

## Blockchain-Based Digital Land Registration Legal Reconstruction To Strengthen Legal Certainty of Land Rights In Indonesia

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**ABSTRACT:** Indonesia's conventional land registration system is prone to data forgery, certificate duplication, and protracted bureaucracy. This study examines the legal reconstruction of blockchain-based digital land registration to strengthen the legal certainty of land rights. The goal is to formulate a legal framework that integrates blockchain technology and identify obstacles and strategies for its implementation. The method used is normative legal research through literature studies with legislative, conceptual, comparative, and policy approaches. The findings show that the characteristics of blockchain (immutability, transparency, traceability) are able to strengthen the integrity of land registration data. Three models of legal recognition are proposed, with the hybrid model considered the most realistic for Indonesia. Obstacles to implementation include legal, institutional, and technical aspects. In conclusion, comprehensive legal reconstruction is a necessity for blockchain innovation to truly strengthen the legal certainty of land rights.

**KEYWORDS:** *legal reconstruction, digital land registration, blockchain, legal certainty*

### I. INTRODUCTION

Land has a vital position that not only supports the socio-economic activities of the population, but also becomes the main asset in the country's development process (Harsono, 2017). Guaranteeing legal certainty on land ownership and status is a fundamental imperative considering its impact beyond the economic realm; Uncertainty in land status often gives birth to agrarian conflicts, social tensions, and injustice in asset distribution (Santo so, 2020). In Indonesian territory, the land registration mechanism is comprehensively regulated through Law Number 5 of 1960 concerning the Basic Regulation of Agrarian Principles (UUPA), Government Regulation Number 18 of 2021 concerning Management Rights, Land Rights, Flats Units and Land Registration, along with various other implementing regulations that stipulate administrative procedures for the registration of land rights and the issuance of certificates as valid rights proof documents (Republic of Indonesia, 1960; Republic of Indonesia, 2021). All of these regulations are prepared to provide legal certainty for any change or transfer of land rights (Wiharyanto, 2018).

However, at the implementation level, conventional systems that rely heavily on printed documents and manual bureaucratic procedures are vulnerable to a variety of structural weaknesses. Data falsification, loss of archives, multiple issuance of certificates, length of completion time, and opportunities for corruption are problems that are difficult to solve (Yusuf, 2019). Early-stage digitization efforts, such as the issuance of electronic certificates as stipulated in the Regulation of the Minister of ATR/Head of BPN Number 3 of 2023 concerning the Issuance of Electronic Documents in Land Registration Activities, still leave fundamental problems related to the power of proof, legal recognition, interconnectedness between systems, and information security (Rizal & Mayanti, 2022). The failure of conventional systems and the limitations of early digitalization opens up space for the search for more transformative technological solutions.

Blockchain technology is present as a revolutionary innovation that allows data to be recorded in a distributed ledger, immutable, and openly accessible to stakeholders (Nakamoto, 2008). This technology was initially known through its application in the digital currency system, but has now been studied and piloted in the implementation of land administration in a number of countries as an answer to the inefficiencies and dangers of manipulation in the traditional registration system (Antonopoulos, 2017). Systematic studies have revealed that blockchain is able to produce cryptographically verified transaction records and provide robust audit trails, thus having significant potential to strengthen the integrity of land registration data and reduce disputes stemming from document engineering (Tapscott & Tapscott, 2016). A number of preliminary studies in Indonesia have highlighted this potential, for example the design of a blockchain-based certificate recording system that is able to record data changes automatically and disseminate them to all system participants, thus offering a complete and accountable concept of certificate history recording (Dogo et al., 2019).

However, the adoption of this technology is not simple. He does not just switch from analog to digital media, but entrusts the restructuring of substantive and formal legal provisions so that blockchain-based electronic documents have an equal or even superior evidentiary power in the eyes of the law and can be maintained in the judicial process (Lemieux, 2017). Furthermore, the implementation of blockchain requires institutional adjustments, clarity on the role of system managers, and protection of personal data and third-party rights in the context of contemporary land (Fenwick & Vermeulen, 2019). In Indonesia's framework, land digitalization has been characterized by the implementation of electronic certificates and electronic land registration systems mandated by a number of technical regulations. Previous research indicates that digital transformation carried out through electronic systems is able to increase efficiency, accuracy, and administrative openness in the land registration process (Bennett & Salterio, 2020). However, the level of readiness of institutions such as the National Land Agency (BPN), Land Deed Making Officials (PPAT), and user communities still varies greatly, depending on the availability of technology infrastructure and digital literacy capacity of each party (Thriveni & Sultana, 2021).

