

▪
The Application of Blockchain Technology in Stock Trading Efficiency

Vidya Ramadhan Putra Pratama

Universitas Ekuitas, Indonesia

Email: vidya.ramadhan@ekuitas.ac.id

Entered : October 03, 2025
Accepted: November 07, 2025

Revised : October 29, 2025
Published : November 24, 2025

ABSTRACT

Indonesia's stock market has grown rapidly in volume and retail participation, creating increasing pressure on market infrastructures to deliver faster, more transparent, and more secure end-to-end processes. This study examines the potential of blockchain technology to enhance the efficiency of stock trading processes, covering trade execution at the Indonesia Stock Exchange, clearing performed by the Indonesia Clearing and Guarantee Corporation, and settlement and asset recording conducted by the Indonesian Central Securities Depository. Using a systematic literature review, the study synthesizes evidence from reputable academic databases and institutional publications through a structured selection approach and critical appraisal. The findings indicate that blockchain introduces substantial opportunities to accelerate transaction processing, strengthen data integrity, streamline clearing workflows, enable near real-time settlement, and automate corporate actions through smart contracts. Nevertheless, the study also reveals significant challenges, including limitations in scalability, infrastructure investment requirements, regulatory gaps, governance complexity, and the need for high-level technical readiness among market institutions. The study concludes that blockchain can serve as a transformative infrastructure for Indonesia's capital market, provided its implementation follows a phased approach supported by rigorous pilot testing and clear regulatory frameworks.

Keywords: Blockchain, Clearing, Efficiency, Settlement, Stock Trading

INTRODUCTION

Stock trading in Indonesia has experienced significant acceleration over the past decade, marked by an increase in the number of investors, the intensity of daily transactions, and the digitization of capital market services, thereby driving the need for a more efficient, transparent, and responsive infrastructure system that can keep pace with market dynamics. A report by the Financial Services Authority shows that the number of capital market investors increased from 1.1 million in 2017 to more than 11.4 million in 2024, with a dominance of retail investors who conduct transactions digitally through securities platforms (Financial Services Authority, 2024). This growth has increased pressure on the Indonesia Stock Exchange as the trading organizer, the Indonesian Clearing House as the clearing institution, and the Indonesian Central Securities Depository as the securities storage and settlement institution. Although Indonesia's capital market infrastructure system has been progressively developed through systems such as JATS, C-BEST, AKSes, and e-IPO, the complexity of the end-to-end ecosystem still leaves operational friction that is difficult to eliminate without comprehensive structural innovation (Indonesian Stock Exchange, 2024). It is in this context that interest in blockchain technology has emerged as an alternative foundation



for improving stock trading efficiency, given its characteristics that enable simultaneous, secure transaction recording that does not depend on inter-agency reconciliation.

Blockchain technology, particularly in the form of permissioned distributed ledgers, has attracted the attention of global regulators and market participants due to its potential to integrate trading, clearing, and settlement functions into a single unified system, thereby reducing the need for reconciliation and accelerating transaction finality (Chiu & Koeppl, 2019). Traditional stock trading systems, including those in Indonesia, currently rely on a layered mechanism that separates trading (trade execution), clearing, and settlement, as well as ownership recording in different entities, so that every transaction status transfer requires synchronization between systems. A study conducted by the Bank for International Settlements confirms that this type of multi-ledger architecture creates default risk, operational risk, and reconciliation costs that can be minimized with a cryptographically accountable shared ledger model (BIS/CPMI, 2017). In markets with high transaction volumes and increasing retail participation, such as Indonesia, these obstacles have the potential to reduce end-to-end efficiency by prolonging settlement times and increasing liquidity requirements to meet margins and collateral.

From a capital market economics perspective, the adoption of blockchain could change the risk structure of transaction settlement. The T+2 system implemented in Indonesia requires KPEI to guarantee transaction settlement as a central counterparty, resulting in complex capital and risk management requirements. A study conducted by Priem (2020) shows that blockchain technology can reduce dependence on third-party guarantees because settlement finality can be achieved almost instantly, thereby significantly reducing the risk of delivery or payment failures. In addition, distributed ledger systems enable real-time recording of share ownership, which can reduce recording disputes, improve the quality of ownership data, and increase the accuracy of corporate actions that currently still require manual verification at various stages (Peters & Panayi, 2016). KSEI, as a securities depository and settlement institution, has the potential to benefit greatly from reduced reconciliation processes and improved data integrity if shared ledger technology is adopted.

