

RESEARCH PAPER

Critical Challenges and Integrated Solutions in the Implementation of Digital Rupiah in Digital Economic Systems

PANEL 2

Surveillance and Privacy in Digital Development

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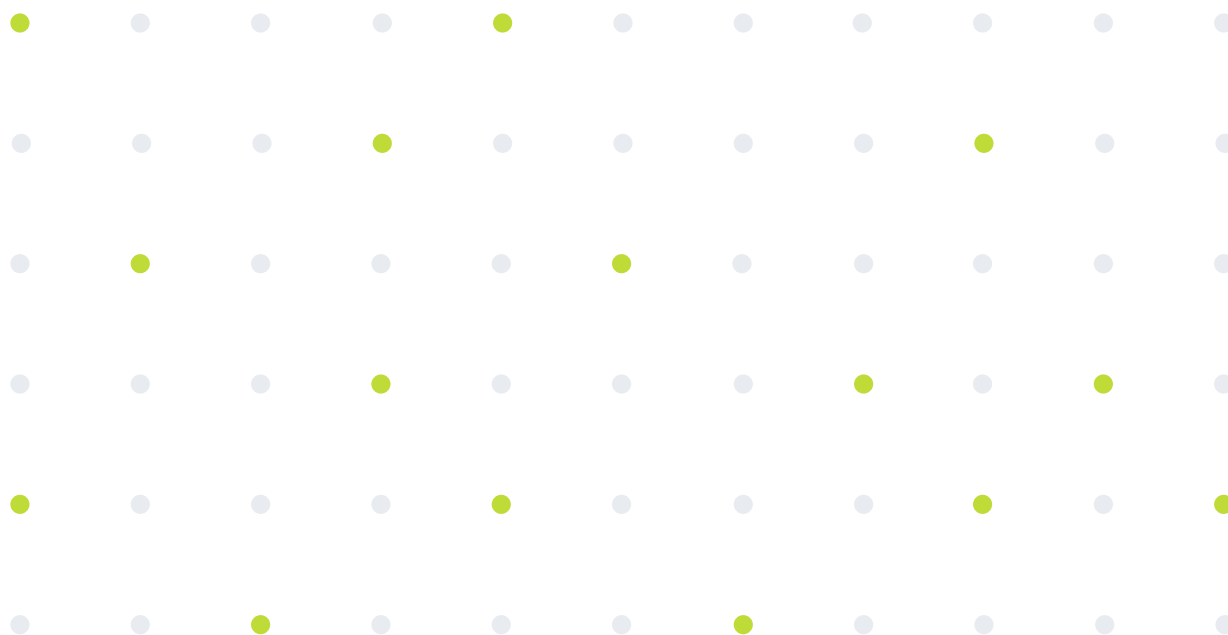


Critical Challenges and Integrated Solutions in the Implementation of Digital Rupiah in Digital Economic Systems

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Bank Indonesia is developing a Central Bank Digital Currency (CBDC) called Rupiah Digital. The three main objectives of the Digital Rupiah as a CBDC are: (1) to serve as a legal digital payment instrument in the Republic of Indonesia; (2) to act as a core tool that will aid Bank Indonesia in conducting its operations in the digital era; and (3) to support financial inclusion. The digital rupiah initiative is expected to bring about positive changes, making transactions easier within Indonesia and across borders. However, the implementation of the Digital Rupiah faces challenges from various angles. This research examines the critical challenges of implementing the Digital Rupiah in the digital financial ecosystem in Indonesia. The research results conclude that there are crucial challenges in terms of regulation, policy, legal issues (privacy and personal data protection), technology infrastructure, public acceptance, and interoperability. The research also presents potential solutions to overcome these challenges. Further research is necessary to prepare for the implementation of the Digital Rupiah and to prevent negative impacts on the country's economic stability. In this context, artificial intelligence (AI) is also explored as a supporting tool to address several key challenges, including fraud detection, scalability, and interoperability.

Keywords: Digital Rupiah, CBDC, Garuda Project, Bank of Indonesia, Artificial Intelligence



Introduction

On November 30, 2022, Bank Indonesia released a White Paper outlining the creation of the Central Bank Digital Currency (CBDC), known as Project Garuda. This document, marking the initial public discussion of the Digital Rupiah,¹ details the high-level design intended for its integration. Over the coming years, the government aims to incorporate the Digital Rupiah within Indonesia's digital economic and financial ecosystem², a network of interconnected information technologies designed to streamline digital finance business processes.³ The shift towards digitalization in this sector was significantly hastened by the COVID-19 pandemic that began in early 2020⁴, shifting transaction behaviors from traditional to online platforms amid extensive social restrictions.⁵ Additionally, the pandemic spurred a notable rise in the adoption of crypto assets, leading to concerns over shadow banking, shadow currency, and a shadow economy.⁶ In response, global central banks are rapidly developing CBDC frameworks that are expected to bridge the gap caused by digital disruptions while fulfilling public transaction needs and supporting the financial system's sustainability.⁷ The introduction of CBDCs is anticipated to counter the unchecked proliferation and economic disturbances caused by widely used, yet unregulated, crypto assets which disrupt the economic and financial order which hampers the effectiveness of economic policies (shadow economy).⁸

The government's initiative to introduce the Digital Rupiah carries multifaceted implications, spanning regulatory and policy domains, technological infrastructure, public reception, and compatibility with existing systems. Initially, when the Garuda Project White Paper was unveiled in 2022, the legal framework dictating the Digital Rupiah's legitimacy relied on Law No. 23 of 1999, amended by Law No. 6 of 2009 (Bank Indonesia Law), equating it with basic checking accounts. However, the Currency Law, specifically Article 2 paragraph (2) of Law

¹ Bank Indonesia, "Proyek Garuda Menavigasi Arsitektur Digital Rupiah," *White Paper*, 2022, 4

² Bank Indonesia, "Proyek Garuda: Menavigasi Arsitektur Digital Rupiah," (2022), <https://www.bi.go.id/id/rupiah/digital-rupiah/default.aspx> (accessed July 10, 2023)

³ Wahyuddin, et al., "Financial Technology: Sistem Keuangan Digital," *Yayasan Kita Menulis*, 2022.

⁴ Suryo Adi Rakhmawan, "Digital Transformation of Informal Workers in the New Normal Era: 'Can It Be the Solution We Are Searching For?,'" *East Java Economic Journal* 6, no. 2 (2022), 202

⁵ *Ibid*, Adi Rakhmawan, 184

⁶ Bank Indonesia, *Op.Cit*, "Proyek Garuda Menavigasi Arsitektur Digital Rupiah," *White Paper*, 2

⁷ *Ibid*, 2

⁸ Bagian Keenam tentang Digital rupiah dalam Undang-Undang Nomor 4 Tahun 2023 tentang Pengembangan dan Penguatan Sektor Keuangan.

Number 7 of 2011, stipulated that the Rupiah encompassed only paper and metal forms⁹, raising doubts about the Digital Rupiah's legal tender status.¹⁰

Over time, legislative changes, notably Law Number 4 of 2023 concerning the Development and Strengthening of the Financial Sector (UU P2SK), amended the Currency Law to recognize the Digital Rupiah alongside traditional forms. Enacted on January 12, 2023, the P2SK Law became the primary legal validation for the Digital Rupiah as an official currency, enabling its integration into the Web 3.0 ecosystem. Web 3.0 represents the evolution of the internet, characterized by intelligent data processing akin to human cognition, facilitating applications such as Artificial Intelligence^{11 12 13} (e.g., ChatGPT, Siri, Alexa, Google) and the Metaverse ecosystem, which exclusively accepts digital currencies.

Given this context, regulatory and policy backing becomes paramount, serving as the foundational support for implementing the Digital Rupiah as a Central Bank Digital Currency (CBDC) and an official medium of exchange in Indonesia.^{14 15 16} While normatively the regulatory hurdles have diminished, ongoing challenges may arise, particularly concerning the harmonization of the P2SK Law with revisions to the Bank Indonesia Law and coordination with other financial institutions such as the OJK and the Ministry of Finance. Consequently, further research is imperative to ensure the Digital Rupiah's effective implementation and utilization.