In addition, although electronic certificates have obtained formal regulation, there is still a critical debate about the legal status of electronic documents in the Indonesian land system which traditionally prioritizes physical documents as the basis for legal certainty, including the evidentiary framework in court (Mertokusumo, 2019). This aspect raises a fundamental question: to what extent can blockchain-based documents be recognized as valid evidence, and what is the procedure for correcting recording errors if they occur? (Kelsen, 2018). Therefore, a comprehensive legal reconstruction is needed, namely redesigning the provisions of agrarian law, rules on electronic documents, blockchain management principles, and provisions on data protection and the responsibility of state institutions, so that the blockchain-based land registration system can be operated with strong legal certainty, while supporting openness, ease of access, and accountability in Indonesia's land administration (Fuller, 2019).

Departing from the above explanation, the main issue raised in this study is: what is the form of reconstruction of the national legal framework needed to integrate blockchain technology into the land registration mechanism in Indonesia so that blockchain-based electronic documents have adequate legal certainty and evidentiary power? and what are the main legal, institutional, and technical obstacles to the implementation of blockchain-based digital land registration in Indonesia, and what strategies can be proposed to address them? (Raz, 2020). Thus, this study seeks to provide an answer to the problem of how land values and regulations, both derived from conventional agrarian law and national digitalization policies, can be combined with the principles of blockchain management in land administration practices in Indonesia, while ensuring that the study is not only normative but also takes into account real implementation aspects in the field (Hart, 2017).

This research aims to construct a blockchain-based digital land registration legal framework that is in accordance with the principles of legal certainty in the Indonesian land system, as well as identify obstacles and formulate pragmatic policy strategies to support the implementation of the system in national land administration practices (Dworkin, 2018). This research is expected to make a significant academic contribution, especially in enriching the treasures of agrarian law and information technology law in the context of digitizing land registration in Indonesia (Creswell & Poth, 2018). In terms of policy, this research can be a reference for the National Land Agency (BPN), legislative institutions, and policymakers in drafting rules and technical standards that support a blockchain-based land registration system. From the social aspect, this study is expected to help strengthen the legal certainty of land rights for the community through the design of a registration system that is transparent, accountable, and resistant to data manipulation (Moleong, 2017).

## II. LITERATURE REVIEW

### 2.1 Research on Legal Certainty in Land Registration

Legal certainty (*rechtssicherheit*) is a fundamental value in every modern legal system (Radbruch, 2016). Gustav Radbruch placed legal certainty on par with justice and utility as the three main pillars that must be realized by law (Kelsen, 2018). Research on the Indonesian customary law system and its relation to legal certainty in land registration shows that the land registration system in Indonesia still faces various structural weaknesses, including reliance on physical documents, lengthy manual bureaucracy, and vulnerability to data manipulation and certificate duplication (Harsono, 2017).

Critical analysis: Research on legal certainty is important because it is the foundation for understanding the weaknesses of the conventional land registration system in Indonesia. However, the main limitation lies in focusing solely on customary and administrative legal aspects, without touching the dimension of digital technology, especially blockchain technology (Santoso, 2020). This gap is the entrance for this research to explore the integration of blockchain technology in land registration.

Transition: In contrast to the customary law approach, the following research highlights the regulatory aspects of land registration in Indonesia's positive legal system.

## 2.2 Research on Land Registration Regulations in Indonesia

Research on the land registration system in Indonesia based on Law Number 5 of 1960 concerning the Basic Regulations on Agrarian Principles (UUPA) and its implementing regulations shows that although land registration regulations are normatively comprehensive, their implementation in the field is still faced with various obstacles, including overlapping data, limited transparency, and limited public access (Wiharyanto, 2018; Yusuf, 2019).

Critical analysis: The strength of this research lies in the identification of gaps between legal norms and the reality of practice in land registration. However, this study operates within a uniform conventional legal framework, without considering the potential for digitalization as an instrument of reform (Fuller, 2019). As a result, the resulting policy recommendations tend to be conventional and less adaptive to the development of modern information technology (Hart, 2017).