A number of international studies state that blockchain can reduce the operational costs of capital market institutions, especially in the post-trade stage, through the automation of recording processes, transfer of ownership, and corporate actions using smart contracts (Agarwal, 2023). For Indonesia, these potential benefits are attractive because, under current conditions, the process of transferring share ownership and implementing corporate actions still involves a number of manual verifications and data exchanges between industry players, even though the system has been digitized. Corporate actions such as dividends, rights issues, stock splits, and digital general meetings of shareholders still require multi-party coordination, so data errors and delays can occur if the quality of electronic data is not consistent across sources (Indonesian Stock Exchange, 2024). By using smart contracts, corporate actions can be executed automatically based on parameters agreed upon by regulators and issuers, thereby reducing processing time and increasing transparency for investors.

However, the literature also emphasizes that the adoption of blockchain in the capital market sector is not without challenges. Issues of scalability, network latency, access control, node concentration risk, and compatibility with capital market regulations are key challenges that must be considered before full implementation (Zetzsche et al., 2022). In the Indonesian context, compliance with the capital market legal framework, including legal recognition of securities ownership recorded in a distributed ledger, is a critical issue that must be resolved before the new infrastructure

can be implemented on a national scale. In addition, the governance model for permissioned blockchain at the national infrastructure level must be designed taking into account the roles of the IDX, KPEI, and KSEI as independent entities with different but interrelated functions. The IMF (2020) study also shows that the success of digital transformation in clearing and settlement is greatly influenced by institutional readiness, regulatory readiness, and technological infrastructure readiness that supports distributed data storage and high-speed transaction processing.

In Indonesian literature, academic research on the potential of blockchain for capital markets is still limited and tends to be conceptual. For example, a study by Fauzan (2024) discusses stakeholders' perceptions of the use of blockchain in improving the transparency of the Indonesian capital market, but has not empirically assessed its impact on end-to-end trading efficiency. Wahyudi's (2024) research on the Islamic capital market shows the potential of smart contracts in improving transaction security, but its scope is limited to security aspects, not the efficiency of the trading system as a whole. Both provide initial contributions but have not fully assessed the implications of distributed ledger implementation on all stages of stock trading, from trade execution to final settlement and corporate action recording.

At the global level, more mature literature has provided a comprehensive picture of the potential and risks of blockchain implementation for capital markets, but the context and architecture of the Indonesian capital market have different characteristics so that global research results cannot be directly applied. For example, research by Chiu and Koepl (2019) models a blockchain-based stock settlement system for advanced markets with high liquidity and legal infrastructure that already supports distributed ledger technology. Thus, although the study provides a strong theoretical framework, the Indonesian context requires additional analysis regarding infrastructure readiness, investor portfolios, and the central role of institutions such as KPEI, which has a mandate for clearing and guaranteeing transactions.

A relevant research gap emerges at this point. First, there has been no comprehensive study assessing the potential of blockchain to improve the end-to-end efficiency of Indonesian stock trading, from trading on the IDX to settlement at KSEI, as most studies only discuss either the transaction or security aspects without linking them in an integrative model. Second, international research such as Jonathan Chiu and Thorsten Koepl's work entitled "Blockchain-Based Settlement for Asset Trading" (2019) emphasizes the potential for economic efficiency and risk reduction, but does not assess the readiness of institutions such as the IDX, KPEI, and KSEI, which have unique structures. Third, a study by Randy Priem, "Distributed Ledger Technology for Securities Clearing and Settlement" (2020), provides an overview of the benefits and risks of DLT, but does not provide a context-based implementation analysis for countries such as Indonesia. Fourth, local research such as that by Z. T. Fauzan, "The Impact of Blockchain Technology on Capital Market Transparency and Security" (2024), is still partial and does not assess the impact of distributed ledger architecture on corporate actions, clearing, and settlement simultaneously.

Based on these gaps, research on the application of blockchain in the efficiency of Indonesian stock trading requires an approach that combines technical, regulatory, operational, and institutional analysis in a single evaluation framework. The novelty of this research lies in its end-to-end analysis, which assesses how blockchain has the potential to simplify the entire Indonesian stock trading cycle, from trade execution, clearing, settlement, ownership registration, to the implementation of corporate actions. This research also offers novelty in the form of identifying a permissioned blockchain model that is in line with the structure of Indonesia's capital market governance, which

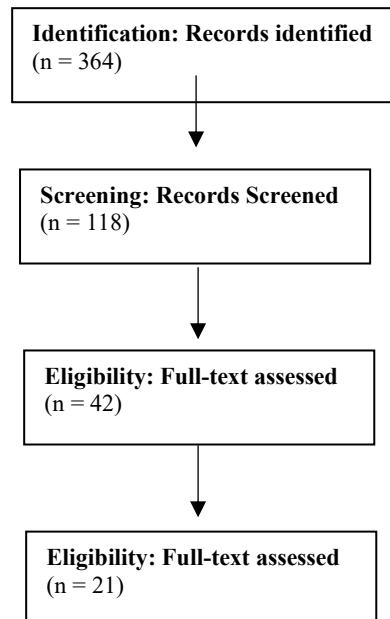
involves the IDX, KPEI, and KSEI as core nodes. Thus, the objectives of this study are to evaluate the potential and limitations of applying blockchain technology to improve the efficiency of Indonesian stock trading, assess the readiness of infrastructure and regulations, and formulate recommendations for a blockchain architecture design that is secure, efficient, and in line with Indonesian capital market practices.