The deployment of Central Bank Digital Currencies (CBDCs) as conducted in China and the Bahamas has highlighted significant challenges pertaining to consumer protection, including privacy concerns and data security.^{17 18} Research underscores the necessity for CBDC regulations to carefully balance personal privacy and data protection against the

⁹ Pasal 2 ayat (2) Undang-Undang Nomor 7 Tahun 2011 tentang Mata Uang

¹⁰ Pasal 2 ayat (2) Undang-Undang Nomor 7 Tahun 2011 tentang Mata Uang

¹¹ Somdip Dey et al., "SmartNoshWaste: Using Blockchain, Machine Learning, Cloud Computing and QR Code to Reduce Food Waste in Decentralized Web 3.0 Enabled Smart Cities," *Smart Cities* Vol. 5, no. 1 (2022), <https://doi.org/10.3390/smartcities5010011>, 162

¹² I. A. Filipova, "Creating the Metaverse: Consequences for Economy, Society, and Law," *Journal of Digital Technologies and Law* Vol.1, no. 1 (2023), <https://doi.org/10.21202/jdtl.2023.1>, 9

¹³ Junichi Suzuki, "Web 3.0 and Blockchain in Real City," 2023, https://doi.org/10.1007/978-981-19-7311-6_18.

¹⁴ Safari Kasiyanto and Mustafa R. Kilinc, "Legal Conundrums of the Metaverse," *Journal of Central Banking Law and Institutions* Vol.1, no. 2 (2022), <https://doi.org/10.21098/jcli.v1i2.25>, 302

¹⁵ Filipova, *Op.Cit.*, 23

¹⁶ Suzuki, *Op.Cit.*

¹⁷ Pangyue Cheng, "Decoding the Rise of Central Bank Digital Currency in China: Designs, Problems, and Prospects," *Journal of Banking Regulation* Vol. 24, no. 2, 2023, <https://doi.org/10.1057/s41261-022-00193-5>, 157

¹⁸ Kilian Wenker, "Retail Central Bank Digital Currencies (CBDC), Disintermediation and Financial Privacy: The Case of the Bahamian Sand Dollar," *FinTech* Vol. 1, no. 4, 2022, <https://doi.org/10.3390/fintech1040026>, 356

requirements of state oversight.^{19 20} In China²¹, issues such as infrastructure readiness, robust consumer protections, transparency, adherence to Know Your Customer (KYC) and Anti-Money Laundering (AML) regulations, effective governance of CBDCs, and the prevention of terrorism financing have all been identified as critical hurdles²². Similarly, studies by Allen et al. (2022) concentrate on pivotal questions like the potential of CBDCs to replace physical currency and the mechanisms by which central banks might introduce retail digital money.²³ ²⁴ Furthermore, other research has addressed the risks associated with the implementation of CBDCs, particularly the possible destabilization they could introduce to the financial system. These studies also explore technological, legal, and economic infrastructures essential for the successful integration of CBDCs.

Additional research themes have focused on fostering widespread consumer adoption of CBDCs, aiming to replace traditional payment methods such as cash, credit/debit cards, checks, and pay-later solutions. Another aspect of great interest is the feasibility of offline CBDC transactions, especially in communities without reliable internet access or electricity, as well as the interoperability of CBDC systems across different platforms and for cross-border payments.^{25 26 27 28} Requiring digital identification for Central Bank Digital Currency (CBDC) implementation raises significant equity concerns, as a notable portion of the population lacks reliable internet access or formal IDs. This digital dependency risks excluding vulnerable groups—such as low-income households and the elderly—from using CBDCs, particularly in societies with low cash usage, thereby potentially exacerbating financial discrimination and social exclusion. On the regulatory front, it is crucial to define the boundaries²⁹ regarding the amounts of CBDC holdings and transfers to protect traditional banking sectors from potential disruptions. The anonymity afforded by CBDC transactions is also a significant regulatory concern³⁰. Proposals suggest allowing anonymity only for minor

¹⁹ Cheng, *Op.Cit*, 162

²⁰ Wenker, *Op.Cit*, 358

²¹ Franklin Allen, Xian Gu, and Julapa Jagtiani, "Fintech, Cryptocurrencies, and CBDC: Financial Structural Transformation in China," *Journal of International Money and Finance*, No. 124, 2022, <https://doi.org/10.1016/j.jimonfin.2022.102625>, 23

²² *Ibid*, 24

²³ Markus K. Brunnermeier, Harold James, and Jean-Pierre Landau, "The Digitalization of Money," *National Bureau of Economic Research*, No. w26300, 2019, DOI 10.3386/w26300., 11

²⁴ Todd Keister and Daniel Sanches, "Should Central Banks Issue Digital Currency?," *Review of Economic Studies* Vol. 90, no. 1, 2023, <https://doi.org/10.1093/restud/rdac017>, 2

²⁵ Allen, *et.al*, *Op.Cit*, 18

²⁶ Brunnermeier, *et.al*, *Op.Cit*, 24

²⁷ Jesús Fernández-Villaverde et al., "Central Bank Digital Currency: Central Banking for All?," *Review of Economic Dynamics* No. 41, 2021, <https://doi.org/10.1016/j.red.2020.12.004>, 237

²⁸ Keister and Sanches, *Op.Cit*, 1

²⁹ Allen, *et.al*, *Op.Cit*, 19

³⁰ Nadia Pocher and Andreas Veneris, "Central Bank Digital Currencies," in *Handbook on Blockchain*, 2022, 463–501, https://doi.org/https://link.springer.com/chapter/10.1007/978-3-031-07535-3_15.

CBDC transactions to mitigate risks like money laundering and terrorism financing, while imposing identity verification for larger sums. This regulatory approach aims to strike a balance between leveraging some of the privacy benefits associated with cryptocurrencies^{31 32 33} and maintaining stringent financial oversight necessary for national and global security.

Reflecting on previous studies from various countries that have introduced CBDCs, the author emphasizes the need for further research on the Garuda Project, initiated by Bank Indonesia at the end of 2022. This need becomes especially pertinent following the enactment of the P2SK Law in 2023, an omnibus law targeting Indonesia's financial sector. Currently, it is essential to identify the key challenges in implementing the Digital Rupiah in Indonesia and propose potential solutions, both of which could provide valuable insights for policymakers and stakeholders of the Digital Rupiah. The author plans to explore the critical challenges to the implementation of the Digital Rupiah from several angles: (1) regulatory and policy frameworks, (2) technological infrastructure, (3) community acceptance (including aspects of financial inclusion and literacy), and (4) interoperability with existing systems such as cybersecurity, distributed ledger technology, and smart contracts. It is anticipated that additional challenges may emerge based on empirical research with Digital Rupiah stakeholders, reflecting the dynamic nature of field data. Given these considerations, the author is motivated to investigate the critical challenges faced in the implementation of the Digital Rupiah within Indonesia's digital financial ecosystem.

This research will address two primary questions: (1) What are the critical challenges in implementing the Digital Rupiah within Indonesia's digital financial ecosystem? (2) What integrated solutions can be proposed for each identified challenge to facilitate the implementation of the Digital Rupiah?