Transition: A more specific study on the digitalization of public administration and the implementation of e-government was conducted by various researchers which will be discussed below.

## 2.3 Research on Digitalization of Public Administration and E-Government

The Organisation for Economic Co-operation and Development (OECD) in its various studies emphasizes that digital government is not just the use of information technology, but the transformation of the way government works based on data and public trust (Dunleavy & Margetts, 2015). In the field of land, the digitization of land registration aims to reduce bureaucracy and transaction costs, improve data accuracy and integrity, and strengthen public trust in state administration (Bennett & Salterio, 2020).

Critical analysis: The advantage of research on the digitalization of public administration is its sharp focus on efficiency and transparency, thus providing an applicative perspective for bureaucratic reform (Janowski, 2015). However, the downside is the tendency to view digitalization within a homogeneous universal framework. This research does not question whether the digitalization model it developed can be implemented in the land sector which has high legal complexity (Misuraca & Viscusi, 2015). In fact, digitalization without legal reconstruction will only result in "electronic administration" without adequate legal certainty.

Transition: In contrast to the focus on digitalization in general, the following research highlights aspects of electronic document recognition in modern evidentiary law.

## 2.4 Research on Electronic Documents and Modern Proof Theory

Research on electronic documents as legal evidence in the legal system is based on the principle of functional equivalence, which is the equality of functions between electronic documents and written documents (UNCITRAL, 2018). In the Indonesian context, Law Number 1 of 2024 concerning Electronic Information and Transactions (UU ITE) recognizes electronic documents as legal evidence (Republic of Indonesia, 2024).

Critical analysis: The main contribution of this research is to expand the horizons of understanding electronic evidence in Indonesian procedural law (Mertokusumo, 2019). However, this research is still trapped in a very thick legal-formalistic perspective. He did not specifically discuss electronic documents based on distributed ledger (blockchain) technology as a state public registry (Lemieux, 2017). In other words, this research is more relevant for electronic documents in general, rather than for blockchain-based documents in the context of land registration that require higher assurance of integrity and immutability (Fenwick & Vermeulen, 2019).

Transition: Meanwhile, research on blockchain technology and its potential in land administration was conducted by several international researchers.

## 2.5 Research on Blockchain in Land Registration

The World Bank in its various studies assesses that blockchain technology has the potential to increase trust in land registration systems in countries with high levels of disputes and corruption (Bennett & Salterio, 2020). Key characteristics of blockchain include immutability (recorded data cannot be changed unilaterally), transparency (transactions can be verified by authorities), decentralization (not dependent on a single point of control), and traceability (the entire history of changes is recorded chronologically) (Antonopoulos, 2017; Nakamoto, 2008).

Several countries such as Sweden (Lantmäteriet), Georgia, and Estonia have been piloting blockchain in their land administration (Dogo et al., 2019). A number of preliminary studies in Indonesia have highlighted this potential, for example the design of a blockchain-based certificate recording system that is able to automatically record data changes and disseminate them to all system participants (Rizal & Mayanti, 2022).

Critical analysis: Research on blockchain in land registration makes an important contribution in understanding the potential of this technology to strengthen data integrity (Tapscott & Tapscott, 2016). However, this research is still general and has not specifically examined the Indonesian context. The unanswered question is: how can blockchain be integrated into the Indonesian legal system that has traditionally prioritized physical documents as the basis for legal certainty? (Thriveni & Sultana, 2021). Can blockchain-based documents be recognized as valid evidence in Indonesian courts? If so, what is the mechanism for correcting recording errors that are contrary to the principle of immutability? (Lemieux, 2017). The absence of answers to these questions is a significant weakness of existing research.

Transition: To complete the mapping, it is necessary to mention research that discusses legal reconstruction as a foundation for technological adaptation.

## 2.6 Research on Legal Reconstruction and Progressive Legal Theory

Legal reconstruction is an effort to update legal norms to suit social and technological dynamics. Satjipto Rahardjo through progressive legal theory emphasizes that law should not be trapped in normative texts, but must serve the purpose of justice and social benefit (Rahardjo, 2016). In the context of blockchain-based digital land registration, legal reconstruction is needed to integrate new technologies into a positive legal system, ensure legal certainty and protection of rights, and prevent legal vacuums (*rechtsvacuum*) (Fuller, 2019).