METHODS

This study uses a systematic literature review approach to comprehensively assess the potential of applying blockchain technology to improve the efficiency of stock trading in Indonesia. This approach was chosen because it provides a structured understanding of the conceptual developments, empirical findings, and implementation challenges related to blockchain in capital market infrastructure. According to Snyder (2019), a systematic literature review is a method that allows researchers to identify patterns, inconsistencies, and gaps in the literature through a systematic and controlled search process. In line with this view, the literature search process for this study utilized reputable databases such as Scopus, ScienceDirect, Taylor & Francis, Emerald Insight, and SINTA-accredited national journals relevant to the topics of capital markets, blockchain technology, and securities transaction settlement systems. The use of this method is also based on the argument of Tranfield et al. (2003) that systematic literature reviews help compile scientific evidence based on strict methodological standards so that the research results are more credible and reliable.

The data collection stage was carried out using keywords such as “blockchain,” “securities settlement,” “stock trading efficiency,” “DLT market infrastructure,” and “Indonesia capital market.” The articles found were then processed through the identification, screening, and eligibility assessment stages based on the inclusion criteria, namely: published in the last ten years, available in full-text format, originating from reputable journals or scientific reports, and having direct relevance to the aspects of trading, clearing, settlement, or corporate actions. Quality evaluation was conducted through critical appraisal to ensure that only sources that met academic and methodological standards were included in the final synthesis, as recommended by Tranfield et al. (2003) and Paul & Criado (2020). This methodological approach allows researchers to obtain a complete picture of the potential application of blockchain in the Indonesian capital market, including the benefits, obstacles, and implications of its implementation for capital market infrastructure institutions such as the Indonesia Stock Exchange, the Indonesian Clearing House, and the Indonesian Central Securities Depository.

The literature selection process was carried out using the PRISMA flow to ensure transparency in the screening of scientific sources. The PRISMA diagram illustrates the number of articles at each stage of selection as follows:



RESULTS AND DISCUSSION

The Effectiveness of Blockchain Technology in Improving Transparency and Speed in Indonesian Stock Trading

The application of blockchain technology in stock trading has the potential to improve data transparency, transaction processing speed, and ownership record integrity, which have been critical issues in the efficiency of the Indonesian capital market. Transparency is the foundation of investor confidence and a crucial element in a market structure involving many institutions such as the Indonesia Stock Exchange, the Indonesian Clearing House, and the Indonesian Central Securities Depository. In conventional systems, each of these institutions maintains transaction records in different databases, requiring a reconciliation process to ensure consistency between trading records and settlement records. This condition increases the risk of administrative errors and slows down the settlement process, especially when transaction volumes increase (Mills et al., 2019). Blockchain technology can reduce the need for reconciliation because all parties share the same ledger, so that every change in transaction status is recorded consistently and can be verified by all authorized nodes.

In the Indonesian capital market, reconciliation is an important issue because daily transaction volumes have reached millions of lots, with retail investors dominating and often conducting high-frequency transactions. When transaction volumes increase sharply during periods of market volatility, the trading system faces enormous pressure to ensure that all transactions can be recorded and forwarded to the clearing system without delay. Global studies show that blockchain can increase transaction processing speed because it no longer relies on a layered clearing model that requires cross-checking between institutions (Catalini & Gans, 2020). Although the implementation of blockchain does not automatically eliminate the role of clearing institutions, the distributed recording method allows transaction status updates to occur almost instantly to all parties, thereby reducing the time lag between transactions and settlements. This

concept is relevant in the Indonesian context, especially during the opening and closing trading sessions, which often experience the heaviest transaction loads.

In addition to transparency and speed, data integrity is another compelling reason to consider implementing blockchain in Indonesia's capital markets. In traditional systems, the risk of data manipulation or recording errors can occur at any point in the process, especially when multiple parties are involved in the post-trade information flow. With blockchain, every change requires consensus on a specific verification mechanism, thereby minimizing the risk of unauthorized data alteration. A study by Schär (2021) shows that distributed ledgers, when configured in permissioned mode, provide a higher level of security while maintaining transaction processing speed. This is important for the Indonesian capital market, which must ensure that share ownership records accurately reflect market realities and serve as an accurate basis for corporate actions such as dividends, rights issues, and electronic general meetings of shareholders.