Method

To address the interdisciplinary problem posed in this research, the author examined how law is applied in practice, integrating perspectives from other disciplines such as sociology, politics, economics, and information systems. Consequently, the author argued that socio-legal research was the appropriate methodology to employ. Socio-legal research views law as a construct influenced by social relationships, logic, context, politics, and economics—

³¹ *Ibid*, 21

³² Vlastimir Vuković, "CBDC as a Solution for Billions of Unbanked People," *Central Bank Money Research, Discussion Paper*, No. 2, October 2021, 11

³³ Wenker, *Op.Cit*, 358

essentially as living law or law in action. This approach aligned with the research's goal to investigate potential critical challenges faced during the implementation of the Digital Rupiah in Indonesia's digital financial ecosystem following the enactment of the P2SK Law as its legal foundation. The author contended that socio-legal research was well-suited for exploring law in action³⁴—how legal norms are actually applied in practice and identifying the stakeholders influencing their implementation.³⁵ Socio-legal research necessitates a critical examination of legal theory, grounded in both normative and empirical evidence. It employs a perspective that views law as a social phenomenon emerging from the collective thought and action of people, influenced by the law's application.³⁶ ³⁷ This method, developed through an interdisciplinary approach, explains legal phenomena and their connection to the social, economic, and cultural contexts in which the law operates.³⁸ ³⁹

The research utilized an interpretive qualitative approach, collecting data through literature reviews and observations. The literature review involved gathering and analyzing texts on Central Bank Digital Currencies (CBDCs) generally, and the Digital Rupiah specifically. Observations were conducted on the ongoing implementation of the Digital Rupiah by Bank Indonesia, following the directives of the P2SK Law. This research relied on secondary data, which included primary legal materials such as the P2SK Law, the Law on Currency, and other official documents, as well as secondary sources like articles, journals, and related research findings, and tertiary sources including language and legal dictionaries. The data analysis results were then descriptively presented in alignment with the research objectives. For data analysis, the author employed the hermeneutic-circle method to enhance understanding and analysis of empirical data by considering the context and interrelationships of the data components observed in the field.⁴⁰ Finally, the collected field data was analyzed and structured using NVIVO, a qualitative data analysis software.

³⁴ Darren O'donovan, "Socio-Legal Methodology: Conceptual Underpinnings, Justifications and Practical Pitfalls," in *Legal Research Methods: Principles and Practicalities*, 2016, 7

³⁵ Darren O'donovan, "Socio-Legal Methodology: Conceptual Underpinnings, Justifications and Practical Pitfalls," in *Legal Research Methods: Principles and Practicalities*, 2016, 7

³⁶ *Ibid*, 9

³⁷ David N. Schiff, "SOCIO-LEGAL THEORY: SOCIAL STRUCTURE AND LAW," *The Modern Law Review* Vol. 39, no. 3, 1976, <https://doi.org/10.1111/j.1468-2230.1976.tb01458.x>, 292

³⁸ *Ibid*, 9

³⁹ David N. Schiff, "SOCIO-LEGAL THEORY: SOCIAL STRUCTURE AND LAW," *The Modern Law Review* Vol. 39, no. 3, 1976, <https://doi.org/10.1111/j.1468-2230.1976.tb01458.x>, 292

⁴⁰ Hans-Georg Gadamer, "On the Scope and Function of Hermeneutical Reflection," *Philosophical Hermeneutics*, 1976, 18–43.

Steps of the Garuda's Project Implementation: Digital Rupiah as CBDC

In the revised interpretation of Article 2 paragraph (2) of the Currency Law, through the enactment of the UUP2SK, the Digital Rupiah is defined as a digital form of Rupiah issued by Bank Indonesia and constitutes a monetary obligation of Bank Indonesia.⁴¹ The Digital Rupiah serves the same functions as its physical counterparts—paper and metal Rupiah—acting as a legal means of payment throughout the Unitary State of the Republic of Indonesia, as well as serving as a medium of exchange and a store of value.⁴²

The Digital Rupiah, as a Central Bank Digital Currency (CBDC), is aimed at achieving three principal objectives: (1) to serve as a legal digital payment instrument within the Republic of Indonesia; (2) to act as a key tool enabling Bank Indonesia to execute its operations in the digital age; and (3) to enhance financial inclusion.⁴³ Since 2022, Bank Indonesia has been actively engaged in the development of the Digital Rupiah, progressing through several phases of implementation. The development process of the Digital Rupiah is segmented into three stages: the initial or immediate state, the intermediary state, and the final stage or end state. As of October 2023, Bank Indonesia is in the immediate state phase of development. The activities undertaken by Bank Indonesia during the immediate state phase include:

1. In November 2022, Bank Indonesia released a White Paper titled "Project Garuda: Navigating the Digital Rupiah Architecture," marking a key strategic initiative to experiment with the Digital Rupiah's architecture for both retail and wholesale applications (w-digital).⁴⁴ Similar to developments in other nations, the Digital Rupiah represents a significant evolution in currency for the digital age, aimed at enhancing financial access for Indonesians. Domestically, the Digital Rupiah's status as legal tender is established under Article 2, paragraph (2) of the Currency Law, as amended by the P2SK Law, which now includes the Digital Rupiah alongside traditional paper and metal forms.
2. As a further advancement in the development of the Digital Rupiah, Bank Indonesia published the Phase I Consultative Paper titled "Garuda Project:

⁴¹ Penjelasan Pasal 2 ayat (2) Undang-Undang Nomor 4 Tahun 2023 tentang Pengembangan dan Penguatan Sektor Keuangan

⁴² *Ibid*, Penjelasan Pasal 2 ayat (2) Undang-Undang Nomor 4 Tahun 2023

⁴³ Bank Indonesia, *Op.Cit*, "Proyek Garuda Menavigasi Arsitektur Digital Rupiah.", *White Paper*, 3

⁴⁴ Bank Indonesia, "Proyek Garuda: Menavigasi Arsitektur Digital Rupiah.", (2022), <https://www.bi.go.id/id/rupiah/digital-rupiah/default.aspx> (accessed July 21,2023)

Wholesale Digital rupiah Cash Ledger" on January 31, 2023 (w-digital).⁴⁵ This paper seeks to collect feedback from various stakeholders, including government ministries, public agencies, and private entities, on the proposed design, impacts, and benefits of the Digital Rupiah to meet both present and future needs. The initial focus of development, described in this paper, is the "immediate state" of wholesale digital cash ledger systems.⁴⁶ It introduces foundational technological functions such as the issuance, destruction, and transfer of funds. Additionally, this Phase 1 paper explores the potential effects of the Digital Rupiah on payment systems, and financial and monetary stability.

Further advancements in the Digital Rupiah development that the public is anticipating include stages such as proof of concept, prototyping, piloting/sandboxing, and a review of the policy stance.⁴⁷ Given that the development of the Digital Rupiah is still in its nascent stages, the author believes it is crucial to examine and identify critical challenges for CBDC implementation by referencing literature on CBDC implementations in various countries. This analysis could provide valuable lessons for Bank Indonesia, which is currently managing the Digital Rupiah in its initial development stage.

Identification of Critical Challenges in Implementing Digital Rupiah in the Digital Financial Ecosystem in Indonesia

In this chapter, the author outlines several challenges identified through a review of literature on the Digital Rupiah, covering the period from 2022, following the release of the Garuda Project White Paper, through to the current year, 2023. The discussion is structured around four main topics: regulatory and policy challenges, technological infrastructure challenges, public acceptance, and interoperability with existing systems.

⁴⁵ Bank Indonesia, "Consultative Paper Proyek Garuda Wholesale Digital Rupiah Cash Ledger," *Consultative Paper*, 2023.

⁴⁶ Bank Indonesia, "Proyek Garuda: Menavigasi Arsitektur Digital Rupiah," (2022), <https://www.bi.go.id/id/rupiah/digital-rupiah/default.aspx>, (accessed July 21, 2023)

⁴⁷ Departemen Komunikasi Bank Indonesia, "Rupiah Digital, Uang Masa Depan Kita," 2023, <https://www.bi.go.id/id/publikasi/ruang-media/cerita-bi/Pages/Rupiah-Digital-Uang-Masa-Depan-Kita.aspx>, (accessed November 10, 2023)

Digital Regulations, Policies and Legal Issues

This section explores the regulatory, policy, and legal challenges that stakeholders may face with the implementation of the Digital Rupiah. Firstly, the regulatory and policy foundation for the Digital Rupiah is established by Article 2 paragraph (2) of the Currency Law, as amended by the P2SK Law. However, enacted in January 2023, the P2SK Law still necessitates the formulation of secondary legislation. Regarding the management and implementation of the Digital Rupiah, the amended Currency Law specifies in Article 14a paragraphs (2) and (5) that Bank Indonesia is the sole institution authorized to manage it, with further details to be governed by Bank Indonesia Regulations.⁴⁸ Another significant stakeholder is the Financial Services Authority (OJK), which is tasked with overseeing commercial banks that distribute the Digital Rupiah, whether as retail or wholesale entities (w-digital). To date, Bank Indonesia has issued Bank Indonesia Regulation (PBI) Number 3 of 2023 concerning Bank Indonesia Consumer Protection (PBI Consumer Protection).⁴⁹ This regulation aims to bolster public trust in financial products and services and ensure the stability of the financial sector, a need that has become more pronounced following the enactment of the P2SK Law. Additionally, with the new Law Number 27 of 2022 concerning Personal Data Protection (UU PDP) and corresponding data protection standards aligned with the High-Level Principles on Financial Consumer Protection, Bank Indonesia is also adjusting its consumer protection policies.