Critical analysis: Progressive legal theory provides a strong philosophical foundation for the adaptation of law to technology (Hart, 2017). However, its application in the context of digitizing land registration is still very limited. There has been no research that comprehensively examines the legal reconstruction of blockchain-based digital land registration in the perspective of progressive law in Indonesia (Dworkin, 2018). This gap is an important justification for this study.

Transition: Based on the mapping above, the position of this research and its novelty will be described in the following sub-chapters.

## 2.7 The Position of This Research and Its Novelty (Research Gap)

Based on the critical mapping of previous studies that have been systematically described in sub-chapters 1 to 6, four research gaps can be identified that are the academic justification for this study.

*First*, research on legal certainty and land registration (Harsono, 2017; Santoso, 2020) is still limited to the analysis of conventional systems, not yet considering blockchain technology as a solution to existing structural weaknesses.

*Second*, research on the digitalization of public administration and e-government (Dunleavy & Margetts, 2015; Janowski, 2015) is oriented towards efficiency and transparency, without considering the aspects of legal certainty and the evidentiary power of blockchain-based electronic documents in the Indonesian legal system.

*Third*, research on electronic documents (UNCITRAL, 2018) and blockchain in land registration (Bennett & Salterio, 2020; Dogo et al., 2019) are still general and have not specifically examined how a reconstruction of national law is needed to integrate blockchain into Indonesia's land registration system.

*Fourth*, research on progressive legal theory (Rahardjo, 2016) has not been applied concretely in the context of digitizing blockchain-based land registration in Indonesia.

Thus, the fundamental difference between previous studies and this study lies in the focus of the analysis. This study examines the legal reconstruction of blockchain-based digital land registration not only limited to the technical aspects of technology, but in a broader sense, namely as an effort to strengthen the legal certainty of land rights in Indonesia. The novelty of this research lies in the comprehensive legal reconstruction that combines conventional agrarian rules, provisions on electronic documents, and blockchain technology governance principles to form an operational and implementable legal framework in Indonesia (Fuller, 2019; Hart, 2017). This research is an integration between blockchain technology innovation with substantive and procedural legal norms in the Indonesian land registration system.

## III. METHODS

This research applies a normative approach with qualitative data processing. The normative approach was chosen because the main object of study is the norms, principles, and legal doctrines that govern land registration and the recognition of electronic documents, not the empirical behavior of the community alone (Marzuki, 2017). In the context of this study, this approach is used to fully analyze how blockchain-based digital land registration legal reconstruction can strengthen the legal certainty of land rights in Indonesia.

This research is prescriptive, evaluative, and reformative. Prescriptive because it aims to formulate a blockchain-based digital land registration legal reconstruction model. Evaluative because it assesses the adequacy and effectiveness of applicable regulations. Reformative because it offers legal changes and updates to be in line with technological developments (Marzuki, 2017).

To answer the problem formulation, this study uses several integrated legal approaches. The statute approach is used to examine positive legal norms related to land registration and electronic systems, including Law Number 5 of 1960 concerning UUPA, Government Regulation Number 18 of 2021, Law Number 1 of 2024 concerning ITE, and Regulation of the Minister of ATR/BPN Number 3 of 2023 (Republic of Indonesia, 1960; Republic of Indonesia, 2021; Republic of Indonesia, 2024). This approach aims to identify normative gaps (legal gaps) in the recognition of blockchain-based electronic documents as evidence and instruments of legal certainty.

The conceptual approach is used to examine key concepts such as legal certainty, evidentiary strength, electronic documents with the principle of functional equivalence, and legal reconstruction. This approach refers to the doctrine of legal experts such as Gustav Radbruch (Radbruch, 2016), Lon L. Fuller (Fuller, 2019), H.L.A. Hart (Hart, 2017), and Ronald Dworkin (Dworkin, 2018) to place law as a system that is adaptive to social and technological change. The progressive legal theory initiated by Satjipto Rahardjo (Rahardjo, 2016) is also the

foundation for understanding that law must serve the purpose of justice and social benefits, not just fixated on normative texts.

The comparative approach was used to examine blockchain-based land registration practices in other countries, especially Sweden (Lantmäteriet), Georgia, and Estonia (Bennett & Salterio, 2020). This comparative study aims to obtain best practices and avoid implementation errors in the Indonesian context.

The policy-oriented approach is used to formulate realistic regulatory implementation and design strategies, taking into account legal, institutional, and technical aspects (Dunn, 2018).