Blockchain technology also offers the possibility of reducing transaction costs and operational costs for capital market institutions. In the current model, operational costs increase due to manual administrative processes such as ownership verification prior to corporate actions and inter-system reconciliation processes. If all capital market institutions access the same ledger, many administrative costs can be eliminated. Research by Collomb and Sok (2016) found that the adoption of blockchain in the financial sector could reduce operational costs by 30–50% in the post-trade stage due to the elimination of redundant data matching processes. Although these figures cannot be directly applied to Indonesia without empirical simulation, the direction of efficiency can be used as a basis for planning the transformation of capital market infrastructure.

On the other hand, increased efficiency in transaction settlement speed has important implications for systemic risk and the liquidity needs of market participants. In the current T+2 system, market participants must set aside funds to meet settlement obligations two days after the transaction. With blockchain potentially accelerating settlement to T+0, short-term liquidity needs could be significantly reduced because the allocation of funds or securities would no longer be subject to a long transit period. Sedlacek et al. (2020) emphasize that T+0 or near real-time settlement reduces excessive leverage and liquidity risks because market participants' financial positions can be settled immediately. In the Indonesian context, this type of settlement acceleration can reduce the risk of default that currently has to be borne by KPEI through a guarantee mechanism. In other words, efficiency not only has an impact on operational costs, but also on the stability of systemic risk as a whole.

However, the implementation of blockchain is not without obstacles, especially from a technical and regulatory perspective. From a technical standpoint, blockchain must be able to handle the high throughput that characterizes daily trading on the Indonesia Stock Exchange. The current IDX trading system must process a large number of transactions in a very short period of time. Thus, the blockchain implemented must have high scalability with minimal latency so as not to interfere with order execution. A study by Mills et al. (2019) shows that although blockchain has advantages in data integrity, scalability remains a challenge, especially in systems that require high throughput levels such as stock exchanges. Therefore, the implementation of blockchain in Indonesian stock trading must adopt a permissioned blockchain model with faster consensus such as Practical Byzantine Fault Tolerance (PBFT), rather than a permissionless model such as proof-of-work, which has high latency.

Regulatory aspects are also a challenge that cannot be ignored. The adoption of a distributed ledger system requires revisions to the applicable legal framework, including legal recognition of securities ownership recorded in digital ledgers and settlement

finality. Current Indonesian capital market regulations are designed for an architecture that separates the roles of the IDX, KPEI, and KSEI. When blockchain interconnects these functions in a single shared ledger, new institutional arrangements are needed to determine governance, access rights, and system oversight. Zetzsche et al. (2020) emphasize that Asia-Pacific regions wishing to adopt blockchain in their financial systems must ensure consistency between digital recording rules and contract law principles so as not to create uncertainty for investors.

This regulatory compatibility will determine whether blockchain adoption will strengthen efficiency or open up new legal risks. From an institutional perspective, the three main entities including BEI, KPEI, and KSEI, must adjust their operational structures if blockchain is adopted. BEI may have to adapt the JATS trading system into an ecosystem compatible with a shared ledger.

KPEI could shift from a reconciliation-based clearing process to a consensus-based transaction validation model. Meanwhile, KSEI would have to adjust its C-BEST and AKSes systems to record share ownership directly on a distributed ledger. This transformation is only possible if the three institutions agree on a shared access model and a clear technical coordination model. In this case, institutional readiness must be assessed systematically because without strong coordination, the potential efficiency of blockchain cannot be realized.

This subchapter's analysis shows that blockchain offers significant benefits in transparency, speed, data integrity, and reduced end-to-end operational costs for Indonesian stock trading. However, its effectiveness depends heavily on the system's ability to overcome challenges related to scalability, latency, regulatory readiness, and inter-agency governance coordination. Thus, to be optimally implemented, the adoption of blockchain in the Indonesian capital market requires a mature technical and institutional design model, as well as regulatory adjustments that support changes in infrastructure architecture.

The Potential of Blockchain in Optimizing Clearing, Settlement, and Corporate Actions in the Indonesian Capital Market

The application of blockchain in Indonesia's capital market infrastructure has the potential to change the way clearing, settlement, and corporate actions are carried out by the Indonesian Securities Clearing House and the Indonesian Central Securities Depository. Clearing is a crucial stage after trading because it is during this phase that the delivery and receipt of funds and securities are calculated and scheduled. Traditional systems rely on multi-party reconciliation, which is time-consuming and increases the risk of settlement failure if there are data discrepancies. When transaction volumes increase sharply, the clearing process can experience delays due to higher system capacity and reconciliation loads. International studies show that distributed ledgers can simplify the clearing process because all parties access transaction data from the same source, thereby significantly reducing the risk of data discrepancies (Liu et al., 2020). In the Indonesian context, where KPEI acts as a central counterparty, blockchain can enable more efficient clearing through the automation of the verification process without having to cross-check data between the IDX, KPEI, and KSEI.