Consumer protection, as defined in this context, includes all efforts to ensure legal certainty and safeguard the interests of consumers, who may be individuals, corporations, or business entities, whether registered as legal entities or not. This PBI further underscores regulations against the use of standard agreements that contain exoneration clauses, as stipulated in Article 15 of the PBI Consumer Protection, aligning with the Consumer Protection Law. The P2SK Law, the PDP Law, and the PBI Consumer Protection currently provide a robust initial legal framework for the development of the Digital Rupiah in Indonesia. However, the ongoing implementation of the Digital Rupiah may still prompt the emergence of additional legal issues.

⁴⁸ Pasal 14A ayat (2) dan ayat (5) Undang-Undang Nomor 4 Tahun 2023 tentang Pengembangan dan Penguatan Sektor Keuangan.

⁴⁹ Pasal 1 ayat (3) Peraturan Bank Indonesia Nomor 22/20/PBI/2020 tentang Perlindungan Konsumen Bank Indonesia

Secondly, the implementation of the Digital Rupiah introduces substantial legal challenges concerning privacy and personal data protection.^{50 51 52 53} According to research by Fanti et al., a Central Bank Digital Currency (CBDC) like the Digital Rupiah could collect sensitive payment and user data on an unprecedented scale, potentially giving the central bank extensive power to monitor and influence individual finances.⁵⁴ While beneficial for detecting fraud or money laundering, this capability could compromise privacy or security, especially if misused to support fiscal policy agendas⁵⁵. This risk is heightened by Article 50 paragraph (1) point d of the Personal Data Protection Law Number 27 of 2022, which exempts certain data controller obligations in the financial sector for state administration purposes, raising concerns about the extent of data access by the Central Bank.⁵⁶ Additionally, in the wrong hands, such sensitive data could be used to spy on private transactions, gather security-sensitive details about individuals and organizations, or facilitate theft, emphasizing the need for strong safeguards and clear regulations to protect individual privacy in the digital currency era.⁵⁷

While technical safeguards, such as privacy-enhancing technologies, are necessary for protecting sensitive data in the Digital Rupiah system, they are not a substitute for robust democratic governance. The Digital Rupiah's design and deployment involve fundamental policy decisions about what kinds of data will be collected, who can access it, and under what circumstances, choices that should reflect Indonesia's own social values and public priorities. Around the world, governance approaches to CBDCs demonstrate how these decisions vary with political context. Sweden's "need-to-know" approach operates within strong democratic institutions that emphasize transparency, accountability, and public engagement. In contrast, China's centralized control and authoritarian governance influence its CBDC deployment. Bilotta in Marmefelt argues that CBDCs could adversely foster an unprecedented centralization of information to the government; fully traceable financial

⁵⁰ Allen, *et.al*, *Op.Cit*, 7

⁵¹ Vuković, *Op.Cit*, 11

⁵² Reza Yamora Siregar, Ibrahim Khoilul Rohman, and Adrindra Putra. Narawangsa Luvianto, Afif Nicolas Gea, "Potensi Dampak CBDC Terhadap Industri Asuransi di Indonesia Potensi Dampak CBDC Terhadap Industri Asuransi Di Indonesia," *Economic Bulletin*, no. 31, 2023, 15-16

⁵³ Wenker, *Op.Cit*, 356

⁵⁴ Maulana Ihsan Fairi, Abidin Sahabuddin Zainal, and Jupriyanto, "Analisis Penerapan Central Bank Digital Currency Dalam Perspektif Keamanan Nasional," *Ekonomi Pertahanan* 7, no. 2 (2021), 230

⁵⁵ Pasal 50 ayat (1) butir d Undang-Undang Pelindungan Data Pribadi Nomor 27 Tahun 2022

⁵⁶ *Ibid*

⁵⁷ Giulia Fanti, Josh Lipsky, and Ole Moehr, "Central Bank Digital Currencies May Pose Security Risks, but Responsible Design Can Turn Them into Opportunities," *Finance and Development*, 2022, (accessed July 21, 2023), 30

transactions would facilitate political surveillance in domestic markets, particularly in authoritarian regimes.⁵⁸

These international experiences underline that effective regulation of the Digital Rupiah requires more than technological safeguards, Indonesia must strengthen democratic oversight, involve civil society, and prioritize public consultation as essential governance components. Such measures will help ensure that the Digital Rupiah advances innovation and inclusion while aligning with democratic values and human rights.

Technology Infrastructure

Digital rupiah utilizes a hybrid technology platform, integrating both Distributed Ledger Technology (DLT) and a centralized infrastructure.⁵⁹ Specifically, DLT is employed for the wholesale Digital Rupiah (w-digital)—restricted for use by entities designated by Bank Indonesia, like third-party checking accounts at the bank.⁶⁰ The DLT adopted by Bank Indonesia is permission-based, meaning it has specific rules and processes that determine which nodes or parties are authorized to read the entire ledger, add new data, and validate entries.⁶¹ This type of DLT is chosen to enhance security, as access is limited to authorized parties only.⁶² Despite this, permissioned DLT is not impervious to cyber threats. For instance, it is still vulnerable to Sybil Attacks, where attackers create multiple fake accounts to influence vote counts that verify transactions, potentially allowing them to manipulate outcomes for personal gain. Since permissioned DLT typically operates with less computing power compared to its non-permissioned counterparts, attackers with access do not need to compete against extensive global computing resources but only against the relatively limited power within the permissioned system.⁶³ To counter these risks, Bank Indonesia must implement protective measures such as selecting reliable parties and periodically monitoring verified transactions to safeguard against potential vulnerabilities.

⁵⁸ Bilotta, N. (2021). CBDCs and stablecoins: The scramble for (controllable) anonymity. In N. Bilotta & F. Botti (Eds.), *The (near) future of central bank digital currencies. Risks and opportunities for the global economy and society* (pp. 167–181). Peter Lang in Thomas Marmefelt, “Central Bank Digital Currencies and International Crises: Toward an Authoritarian International Monetary Order?,” *Politics and Governance* 12 (2024): 15, <https://doi.org/https://doi.org/10.17645/pag.i359>.

⁵⁹ Bank Indonesia, *Op.Cit*, “Proyek Garuda Menavigasi Arsitektur Digital Rupiah,” *White Paper*, 23

⁶⁰ International Bank for Reconstruction and Development and The World Bank, “Distributed Ledger Technology & Secured Transactions: Legal, Regulatory and Technological Perspectives-Guidance Notes Series Note 3: Distributed Ledger Technology and Secured Transactions Framework,” *Guidance Note*, 2020, 16

⁶¹ Bank Indonesia, *Op.Cit*, “Proyek Garuda Menavigasi Arsitektur Digital Rupiah,” *White Paper*, 23

⁶² Sri Nikhil Gupta Gouriseti et al., “Standardization of the Distributed Ledger Technology Cybersecurity Stack for Power and Energy Applications,” *Sustainable Energy, Grids and Networks*, No. 28, 2021, <https://doi.org/10.1016/j.segan.2021.100553>, 5

⁶³ *Ibid*, 5

Public's Acceptance

In 2023, a key article highlighted the potential disruptions in the economy due to the introduction of a CBDC, particularly one that bears interest. Such a CBDC aims to draw public interest by offering an "incentive" to its users⁶⁴, ensuring that all funds held at the central bank accrue the same interest rate, regardless of the holder being an individual, a corporation, or a financial institution.⁶⁵ The prospect of an interest-bearing CBDC could potentially disrupt the banking sector⁶⁶ by possibly leading to higher deposit interest rates, which in turn might increase the rates of loans or credits. Consequently, this could reduce credit uptake and investment in the economy⁶⁷. However, Bank Indonesia's White Paper clarifies that the Digital Rupiah will not offer remuneration (non-interest bearing) to its holders.⁶⁸ This decision aligns with findings from research conducted by Zams et al. at 2020, which suggested that a cash-like CBDC with no remuneration is most suitable for Indonesia. Given these characteristics, it becomes crucial to conduct thorough socialization and introduction of the Digital Rupiah to the banking and insurance industries to ensure understanding and acceptance within the financial sector.