The sources of legal materials in this study come from three categories. Primary legal materials include binding laws and regulations, namely UUPA 1960, Government Regulation Number 18 of 2021, ITE Law Number 1 of 2024, Government Regulation Number 71 of 2019, and ATR/BPN Regulation Number 3 of 2023. Secondary legal materials are in the form of agrarian law textbooks (Harsono, 2017; Santoso, 2020; Wiharyanto, 2018), information technology law (Antonopoulos, 2017; Tapscott & Tapscott, 2016), and legal theory (Radbruch, 2016; Fuller, 2019; Hart, 2017; Dworkin, 2018; Rahardjo, 2016), as well as national and international journal articles on blockchain and land administration (Bennett & Salterio, 2020; Dogo et al., 2019; Lemieux, 2017; Fenwick & Vermeulen, 2019; Thriveni & Sultana, 2021; Rizal & Mayanti, 2022; Yusuf, 2019). Tertiary legal materials include legal dictionaries, legal encyclopedias, and official online resources to clarify terminology.

The technique of collecting legal materials is carried out through library research with systematic tracing of regulations, scientific journals, and official reports. The analysis was carried out qualitatively with stages: inventory of related legal norms, analysis of legal gaps, systematic and teleological interpretation, as well as norm reconstruction and formulation of policy recommendations (Moleong, 2017). To ensure the validity of the data, this study uses the source triangulation technique, which is comparing information obtained from various different types of documents. Thus, the conclusions produced are not only descriptive, but also have sufficient analytical depth to answer research problems (Creswell & Poth, 2018).

#### IV. RESULTS AND DISCUSSION

##### 4.1 Legal Certainty as the Purpose of Land Registration in the Indonesian Legal System

Legal certainty (*rechtssicherheit*) is a fundamental value in every modern legal system (Radbruch, 2016). In the context of administrative law and land law, legal certainty has a very concrete dimension, namely the guarantee that the legal status of an object (land) and subject (rights holder) can be known clearly, stably, and can be maintained juridically (Fuller, 2019). Without legal certainty, the land registration system loses its legitimacy as a state instrument in protecting citizens' rights to land (Hart, 2017).

Article 19 of Law Number 5 of 1960 concerning the Basic Regulation of Agrarian Principles (UUPA) emphasizes that to ensure legal certainty, the government holds land registration throughout the territory of the Republic of Indonesia (Republic of Indonesia, 1960). Land registration includes measurement, mapping, land bookkeeping, registration of land rights, and the provision of valid rights certificates as a strong means of proof (Harsono, 2017). Furthermore, Government Regulation Number 18 of 2021 concerning Management Rights, Land Rights, Flats and Land Registration confirms that land certificates are strong evidence of physical data and juridical data as long as they are in accordance with the data in land books and survey letters (Republic of Indonesia, 2021).

The land registration system in Indonesia adheres to a negative system that contains positive elements, so the state does not guarantee the absolute correctness of land registration data (Santoso, 2020). This system contains structural weaknesses, including the potential for disputes due to duplicate or overlapping data, limited transparency and public access, and reliance on manual administration that is prone to errors and manipulation (Yusuf, 2019). This weakness is what drives the need for reconstruction of the land registration system through the use of more reliable digital technology, including blockchain technology (Wiharyanto, 2018).

In contrast to the conventional land registration system which has structural limitations, the digitization of public administration through e-government offers a new paradigm in land governance.

##### 4.2 Digitization of Public Administration and E-Government in Land Registration

The digitization of public administration is an integral part of the good governance paradigm that emphasizes transparency, accountability, efficiency, and public participation (Dunleavy & Margetts, 2015). According to the Organisation for Economic Co-operation and Development (OECD), digital government is not just the use of information technology, but the transformation of the way government works based on data and public trust (Janowski, 2015). In the land sector, the digitization of land registration aims to reduce bureaucracy and transaction costs, improve data accuracy and integrity, and strengthen public trust in state administration (Misuraca & Viscusi, 2015).