Apart from clearing, settlement is the stage most prone to delays and operational risks. T+2 settlement exposes market participants to credit risk for two days between trading and final settlement. In some cases, market volatility can cause positions to change drastically before settlement is complete, increasing the risk of default or failure to deliver that must be borne by KPEI. Blockchain can reduce this risk interval because the shared ledger system allows changes in share ownership to be recorded directly and

definitively without relying on a multi-level verification process. Deloitte (2016) noted that global clearing houses testing the use of blockchain in derivatives settlement found that settlement times could be significantly accelerated, while operational risks decreased due to the elimination of the need for multi-system reconciliation. Although Indonesia has different institutional characteristics, the same economic logic applies: the shorter the settlement time, the lower the systemic risk that clearing houses must manage.

This settlement efficiency is also closely related to the working capital management of market participants. When settlement is reduced to T+0 or near real-time, the need to provide collateral and margin funds can decrease significantly because participants' financial positions are no longer held in the system before final settlement. Yermack's (2017) research shows that real-time settlement can increase working capital efficiency and reduce investors' dependence on intraday loans. The application of a similar mechanism in Indonesia's capital market infrastructure could benefit securities companies and institutional investors who have to allocate large amounts of funds to meet their daily obligations. Thus, the efficiency of blockchain not only impacts market infrastructure institutions, but also the overall cost structure and liquidity of market participants.

Along with clearing and settlement, corporate actions are an important part of the stock trading cycle that can benefit significantly from the use of blockchain. Corporate actions such as dividend distributions, rights issues, stock splits, and voting in digital general meetings of shareholders depend on accurate and up-to-date ownership data. In traditional systems, errors in ownership data or delays in updating information can lead to incorrect dividend distributions, discrepancies in shareholder lists, or disputes in the exercise of investor rights. Blockchain can solve these problems because the ledger provides a permanent, verified, and consistent record that reflects share ownership at a given point in time. Research by Chen and Bellavitis (2020) confirms that smart contracts can be used to automate corporate actions so that processes that previously required manual verification can be carried out directly based on instructions in the code that has been approved by issuers and regulators.

To clarify how blockchain affects clearing, settlement, and corporate actions, the following is an analytical table summarizing the differences between traditional and blockchain-based systems in the context of the Indonesian capital market. This table is not only descriptive but also analytical as it shows the direct impact on the operational efficiency of institutions and market participants.

Process Stage	Traditional Infrastructure (Indonesia)	Blockchain-Based Model (Permissioned)	Efficiency Impact
Clearing	Multi-party reconciliation; dependent on CCP validation	Shared ledger with synchronized transaction states across nodes	Reduced reconciliation time and operational risk
Settlement	T+2 finality; requires guarantee from CCP	Near real-time or T+0 finality with cryptographic validation	Lower credit risk and capital requirement
Ownership Recording	Centralized registry (KSEI) with periodic updates	Real-time distributed recording of ownership changes	Higher accuracy and reduced disputes

Corporate Actions	Manual verification and multi-step confirmation	Automated execution using smart contracts	Faster processing and fewer administrative errors
Auditability	Fragmented records across institutions	Unified immutable ledger	Simplified compliance and transparency

The table shows that blockchain not only replaces the recording system, but fundamentally changes the way the entire post-trade process is managed. In the Indonesian context, this means that the IDX, KPEI, and KSEI can work within a single, consistent data framework without having to synchronize between systems. In addition, these changes in governance can accelerate data reporting to regulators and improve the Financial Services Authority's ability to conduct real-time risk-based supervision.

However, although the benefits of blockchain in improving efficiency appear promising, the application of this technology in the Indonesian capital market faces implementation challenges that need to be critically analyzed. One of the main issues is compatibility with existing systems such as JATS, C-BEST, and AKSes. Rapid technological transformation without a transition strategy has the potential to disrupt market operations that are sensitive to even the slightest technical disruption. Technology design choices such as PBFT or RAFT consensus must consider the characteristics of the Indonesia Stock Exchange's transaction volume, which can reach hundreds of thousands of transactions per minute during periods of volatility. Research by Xu et al. (2021) shows that the successful implementation of blockchain in financial markets is highly dependent on the system's ability to maintain high throughput while maintaining data integrity.

The next challenge relates to governance and node access. In a permissioned distributed system, questions about which institutions serve as validators, the access rights of each institution, and the recording mechanism are shifted from the technical scale to the institutional scale. The IDX, KPEI, and KSEI must agree on technical roles and access rights to the ledger, as even the smallest change in access rights can have a major impact on the supervisory and operational processes. Research by Lewenberg et al. (2015) shows that network governance is a key determinant of blockchain success in the financial sector because errors in governance design can create new centralization or conflicts of interest in data management.

In addition to institutional arrangements, regulatory adaptation is also very important.