Moreover, familiarizing the public with the Digital Rupiah is equally important, especially as people are already accustomed to using electronic money and various card payment instruments such as credit cards, ATM cards, and debit cards. This familiarity raises inevitable questions about how the Digital Rupiah differs from other existing payment methods as follows.^{69 70}

Table 1. The differences between rupiah Digital, electronic money and banking

Differences	Rupiah Digital	Electronic Money	Banking
Issuer	Issued by Bank Indonesia as well as banknotes and coins.	Comes from money recorded or circulating in commercial banks.	Comes from money recorded or circulating in commercial banks.

⁶⁴ Siregar, et.al, *Op.Cit*, 15

⁶⁵ Berry A. Harahap et al., "Perkembangan Financial Technology Terkait Central Bank Digital Currency (CBDC) Terhadap Transmisi Kebijakan Moneter dan Makroekonomi," *Bank Indonesia*, No.2 ,2017, 22

⁶⁶ Siregar, et.al, *Op.Cit*, 15

⁶⁷ Siregar, et.al, *Op.Cit*, 15

⁶⁸ Bank Indonesia, *Op.Cit*, "Proyek Garuda Menavigasi Arsitektur Digital Rupiah.", *White Paper*, 33

⁶⁹ Bank Indonesia, "Proyek Garuda: Menavigasi Arsitektur Digital Rupiah," <https://www.bi.go.id/id/rupiah/digital-rupiah/default.aspx>, (accessed November 13, 2023)

⁷⁰ Bank Indonesia, *Op.Cit*, "Proyek Garuda Menavigasi Arsitektur Digital Rupiah.", *White Paper*, 33

Holder's Obligations	Digital Rupiah is a direct obligation/claim of the holder against Bank Indonesia as the Issuer.	Electronic Money represents the holder's claim against the commercial bank/JP that issued it	Money in APMK is the holder's claim against the commercial bank/PJP that issued it.
Interest Rate	Non-interest bearing	Non-interest bearing	Interest bearing
Security	High security because using DLT or blockchain	Lower security than Digital Rupiah	Lower security than Digital Rupiah
Interoperability	Digital Rupiah has been designed to expand cross-border transactions.	Cannot be used for interstate transactions	Can be used for transactions between countries with longer processing time.

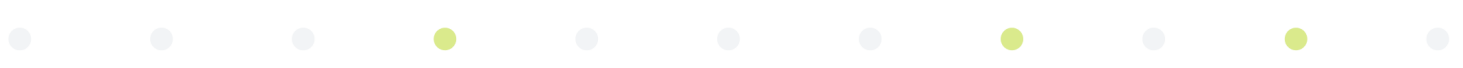
It is crucial to communicate the benefits and unique features of the Digital Rupiah to the public to ensure its positive responses. Additionally, addressing concerns about security and privacy is essential to prevent these issues from casting a negative light on the Digital Rupiah and dampening public excitement about its introduction. Beyond these challenges, requiring a digital ID for CBDC implementation can also pose significant barriers for public acceptance. Seven percent of UK households do not have internet access; this rises to 18 percent for low-income households and 18 percent of people aged 65 years or older, respectively.⁷¹ Incorporating digital identification into a CBDC may pose a serious risk of discrimination, potentially barring certain individuals from accessing the CBDC—an issue that becomes especially important in societies where cash use is minimal.

Inter-state Interoperability Issues

The design of Digital rupiah technology will adhere to six foundational principles: speed, security, resilience, interoperability, ease of development, and flexibility.⁷² A particularly

⁷¹ Ofcom Technology Tracker 2023: <https://www.ofcom.org.uk/siteassets/resources/documents/research-and-data/data/statistics/2023/technology-tracker/technology-tracker-2023-data-tables?v=329770#page=217> in Rebecca Vincent et al., "Big Bank Is Watching You: Preserving Privacy Amid the Rise of CBDCs," 2025., 21.

⁷² Bank Indonesia, *Op.Cit*, "Proyek Garuda Menavigasi Arsitektur Digital Rupiah.", *White Paper*, 29



critical principle and standout feature of Digital rupiah is its interoperability. This attribute is highlighted in the Digital rupiah business model, which focuses on the 3i aspect: integration, interoperability, and interconnection. According to Bank Indonesia, interoperability is defined as the ability of two systems to communicate or transact directly. It is anticipated that the Digital Rupiah will facilitate smoother transactions between countries, making the technology that enables interoperability exceedingly important.

Interoperability between systems can be achieved either using uniform technology or by ensuring technology compatibility.⁷³ The effectiveness of interoperability largely hinges on the connectivity of existing or future systems. In 2022, the BIS Committee issued a report on CBDC interoperability for cross-border payments titled "Options for Access to and Interoperability of CBDCs for Cross-Border Payments." This report outlines several challenges to CBDC interoperability in facilitating cross-regional transactions. Here are some of the identified challenges to CBDC interoperability in enabling transactions across different regions, as per the BIS Committee:⁷⁴

A. Investment and Maintenance Cost

Implementing a system on a uniform platform necessitates a comprehensive setup and is likely to be the most costly option initially, due to the need to ensure operational resilience and avoid any single points of failure. Consequently, it is crucial to establish a framework for how costs will be distributed among participating countries to ensure the long-term sustainability of the system.

B. Scalability

Achieving broad scalability requires countries to adopt uniform standards. Allowing variations in standards would restrict scalability, due to the complexities arising from numerous bilateral relationships among single point access systems, payment systems, and other frameworks. This leads to intricate processes and necessitates the maintenance of extensive interoperability arrangements.

C. Legal Framework and Regulations

Differences in rules and regulations, such as tax laws, payments, data-sharing, and privacy protection, across countries can lead to legal uncertainties. It is essential to confirm that the issuance of a Central Bank Digital Currency (CBDC) is legally permissible within the issuing

⁷³ Boar Codruta *et al.*, "BIS Bulletin Interoperability between Payment System across Border," no. 49, 2021., 2

⁷⁴ Bank for International Settlements, "Options for Access to and Interoperability of CBDCs for Cross-Border Payments" *Report to the G20*, 2022, 24-26

country and that the CBDC is fully recognized as legal tender under the laws of the recipient country.

D. Technology Standardization

One of the main hurdles in achieving technology standardization for CBDC systems is the coordination of technology. The lack of uniform technical standards in areas such as message formats, data elements, cryptographic algorithms, and coding systems can create friction and inefficiencies, impeding the goal of interoperability between different CBDC systems. Adopting uniform technical standards could resolve these issues, although this approach demands significant initial effort.

Additionally, the White Paper published by Bank Indonesia highlights that, beyond technical solutions for CBDC interoperability, a significant challenge in facilitating interoperability across CBDCs from different jurisdictions involves addressing business-related issues. Specifically, managing currency conversions (currency arrangements), including controlling capital flows and ensuring the provision of liquidity in different currencies, presents complex challenges that must be tackled to ensure smooth and effective cross-jurisdictional CBDC transactions.⁷⁵

Beyond the technical and legal challenges of CBDC interoperability, there are profound implications for surveillance governance that must not be overlooked. As interoperable CBDCs enable real-time data sharing across jurisdictions, they could also facilitate unprecedented levels of cross-border financial surveillance. This raises significant concerns regarding digital sovereignty, data governance, and democratic accountability. When CBDCs are interconnected, differences in national surveillance laws and data access standards can create friction, especially where authoritarian and democratic regimes interact.

