while simultaneously providing greater legal certainty for creditors.

Mechanism for the Liquidation and Administration of Digital Assets

Unlike conventional assets, the liquidation of digital assets requires specific procedures because transactions are conducted through electronic systems operating across national borders. Accordingly, the administration and liquidation process should take into account the following considerations:

1. transaction security;
2. transparency in the sale process;
3. preservation of the value of digital assets; and
4. certainty regarding the distribution of liquidation proceeds to creditors.

In international practice, the utilization of licensed and regulated digital asset exchanges has become one of the principal mechanisms for ensuring the accountability and transparency of the liquidation process (L. C. of E. and Wales, 2023).

Strengthening Institutional Capacity

The transformation of the digital economy requires a corresponding enhancement of institutional capacity within the Indonesian bankruptcy system. Insolvency administrators are no longer required merely to possess expertise in company law and bankruptcy law; they must also develop a comprehensive understanding of blockchain technology, digital forensics, and digital asset trading mechanisms.

Accordingly, this study proposes:

1. the formulation of official guidelines for the administration of digital assets in bankruptcy proceedings;
2. specialized professional training for insolvency administrators;
3. enhanced cooperation among insolvency administrators, regulators, and virtual asset service providers (VASPs) or other regulated digital asset service providers; and

4. the development of digital forensic capabilities in the administration and liquidation of the bankruptcy estate.

Fundamentally, legal reform is intended not merely to align legal rules with social developments, but also to ensure that law continues to perform its essential functions as an instrument of justice and legal protection. Nonet and Selznick explain that responsive law represents a stage in legal development in which legal institutions are capable of adapting to social change without sacrificing their legitimacy or fundamental normative objectives (Bora, 2026; Nonet & Selznick, 1978). Within the context of the digital economy, this responsive character of law becomes increasingly important because technological innovation advances at a considerably faster pace than the legislative process. Operationally, legislators should define the powers of insolvency administrators and the debtor's disclosure duties; commercial courts should be able to issue effective access and preservation orders; insolvency administrators should apply documented custody, valuation, and disposal protocols; regulators should establish cooperation channels with licensed digital asset service providers; and service providers should maintain procedures for lawful account preservation, identity verification, and transfers pursuant to insolvency orders.

CONCLUSION

This study demonstrates that digital assets have evolved into economic assets that can be included in the bankruptcy estate under the universality principle of Law No. 37 of 2004, despite the absence of explicit regulations. The central challenge no longer concerns their legal status, but rather the operational issues of identification, control, valuation, and administration arising from the decentralized, volatile, and cross-border nature of digital assets.

To bridge traditional bankruptcy principles with the digital economy, this research proposes the Digital Asset Insolvency Framework, based on responsive law and modern property theories. Future bankruptcy law reforms in Indonesia must look beyond mere legal recognition by establishing robust administrative mechanisms, technical guidelines, and institutional cooperation to ensure the equitable distribution of assets among creditors.

ACKNOWLEDGEMENTS

The authors would like to express their sincere gratitude to Universitas Lancang Kuning and Universitas Adiwangsa Jambi for providing the academic support and institutional resources necessary to complete this research. We also extend our appreciation to the editorial board and anonymous reviewers of the *Journal of Law & Social Politics* for their insightful feedback and constructive suggestions, which significantly enhanced the quality and rigor of this manuscript.

AUTHOR CONTRIBUTION STATEMENT

Yalid conceptualized the research, formulated the main theoretical framework, and drafted the original manuscript; Yeni Triana executed the comparative legal analysis across the targeted jurisdictions and refined the methodological structure; Irawan Harahap developed the five-pillar *Digital Asset Insolvency Framework* and analyzed Indonesian statutory provisions; Riantika Pratiwi collected and categorized the primary and secondary legal materials using the document-analysis matrix; and Emir Adzan Syazali performed legal validation, policy refinement, and critical editing of the final manuscript.

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