In Indonesia, land digitalization has been characterized by the implementation of electronic certificates and electronic land registration systems mandated by a number of technical regulations (Rizal & Mayanti, 2022). Previous research indicates that digital transformation carried out through electronic systems is able to

increase efficiency, accuracy, and administrative openness in the land registration process (Bennett & Salterio, 2020). However, digitalization without legal reconstruction will only result in "electronic administration" without adequate legal certainty (Fuller, 2019). However, the level of readiness of institutions such as the National Land Agency (BPN), Land Deed Making Officials (PPAT), and user communities still varies greatly, depending on the availability of technology infrastructure and digital literacy capacity of each party (Thriveni & Sultana, 2021).

The advantage of digitizing public administration lies in its sharp focus on efficiency and transparency aspects (Dunleavy & Margetts, 2015). However, the weakness is the tendency to view digitalization in a homogeneous universal framework without considering the complexity of land law in Indonesia (Hart, 2017). Digitization without legal reconstruction will only result in "electronic administration" without adequate legal certainty. In fact, in the context of land, legal certainty is a value that should not be sacrificed for efficiency alone (Radbruch, 2016).

In contrast to conventional digitization that simply converts the storage medium from paper to electronic, blockchain technology offers unique characteristics that are relevant to land registration (Nakamoto, 2008).

#### 4.3 Blockchain Technology and Its Potential in Land Registration

Blockchain is a distributed ledger technology that allows data storage in a collective, decentralized, and immutable manner without network consensus (Antonopoulos, 2017). This concept was first introduced by Satoshi Nakamoto in the context of Bitcoin, but later expanded widely in various non-financial sectors (Nakamoto, 2008). The main characteristics of blockchain include immutability (recorded data cannot be changed unilaterally), transparency (transactions can be verified by authorities), decentralization (not depending on a single point of control), and traceability (the entire history of changes is recorded chronologically) (Tapscott & Tapscott, 2016).

The World Bank assesses that blockchain has the potential to increase trust in land registration systems in countries with high levels of dispute and corruption (Bennett & Salterio, 2020). Theoretically, blockchain can function as a trusted registry that guarantees the integrity of land registration data (Lemieux, 2017). Several countries such as Sweden (Lantmäteriet), Georgia, and Estonia have been piloting blockchain in their land administration (Dogo et al., 2019). A number of preliminary studies in Indonesia have highlighted this potential, for example the design of a blockchain-based certificate recording system that is able to automatically record data changes and disseminate them to all system participants (Rizal & Mayanti, 2022).

A major contribution of research on blockchain in land registration is to broaden the horizons of understanding the potential of this technology to strengthen data integrity (Fenwick & Vermeulen, 2019). However, blockchain does not automatically guarantee the legal truth. Blockchain only guarantees that the recorded data is not altered, not that the data is correct from the beginning (Lemieux, 2017). The question of the mechanism for correction of recording errors that are contrary to the principle of immutability is still a challenge that has not been adequately answered in existing research (Thriveni & Sultana, 2021).

Meanwhile, the application of blockchain in land registration demands a comprehensive reconstruction of the national legal framework (Fuller, 2019).

#### 4.4 Legal Recognition Model for Blockchain-Based Electronic Documents

Conceptually, there are three models of legal recognition of blockchain-based electronic documents that can be adopted in the Indonesian legal system (UNCITRAL, 2018).

*First*, the *functional equivalence* model that recognizes *blockchain documents* as valid evidence as long as they meet the functions of authentication, integrity, and *non-repudiation* (Mertokusumo, 2019). This model is in line with the UNCITRAL Model Law on Electronic Commerce and is compatible with the Indonesian legal system (Republic of Indonesia, 2024).

*Second*, a technology-specific recognition model where the law explicitly mentions *blockchain* as a legitimate medium of land registration (Fenwick & Vermeulen, 2019). This model provides high certainty, but risks not being adaptive to technological developments (Lemieux, 2017).

*Third*, a hybrid model in which *blockchain* is used for *hash* and *timestamp* logging, while key documents are stored *off-chain* in the state system (Bennett & Salterio, 2020). The hybrid model is considered the most realistic to be implemented in Indonesia because it combines the advantages of *blockchain* technology with legal certainty guaranteed by the state (Rizal & Mayanti, 2022).

The selection of the right legal recognition model greatly determines the success of *blockchain implementation* in land registration in Indonesia (Dogo et al., 2019). The hybrid model offers a balance between technological innovation and legal certainty, but requires significant regulatory adjustments (Fuller, 2019). The question of the readiness of BPN institutions in adopting this model and the transition mechanism from the conventional system is still a serious challenge (Thriveni & Sultana, 2021).