Legal recognition of ownership of securities based on distributed ledgers must be enshrined in OJK laws and regulations to avoid legal conflicts between digital ledgers and official records at KSEI. Without legal certainty regarding the finality of transactions and ownership status on the blockchain, infrastructure transformation cannot proceed safely. Chen and Bellavitis (2020) state that one of the biggest obstacles to the application of blockchain in capital markets is the gap between technological innovation and regulatory adaptation, which is too slow.

The analysis in this subchapter shows that blockchain has great potential to improve the efficiency of clearing, settlement, and corporate actions in the Indonesian capital market through real-time data integration, reduced reconciliation risk, and process automation. However, its realization requires a deep understanding of technical readiness, governance, and regulations. Therefore, the implementation of blockchain requires a phased approach, starting with pilot projects on specific post-trade processes before being fully implemented across the entire trading chain.

Challenges of Blockchain Implementation in the Indonesian Capital Market and Its Implications for Long-Term Efficiency

Although the potential of blockchain technology to improve the efficiency of Indonesian stock trading looks very promising, its implementation cannot be separated from various structural, technical, regulatory, and institutional challenges that could hinder the realization of its benefits.

These challenges are determining factors in whether this digital transformation will be able to produce significant long-term efficiency for Indonesia's capital market infrastructure or instead create high transition costs without delivering optimal results. At a fundamental level, blockchain is a technology that combines the concepts of distributed computing, cryptography, and consensus mechanisms, so it cannot be implemented without adequate technological capacity readiness from market participants. In the Indonesian context, the technological capacity gap between capital market institutions and securities companies is one of the main issues that needs to be addressed before a blockchain implementation design can be formulated appropriately. Research by Li et al. (2020) confirms that IT infrastructure readiness is a critical factor that distinguishes the success and failure of distributed ledger technology adoption in financial institutions.

The technical readiness of the Indonesian capital market must be viewed in relation to the ability of existing systems to integrate with the new architecture. The Indonesia Stock Exchange relies on the JATS trading system, while KPEI uses its own risk engine-based clearing system, and KSEI uses C-BEST and AKSes as investor ownership recording systems. The integration of all these systems with blockchain requires very in-depth technical mapping, including issues of interoperability and the potential for system fragmentation if migration is carried out partially. This is in line with the findings of Allen et al. (2020), who state that the integration of blockchain into financial infrastructure that has been in place for decades requires data harmonization and protocol standardization efforts to avoid incompatibilities between the new ledger and the systems currently in use. If the IDX, KPEI, and KSEI implement blockchain separately or in an uncoordinated manner, the benefits of digital ledgers will not materialize because the data will remain scattered across several unsynchronized platforms.

In addition to internal technical challenges, there are also systemic challenges related to the scalability and latency of blockchain networks. Unlike the centralized database systems commonly used by stock exchanges, blockchain requires every data change to be validated by the nodes participating in the network. Although the use of permissioned blockchain can speed up the validation process, this speed must still be able to keep up with the IDX's throughput requirements, which can reach hundreds of thousands of orders per minute during peak market activity. Based on a study by Gervais et al. (2016), blockchain faces significant throughput limitations when the number of nodes increases or when the transaction load is too high. This challenge is even greater in the Indonesian context, which requires a quick response to execute orders, send transaction data to KPEI, and record securities ownership at KSEI almost simultaneously.

Parallel to technical aspects, regulatory issues are another factor limiting the implementation of blockchain in stock trading. The securities ownership system in Indonesia is currently regulated within a capital market legal framework that clearly stipulates that KSEI is the only institution authorized to record securities ownership. Changes to the recording infrastructure through blockchain will require structural revisions to OJK regulations, including legal definitions of book-entry, settlement finality, and digital ownership status. As analyzed by Hafid et al. (2020), the adoption of distributed ledger technology in the financial sector requires strong legal certainty so that the data recorded in the ledger has the same evidentiary power as conventional records.

Without a clear legal basis, the risk of litigation over ownership disputes or corporate action disputes increases, which can undermine investor confidence.

In capital markets that are highly sensitive to regulatory certainty, such as Indonesia, legal uncertainty has the potential to create operational instability. The issue of blockchain governance in the Indonesian capital market is also a strategic challenge that cannot be ignored. Permissioned blockchain requires the determination of validator roles, node structures, and data access levels.

The IDX, KPEI, and KSEI need to determine whether the three of them will be the main validators or whether certain market participants will be given a role in the verification process. Research by Androulaki et al. (2018) shows that blockchain governance determines its long-term success, and an unbalanced governance design can create new centralization or conflicts of interest between market participants. If, for example, one institution has greater control over nodes than others, the ledger no longer reflects the principle of shared state that is the basis of blockchain. This can hinder transparency and cause information inequality that could potentially reduce market efficiency.