For instance, China's approach to the e-CNY reflects a centralized and government-controlled system that integrates digital surveillance into its CBDC infrastructure. Despite applying anonymization technology at the wallet level, the People's Bank of China (PBoC) retains significant oversight, actively monitoring transaction patterns.⁷⁶ In contrast, Sweden's e-krona, based on the Corda DLT framework, prioritizes user privacy through a "need-to-

⁷⁵ Bank Indonesia, *Op.Cit.*, "Proyek Garuda Menavigasi Arsitektur Digital Rupiah.", *White Paper*, 43

⁷⁶ World Economic Forum, "Central Bank Digital Currency Global Interoperability Principles," *World Economic Forum*, no. June (2023): 41, https://www3.weforum.org/docs/WEF_Central_Bank_Digital_Currency_Global_Interoperability_Principles_2023.pdf.

know” architecture that restricts data access even from the central bank, in line with its democratic norms and transparent governance systems.⁷⁷

These divergent models illustrate how CBDC interoperability could exacerbate governance conflicts. For example, cross-border transaction data shared between a country like Sweden and China may face incompatible expectations around data retention, access rights, or legal recourse. Therefore, an interoperable CBDC framework must be accompanied by clear, enforceable international governance mechanisms that protect user privacy, uphold democratic norms, and ensure that cross-border CBDC initiatives support equitable development rather than enabling surveillance-based cooperation that undermines local accountability.

Integrated Solutions, Including AI-Driven Approaches, to Challenges in Implementing the Digital Rupiah within Indonesia’s Financial Ecosystem

Solutions for Regulations, Policies and Legal Digital Issues

As the Central Bank, Bank Indonesia must ensure that the design of the CBDC is crafted meticulously to safeguard public privacy and protect against cyber threats. There are examples of countries that have already developed CBDC concepts with a strong focus on privacy protection. These examples should be considered when developing a privacy security framework for the Digital Rupiah.

Swedish

The implementation of the e-krona, a CBDC issued by Sweden's Riksbank, utilizes a system known as Corda. Corda is a distributed ledger technology that operates on a "need-to-know basis" model.⁷⁸ This model ensures that only authorized parties can access information, and only as much as they need for their specific purposes.⁷⁹ The e-krona's deployment is structured on two levels: initially, the Riksbank issues SEK (Swedish Krona) to intermediaries such as banks within the e-krona network.⁸⁰ Subsequently, these intermediaries distribute SEK to end users and provide them with pseudonymous identities, which serve as network

⁷⁷ World Economic Forum.

⁷⁸ World Economic Forum, "Privacy and Confidentiality Options for Central Bank Digital Currency," *Digital Currency Governance Consortium White Paper Series*, no. November (2021), 4

⁷⁹ "ON A NEED-TO-KNOW BASIS - Cambridge English Dictionary," <https://dictionary.cambridge.org/dictionary/english/on-a-need-to-know-basis>, (accessed May 1,2023)

⁸⁰ World Economic Forum, *Op.cit*, 4

addresses for making CBDC payments.⁸¹ Within the Corda network, access to information is tightly controlled and limited to central banks, financial authorities, and intermediaries in the financial sector.⁸² This design ensures that user data and information are highly restricted and only accessible to duly authorized parties.

The primary rationale and impetus for the Swedish CBDC stems from a steep decline in cash utilization within the nation since pre COVID era in 2017.⁸³ With the decrease in cash use, the Corda may guarantee that all residents own a state-backed payment method, thus confirming the Riksbank's dedication to sustaining a stable and efficient payment system. The objective of the Swedish government is to modernize the payment system and enhance financial inclusion.⁸⁴ However, bear in mind that when applying CBDC in 2023, Sweden is already a country that operates as a predominantly cashless economy. In 2023, merely 6% of all transactions were conducted in cash, but 58% were executed via card, and over 80% of Swedes consistently utilize cards for payments.⁸⁵ ⁸⁶ Therefore, the technological and social infrastructure is already CBDC ready at this stage.

Furthermore, what worthy to note is that the introduction of an e-krona in Sweden is fundamentally a political decision.⁸⁷ An investigation on the state's role in the payment sector, conducted in March 2023, concludes that there is presently inadequate social demand for the Riksbank to issue an e-krona. Nevertheless, global transformations may result in an altered evaluation in the future. Factors in the global environment that may impact Sweden encompass market dynamics, the European Central Bank's (ECB) initiatives for a digital euro, and the European Commission's legislative proposal concerning the digital euro.⁸⁸

China

Unlike Sweden, in implementing CBDC, China has different motivation. China aims to implement CBDC to control digital money and implement government surveillance simultaneously.⁸⁹ Alongside governmental control, CBDCs in China's context may facilitate

⁸¹ *Ibid*, 4

⁸² *Ibid*, 4

⁸³ Marmefelt, "Central Bank Digital Currencies and International Crises: Toward an Authoritarian International Monetary Order?"

⁸⁴ Enrico Moch, "The Introduction of a Central Bank Digital Currency: Case Studies and Experiences from Other Countries," *European Journal of Business, Economics, and Accountancy* 12, no. 1 (2024).

⁸⁵ "Sweden Joins TIPS – Eurosystem Instant Payments Platform Also Settles in Kronor," accessed August 6, 2025, <https://www.ecb.europa.eu/press/intro/news/html/ecb.mipnews240227.en.html>.

⁸⁶ "Sweden: How to Live in the World's First Cashless Society," accessed August 6, 2025, <https://interestingengineering.com/innovation/sweden-how-to-live-in-the-worlds-first-cashless-society>.

⁸⁷ "The E-Krona – State Money in Digital Form | Sveriges Riksbank," accessed August 6, 2025, <https://www.riksbank.se/en-gb/payments--cash/e-krona/>.

⁸⁸ Marmefelt, "Central Bank Digital Currencies and International Crises: Toward an Authoritarian International Monetary Order?"

⁸⁹ Marmefelt.

digital authoritarianism. The Blockchain-based Service Network of China, introduced in 2019, seeks to promote e-CNY transactions and augment governmental digital surveillance.⁹⁰ ⁹¹ It is therefore crucial to evaluate the comprehensive blockchain strategy, which encompasses the advocacy of CBDC and the implementation of digital surveillance by the government.⁹² Despite this controversy, the implementation of e-CNY has been widespread and accepted by the public and increase financial inclusion in China.⁹³ The People's Bank of China articulated four primary reasons for the development of the e-CNY. First, potentially augment the robustness of the retail payment system; second, contribute to an improved financial system; third, boost the efficiency of the central bank payment system; and lastly, foster financial inclusion within society.⁹⁴

The People's Bank of China (PBOC) employs a two-stage process for the operation of e-CNY. In the first stage, the PBOC issues e-CNY to licensed operators.⁹⁵ Then, in the second stage, these licensed operators provide e-CNY exchange services to the public.⁹⁶ However, there are some differences in how personal data is handled compared to Sweden. In China, individual personal data is processed exclusively by licensed operators, and not by the PBOC. The central bank only maintains records of transactions between institutions.⁹⁷ To enhance privacy protection, e-CNY wallets incorporate ID anonymization technology. This ensures that personal data transmitted between wallets remains anonymous to other parties and institutions.⁹⁸ Despite these privacy measures, the PBOC actively monitors and tracks transactions to detect and prevent illegal activities.⁹⁹ Adoption of E-CNY could increase the PBOC's ability to create and implement monetary policy. Increased capacity has both benefits and drawbacks. Digital currencies provide targeted economic interventions by managing monetary flow and interest rates.¹⁰⁰

⁹⁰ Harsono H., "The Blockchain-Based Service Network: The People's Republic of China's Implementation of Digital Authoritarianism in Web3," *SAIS Review of International Affairs* 42, no. 2 (2022).

⁹¹ Marmefelt, "Central Bank Digital Currencies and International Crises: Toward an Authoritarian International Monetary Order?"

⁹² *ibid*

⁹³ Chin, G.T. China's 'digital renminbi' (e-CNY) as financial inclusion: the global frontier of central bank digital currency. *Glob. Public Policy Gov.* 5, 63–81 (2025). <https://doi.org/10.1007/s43508-025-00112-0>

⁹⁴ *Ibid*

⁹⁵ Changchun Mu, "Balancing Privacy and Security: Theory and Practice of the E-CNY's Managed Anonymity," *The People's Banks Of China*, 2022., 2

⁹⁶ *Ibid*, .2

⁹⁷ *Ibid*, .2

⁹⁸ *Ibid*, .2

⁹⁹ World Economic Forum, "Central Bank Digital Currency Global Interoperability Principles.", .16

¹⁰⁰ Jiang, J., & Lucero, K. (2022). Background and Implications of China's E-CNY. *U. Fla. JL & Pub. Pol'y*, 33, 237.

Canada

The Bank of Canada has suggested a model with three levels of privacy for transactions: confidential, pseudonymous, and anonymous.¹⁰¹ In confidential payments, only a select group of trusted parties, such as the involved bank or payment system provider, knows a person's identity.¹⁰² Pseudonymous payments mask the identity of the individual, yet there is some identifier or information that could potentially link the payment to a specific person, similar to how transactions occur in Bitcoin.¹⁰³ For anonymous payments, the transactions are structured such that they cannot be traced back to any individual.¹⁰⁴

The implementation of the Digital Rupiah could consider adopting a tiered or gradual access system, similar to those planned by the Riksbank and the PBC. This system would allow special permissions to access certain data for authorized users only, facilitating easier monitoring and stricter control over access to personal data. Additionally, the Indonesian Payment Systems Association (ASPI) recommends the use of Privacy Enhancing Technologies (PET), which incorporate methods like encryption, cryptography, authorization, smart contracts, and information retrieval for resolving conflicts during *gridlock*.¹⁰⁵

However, in the Consultative Paper released by Bank Indonesia, it is mentioned that while PET offers significant benefits, there are also several risks associated with its use. An in-depth assessment is necessary to understand the impacts of deploying PET.¹⁰⁶ Moreover, there needs to be a standardization of the data that can be accessed, viewed, or published to ensure a balanced approach between maintaining confidentiality and enabling auditability.¹⁰⁷

In addition to cyber threats and privacy challenges, the risk of fraud may also increase with the implementation of central bank digital currencies (CBDCs). One potential solution to mitigate these risks is the use of artificial intelligence (AI). AI-driven data mining tools can analyze large volumes of retail central bank digital currency transaction data to identify suspicious low-value transactions that may be intentionally structured to evade existing know-your-customer (KYC) and anti-money laundering (AML) measures.¹⁰⁸ Upon detecting such transactions, the AI system flags them and generates a concise AML risk summary

¹⁰¹ BIS Innovation Hub, *Project Tourbillon Exploring Privacy, Security and Scalability for CBDCs*, 2023, 7

¹⁰² *Ibid*, 7

¹⁰³ *Ibid*, 7

¹⁰⁴ *Ibid*, 7

¹⁰⁵ Asosiasi Sistem Pembayaran, "Tanggapan ASPI Atas Consultative Paper Project Garuda Bank Indonesia – Wholesale Digital Rupiah Cash Ledger," n.d., 17

¹⁰⁶ Bank Indonesia, *Op.Cit*, "Consultative Paper Proyek Garuda Wholesale Digital rupiah Cash Ledger," *Consultative Paper*, 11

¹⁰⁷ *Ibid*, 11

¹⁰⁸ Peterson K Ozili, "Artificial Intelligence and Central Bank Digital Currency," *Munich Personal RePEc Archive*, 2024.

explaining why these transactions are considered suspicious.¹⁰⁹ These flagged transactions, along with the AML summary, are then sent to AML compliance personnel for verification and appropriate follow-up.¹¹⁰ By continuously monitoring transactions in real time, AI systems help prevent illicit financial activities involving CBDCs, combat fraud and money laundering, and improve risk management for central banks and financial institutions.

Solutions for Technology Infrastructure

The implementation of R-Digital Rupiah (retail Digital Rupiah that functions like traditional banknotes and coins for general use) will rely on centralized infrastructure. This decision arises from the belief that permissioned distributed ledger technology (DLT) lacks the scalability needed for high-volume retail transactions, potentially slowing down the settlement process.¹¹¹ In contrast, a centralized system enables operators to increase transaction throughput without compromising security.¹¹² Moreover, this system will incorporate mechanisms for resolving gridlock in large-value transactions.¹¹³ At first glance, centralization may appear more secure and efficient¹¹⁴, but it introduces the risk of a single point of failure, where a failure in one part could incapacitate the entire system.¹¹⁵ This vulnerability, detailed in Bank Indonesia's Consultative Paper, contrasts with the resilience of DLT, where the system can continue operating despite issues with any single validator or even the central bank itself.¹¹⁶ Based on these considerations, Bank Indonesia suggests that DLT remains a viable alternative for the R-Digital Rupiah, especially given its potential to address scalability challenges effectively.¹¹⁷

Another alternative for addressing scalability challenges is the implementation of AI to optimize consensus mechanisms, thereby improving scalability concerns.¹¹⁸ However, this approach requires further in-depth research to fully understand its potential benefits, limitations, and practical deployment in retail CBDC systems.

¹⁰⁹ Han, *et.al*, in Ozili.

¹¹⁰ Ozili.

¹¹¹ Bank Indonesia, *Op.Cit*, "Proyek Garuda Menavigasi Arsitektur Digital Rupiah.", *White Paper*, 23

¹¹² *Ibid*, 24

¹¹³ Bank Indonesia, *Op.Cit*, "Consultative Paper Proyek Garuda Wholesale Digital rupiah Cash Ledger," *Consultative Paper*, 12

¹¹⁴ Bank Indonesia, *Op.Cit*, "Proyek Garuda Menavigasi Arsitektur Digital Rupiah.", *White Paper*, 24

¹¹⁵ Bank Indonesia, *Op.Cit*, "Consultative Paper Proyek Garuda Wholesale Digital rupiah Cash Ledger," *Consultative Paper*, 18

¹¹⁶ Vijak Sethaput and Supachate Innet, "Blockchain Application for Central Bank Digital Currencies (CBDC)," *Cluster Computing* 26, no. 4, 2023, <https://doi.org/10.1007/s10586-022-03962-z>, 2191

¹¹⁷ Bank Indonesia, *Op.Cit*, "Proyek Garuda Menavigasi Arsitektur Digital Rupiah.", *White Paper*, 23

¹¹⁸ Fujiang Yuan et al., "AI-Driven Optimization of Blockchain Scalability, Security, and Privacy Protection," *Algorithms*, 2025.

Solutions to Issues on Public Acceptance

In their research, Alex Zarifis and Xusen Cheng explored strategies to enhance public trust in Central Bank Digital Currencies (CBDCs).¹¹⁹ Their research put forward eight hypotheses concerning factors that could boost trust in CBDCs, and through extensive surveying and analysis, six of these were confirmed to significantly foster trust. These include: (1) confidence in the government and central bank issuing the CBDC, (2) assurances provided to users, (3) the established positive reputation of CBDCs previously launched, (4) the minimization of human intervention through automation in CBDC technology, (5) trust-enhancing features of CBDC wallet applications, and (6) robust privacy protections in CBDC wallet applications and backend processes, including options for anonymity. These factors play crucial roles in improving public trust and, consequently, acceptance of CBDCs.

A key approach to promoting this acceptance involves effectively communicating and educating the public about CBDCs. For instance, the Bank of England has implemented an educational strategy through a dedicated information page formatted in a Q&A style.¹²⁰ This resource addresses common concerns by answering questions such as "Will the digital pound be used to monitor my financial activities?", "Will there be restrictions on how I can use my digital pound?", and "Will the digital pound be safe and secure?".