The next challenge arises from security and operational risks. Although blockchain is known for its high resistance to data manipulation, this technology remains vulnerable to certain risks such as smart contract vulnerabilities, coding errors, or network failures. These limitations have been highlighted by Atzori (2017), who states that potential vulnerabilities in smart contracts can be a gateway to significant system failures. In the context of corporate actions, a small error in the smart contract code can result in incorrect dividend distribution or failure to exercise other investor rights. This shows that blockchain adoption is not only a matter of technology, but also the ability to consistently maintain code integrity and security.

Beyond technical and institutional challenges, the cost of implementation is also an important strategic consideration. The transformation of capital market infrastructure that combines trading, clearing, settlement, and ownership recording in a single shared ledger requires significant technological investment. In addition, securities firms and market participants must update their internal systems to be compatible with the new infrastructure. This is reinforced by the findings of Rauchs et al. (2018), which show that blockchain adoption in the financial sector has high transition costs, especially in the early stages when integration with existing systems must still be done gradually. If the implementation and maintenance costs are greater than the long-term efficiency benefits, blockchain adoption may not be acceptable to market participants.

The human resources aspect also poses a particular challenge for Indonesia. The availability of experts who understand blockchain at the system architecture and financial application levels is still limited. Many securities companies and capital market institutions are still in the exploration stage and do not yet have a dedicated division handling distributed ledger-based innovations. This phenomenon is in line with the study by Crosby et al. (2016), which emphasizes that blockchain adoption requires technical and organizational competencies that cannot be obtained instantly. The lack of skilled human resources can reduce institutions' readiness to migrate their infrastructure.

Despite the many challenges, long-term analysis shows that most of these obstacles can be overcome through phased implementation design. For example, blockchain implementation can begin with corporate actions that are relatively isolated from daily trading flows, such as dividend distribution or e-voting at general meetings of shareholders, before moving on to more complex processes such as clearing and settlement. This phased approach is in line with the recommendations of Saka et al. (2022), which emphasize that a gradual transition in the financial sector allows for risk

mitigation and ongoing evaluation prior to full implementation. With phased testing, the IDX, KPEI, and KSEI can assess the readiness of technology, regulations, and human resources without disrupting the overall capital market operations.

The analysis in this subsection shows that although blockchain offers significant long-term efficiency potential, its application in Indonesian stock trading requires careful consideration of technical, regulatory, governance, cost, and human resource competency challenges. However, with a phased transition design and strong regulatory support, these challenges can be overcome so that the efficiency promised by blockchain technology becomes not just a theoretical possibility, but a reality in the management of Indonesia's capital market.

CONCLUSIONS

An analysis of the potential application of blockchain technology in improving the efficiency of stock trading in Indonesia shows that this technology offers strategic opportunities to improve transparency, recording speed, data integrity, and reduce the need for cross-institutional reconciliation throughout the trading chain. In the context of the Indonesia Stock Exchange trading system, clearing by the Indonesia Securities Clearing House, and settlement and ownership recording by the Indonesia Central Securities Depository, blockchain is capable of creating a shared ledger that records transactions and changes in ownership consistently and in real time, thereby reducing operational risk and accelerating settlement finality. Research findings also show that blockchain has the potential to optimize corporate actions and reduce operational costs through smart contract-based automation. However, these benefits can only be achieved if balanced with technological readiness, clear network governance, and a regulatory framework that supports the legal status of digital recording.

Nevertheless, blockchain implementation is not without obstacles. The biggest challenges lie in scalability, interoperability with existing capital market systems, and the readiness of human resources and technological infrastructure in each capital market institution. Governance design also plays an important role in ensuring that the IDX, KPEI, and KSEI can carry out their roles in a distributed network without creating new centralization or conflicts of interest. In addition, Indonesia's capital market legal framework needs to be updated to accommodate legal recognition of distributed ledger-based securities ownership and automatic settlement finality. Without regulatory adjustments, the potential efficiency of blockchain will be difficult to realize in practice.

Based on the research findings, the recommendation that can be given is the need for a phased approach to blockchain implementation, starting with relatively isolated areas such as corporate actions before applying it to clearing and settlement. Capital market institutions need to develop pilot projects that test the compatibility of the technology with their systems, while assessing the operational impact and risks in a measurable manner. In addition, the Financial Services Authority needs to develop a regulatory framework that explicitly regulates the legal status of digital ledgers, node governance, and supervisory procedures for the use of blockchain in capital market systems. With a careful and data-driven implementation strategy, this technology has the potential to become the foundation for the transformation of Indonesia's capital market infrastructure towards a more efficient, secure, and sustainable trading system.