Other than effective communication, the implementation of artificial intelligence can also increase customer willingness to use CBDC. A study shows that artificial intelligence positively impacts consumers' willingness to use CBDCs in the Chinese banking sector through digital technology awareness, addressing privacy concerns, and ease of use.¹²¹ AI chatbots and virtual assistants can deliver better customer support and assistance in using CBDCs. This can make the experience more user-friendly, boosting consumers' confidence in using digital currencies.¹²²

¹¹⁹ Alex Zarifis and Xusen Cheng, "The Six Ways to Build Trust and Reduce Privacy Concern in a Central Bank Digital Currency (CBDC)," *Business Digital Transformation*, 2024, 115–38, https://doi.org/10.1007/978-3-031-33665-2_6, 133

¹²⁰ Sandra Waliczek, "Privacy Concerns around CBDCs – Are They Justified? | World Economic Forum," 2023, <https://www.weforum.org/agenda/2023/11/privacy-concerns-around-cbdc/>, (accessed November 10, 2023)

¹²¹ Huizheng Liu et al., "The Impact of Artificial Intelligence on Consumers' Willingness to Use CBDCs: Evidence from the Chinese Banking Sector," *Humanities & Social Sciences Communications*, n.d., <https://doi.org/10.1057/s41599-025-05067-5>, 1

¹²² Liu et al., 10

Solutions to Inter-state Interoperability Issues

Interoperability stands as a critical and central goal of CBDCs, designed to facilitate seamless transactions across different regions or countries. Yet, as mentioned earlier, achieving interoperability is fraught with challenges that require effective solutions. In addressing these issues, the World Economic Forum has released a paper outlining potential solutions for interoperability concerns within CBDCs. The paper highlights that while a universal consensus on a CBDC interoperability framework is yet to be established, there are fundamental principles that could guide its development. The key principles proposed include:¹²³

- a. **Standardization:** Implementing uniform standards across all CBDC systems to ensure seamless interoperability.
- b. **Openness and Inclusiveness:** Interoperability should foster inclusivity, enabling participation from a diverse range of stakeholders.
- c. **Scalability:** Designing the infrastructure and protocols for CBDC interoperability to efficiently manage large volumes of transactions and scale up as demand increases, without sacrificing security or performance.
- d. **Resilience and Business Continuity:** Ensuring the interoperability framework is robust against disruptions and maintains continuous operations. Distributed ledger technology (DLT) may be employed to reduce the risk of single points of failure.
- e. **Stakeholder Collaboration:** Central banks, regulatory bodies, and other relevant parties should collaborate in establishing standards, launching pilot projects, and developing effective interoperability frameworks.
- f. **Interregional Integration:** CBDC interoperability should enhance the ease of conducting cross-border transactions and facilitate exchanges among different CBDCs.

Interoperability in CBDCs should also enable transactions between CBDCs and non-CBDC payment systems. For instance, in the e-CNY pilot project, the system is engineered to coexist and function alongside traditional payment platforms like Alipay and WeChat Pay.¹²⁴

¹²³ World Economic Forum, *op.cit*, 28

¹²⁴ *Ibid*, 16

Similarly, the Thai digital baht pilot integrates the CBDC with Thailand's RTGS (Real Time Gross Settlement) system and other authorized financial service providers.¹²⁵

Furthermore, preparing for CBDC and non-CBDC interoperability on an international level is essential from the outset. According to a publication by the Bank for International Settlements (BIS), there are three options that could facilitate cross-border transactions involving CBDCs and non-CBDC systems, including:¹²⁶

- a. Transactions can be initiated in the CBDC system of the sending party's country, transferred to the non-CBDC system within the same country, and then sent to the non-CBDC system in the receiving party's country via inter-regional interoperability arrangements established for both non-CBDC systems.
- b. Transactions can be conducted from the CBDC system of the sending party's country to the CBDC system of the receiving party's country using inter-regional interoperability arrangements. Following this, funds can be transferred from the CBDC system to the non-CBDC system in the receiving country.
- c. Transactions can be processed directly from the CBDC system of the sending country to the non-CBDC system of the receiving country using interoperability arrangements that bridge domestic CBDC systems with international non-CBDC systems.

To date, there has been no dedicated research that directly examines how artificial intelligence (AI) can address interoperability challenges in central bank digital currency (CBDC) systems. This gap underscores the need for comprehensive studies to explore the potential of AI in this domain. Future research could focus on how AI-driven protocol optimization might facilitate seamless integration across diverse CBDC platforms, thereby enhancing interoperability and efficiency in both cross-border and domestic digital currency transactions.

¹²⁵ *Ibid*, 18

¹²⁶ *Ibid*, 18

Conclusion

Based on the research and discussions conducted, it has been determined that the Digital Rupiah, as a CBDC from Bank Indonesia, represents a promising initiative that could lead to significant improvements in transaction ease. However, several challenges remain that require attention from policymakers. Notably, these challenges are not confined to a single domain. The identified challenges to implementing the CBDC in Indonesia, along with the proposed solutions as follows.

- A. Regarding regulations and policies, the implementation of the Digital Rupiah is grounded in Article 2 paragraph (2) of the Currency Law, as amended by the P2SK Law. Although the P2SK Law provides a strong initial legal foundation, it still requires further derivative regulations to be fully operational. Alongside the PDP Law and PBI Consumer Protection, these regulations form a robust regulatory framework for the development of the Digital Rupiah in Indonesia. However, as implementation progresses, additional legal challenges, particularly concerning personal data security, may emerge. However, as implementation progresses, additional legal and institutional challenges, particularly concerning personal data security, transparency, and accountability, may emerge and will require ongoing governance responses, not just legal instruments.
- B. The implementation of the Digital Rupiah may also introduce legal challenges related to privacy and personal data protection. The selection of entities involved in the CBDC infrastructure is critical to minimizing security risks, privacy violations, and unforeseen incidents. Implementing a tiered access system and/or privacy-enhancing technologies could be viable technical responses, but they must be accompanied by mechanisms that ensure democratic oversight, inclusive stakeholder engagement, and public trust.
- C. The technological infrastructure for the Digital Rupiah incorporates both distributed ledger technology (DLT) and centralized systems. DLT is employed for the wholesale Digital Rupiah (w-digital), while centralized infrastructure is used for the retail Digital Rupiah. The combination of these technologies faces various challenges, including cybersecurity risks and potential single points of failure. These issues can be mitigated by developing a well-thought-out CBDC design that ensures robust security and resilience in operation. While these may be addressed through careful technical design, the question of who controls the infrastructure and how those

decisions are made remains a matter of institutional governance and legitimacy, not merely technical design.

- D. The acceptance and integration of the CBDC are crucial to avoid conflicts with other financial sectors. Bank Indonesia should continue to engage with the financial industry to ensure economic stability is maintained. Moreover, increasing public literacy about CBDC is vital for fostering trust and enthusiasm for its future use. This cannot be treated as a top-down information campaign only, public engagement and participatory processes are essential to ensure that digital currency development aligns with broader societal values and expectations.
- E. Interoperability, a key component in the implementation of CBDC, presents multiple challenges, including the costs of investment and system maintenance, scalability, the legal and regulatory framework, and the need for technology standardization. These issues, while partly technical, are also tied to broader questions of international cooperation, jurisdictional alignment, and digital sovereignty. International collaboration among countries preparing CBDCs is essential to ensure the success of interoperability systems.

Further research of CBDC that has been implemented in other countries is necessary to support the successful implementation of CBDC in Indonesia and can provide solutions to problems that may arise.

In addition, the integration of artificial intelligence (AI) into various stages of CBDC development presents promising opportunities to address complex implementation challenges. AI can be used to enhance fraud detection, optimize consensus mechanisms to improve scalability, personalize user support to drive adoption, and potentially facilitate cross-border interoperability through intelligent protocol harmonization. However, the adoption of AI also raises fundamental questions about surveillance, bias, accountability, and control, all of which require transparent and democratic governance mechanisms. Thus, adopting AI-driven solutions could play a pivotal role in ensuring the secure, efficient, and inclusive rollout of the Digital Rupiah, but only if accompanied by ongoing public deliberation and institutional accountability.

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Universitas Gadjah Mada

➤ 21 August 2025