REFERENCE

- Agarwal, N. (2023). Blockchain application to financial market clearing and settlement: A review. *Journal of Financial Market Infrastructures*, 16(10), 452–478.
- Allen, D. W., Berg, C., & Novak, M. (2020). Blockchain governance: What we can learn from the economics of corporate governance. *Journal of Institutional Economics*, 16(4), 645–663.
- Androulaki, E., et al. (2018). Hyperledger Fabric: A distributed operating system for permissioned blockchains. *Proceedings of the EuroSys Conference*, 1–15.
- Atzori, M. (2017). Blockchain technology and decentralized governance: Is the state still necessary? *Journal of Governance and Regulation*, 6(1), 45–62.
- Bank for International Settlements — Committee on Payments and Market Infrastructures. (2017). *Distributed ledger technology in payment, clearing and settlement: An analytical framework*. BIS.
- Catalini, C., & Gans, J. (2020). Some simple economics of blockchain. *Communications of the ACM*, 63(7), 80–90.
- Chen, Y., & Bellavitis, C. (2020). Blockchain disruption and decentralized finance: The rise of decentralized business models. *Journal of Business Venturing Insights*, 13, e00151.
- Chiu, J., & Koepl, T. V. (2019). Blockchain-based settlement for asset trading. *The Review of Financial Studies*, 32(5), 1716–1753.
- Collomb, A., & Sok, K. (2016). Blockchain/distributed ledger technology: Challenges and opportunities. *Journal of Financial Perspectives*, 3(3), 1–54.
- Crosby, M., Pattanayak, P., Verma, S., & Kalyanaraman, V. (2016). Blockchain technology: Beyond bitcoin. *Applied Innovation Review*, 2, 6–19.
- Deloitte. (2016). *Blockchain in securities settlement*. Deloitte Insights.
- Fauzan, Z. T. (2024). The impact of blockchain technology on capital market transparency and security. *Jurnal Ekonomi*, 13(2), 1243–1260.
- Gervais, A., Karame, G., Wüst, K., Glykantzis, V., Ritzdorf, H., & Capkun, S. (2016). On the security and performance of proof-of-work blockchains. *Proceedings of the ACM CCS*, 3–15.
- Hafid, A., Khoukhi, L., & Cherfaoui, V. (2020). Blockchain for trustful collaborative networks. *IEEE Transactions on Engineering Management*, 67(4), 1103–1115.
- Indonesian Stock Exchange. (2024). *Annual Market Report 2024*. IDX.
- International Monetary Fund. (2020). *Distributed ledger technology experiments in payments and settlement (IMF Working Paper)*. IMF.
- Lewenberg, Y., Sompolinsky, Y., & Zohar, A. (2015). Inclusive blockchain protocols. *Financial Cryptography Conference Proceedings*, 1–17.
- Li, J., Greenwood, D., & Kassem, M. (2020). Blockchain in the built environment and financial institutions: A readiness model. *International Journal of Information Management*, 52, 102–118.
- Liu, Y., Zhang, R., & Xu, X. (2020). The adoption of blockchain in post-trade processing. *Journal of Finance and Data Science*, 6(3), 48–63.
- Mills, D., Wang, K., Malone, B., Ravi, A., Marquardt, J., Chen, C., & Badev, A. (2019). *Distributed ledger technology in payments, clearing, and settlement*. Federal Reserve Finance and Economics Discussion Series.
- Otoritas Jasa Keuangan. (2024). *Laporan Perkembangan Pasar Modal 2024*. OJK.
- Peters, G. W., & Panayi, E. (2016). Understanding modern banking ledgers through blockchain technologies. *Journal of Financial Transformation*, 44, 81–91.

- Priem, R. (2020). Distributed ledger technology for securities clearing and settlement: Benefits, risks, and regulatory implications. *Financial Innovation*, 6(11), 1–21.
- Rauchs, M., Glidden, A., Gordon, B., Pieters, G., Recanatini, M., Rostand, F., & Zhang, B. (2018). Distributed ledger technology systems: A conceptual framework. Cambridge Centre for Alternative Finance.
- Saka, O., Andrews, S., & Williams, J. (2022). Distributed ledger adoption in financial markets: Lessons from pilot projects. *Journal of Financial Regulation*, 8(2), 315–340.
- Schär, F. (2021). Blockchain-based digital assets. *Federal Reserve Bank of St. Louis Review*, 103(2), 153–174.
- Sedlacek, J., Svec, P., & Hlavacek, M. (2020). Real-time settlement and systemic risk mitigation: The role of distributed ledger systems. *Journal of Financial Market Infrastructures*, 8(4), 112–137.
- Xu, X., Weber, I., & Staples, M. (2021). A systematic review of blockchain scalability in financial markets. *Future Generation Computer Systems*, 124, 300–314.
- Yermack, D. (2017). Corporate governance and blockchains. *Review of Finance*, 21(1), 7–31.
- Zetzsche, D. A., Arner, D. W., Buckley, R. P., & Veermäe, I. (2022). DLT-based enhancements of cross-border payments: Lessons for securities settlement. BIS Working Papers.