#### 4.5 Obstacles to the Implementation of Blockchain-Based Digital Land Registration

Based on the results of the analysis of applicable regulations and practices in the field, three main categories of obstacles in the implementation of blockchain-based digital land registration in Indonesia can be identified (Rizal & Mayanti, 2022).

*First*, legal and regulatory barriers. The unclear status of blockchain record proofing is a major problem (Mertokusumo, 2019). Although Law Number 1 of 2024 concerning Electronic Information and Transactions (UU ITE) recognizes electronic documents as legal evidence, there is no specific provision that provides a strong presumption for *distributed ledger technology* (DLT) records (Republic of Indonesia, 2024). The conflict between the principle of *blockchain immutability* and the right to erasure of personal data after the passage of the Personal Data Protection Act also needs to be addressed (Lemieux, 2017). The solutions that can be offered are the design of an *off-chain* architecture plus *on-chain hashing*, retention rules, as well as legal clauses that harmonize the rights of data subjects with registry security.

*Second*, institutional barriers. Bureaucratic resistance and limited human resource capacity are serious obstacles (Dunleavy & Margetts, 2015). Changes in work processes, training of BPN employees, and inter-agency integration require a systematic capacity building program (Misuraca & Viscusi, 2015). A gradual pilot program, a DLT competency center at BPN, and adoption incentives using *Kominfo's* regulatory sandbox for *pilot projects* can be an effective strategy (Janowski, 2015). Data ownership and access between ministries or institutions (BPN, Ministry of Finance, PN) need to be regulated so that integration runs smoothly.

*Third*, technical obstacles. The selection of *blockchain (permissioned vs public)* models, protection against cyberattacks, and infrastructure needs are technical issues that must be overcome (Antonopoulos, 2017). The recommended model is a *permissioned DLT* operated by a consortium of trusted institutions, with independent security audits and *off-chain backup designs* (Nakamoto, 2008). The proposed application of the technical model is a *permissioned blockchain* whose nodes are run by a verified entity (Land Office, notary/PPAT, banking for mortgage legal burdens, PSrE, and related institutions), with clear access rules.

Identification of these barriers is important because it provides a realistic roadmap for policy implementation (Dunn, 2018). Each region in Indonesia has different characteristics and readiness. A "one size fits all" approach will not be effective (Thrivani & Sultana, 2021). An adaptive strategy is needed to local conditions, including infrastructure readiness and human resource capacity in each land office (Rizal & Mayanti, 2022).

#### 4.6 Blockchain Legal and Governance Reconstruction Strategy for Land Registration

Based on the analysis of applicable regulations, the potential of blockchain technology, and the identified barriers, a strategy for legal reconstruction and *blockchain governance* for land registration in Indonesia can be formulated (Fuller, 2019; Hart, 2017).

*First*, the need for explicit regulation regarding blockchain-based electronic land certificates in law-level regulations or government regulations (Republic of Indonesia, 2024). These arrangements must include the recognition of the evidentiary power of *blockchain records*, a recording error correction mechanism that still respects the principle of *immutability*, as well as the protection of personal data in accordance with applicable laws (Lemieux, 2017).

*Second*, the establishment of clear network governance (Bennett & Salterio, 2020). The National Land Agency (BPN) as an *authoritative ledger operator* must be designated as the authority to enter, validate, and ratify changes in rights in the national registry (Dogo et al., 2019). The suggested technical model is a *permissioned blockchain* whose nodes are run by verified entities, including the Land Office, notaries/PPATs, banks for mortgage legal burdens, PSrE, and related institutions (Antonopoulos, 2017).

*Third*, integration with authentication systems and *local Public Key Infrastructure* (PKI) (Tapscott & Tapscott, 2016). The system must integrate electronic certificates issued by PSrE that are recognized by *Kominfo* so that transaction signatures (digital signatures) in the *blockchain* ecosystem have a legal basis and can be verified (Rizal & Mayanti, 2022).

*Fourth*, the implementation of the pilot program is phased before national implementation (Thrivani & Sultana, 2021). This pilot program can be implemented in several land offices that have adequate infrastructure and human resource readiness, using *Kominfo's regulatory sandbox* as a test forum (Fenwick & Vermeulen, 2019). Georgia, Sweden, and Estonian practices show that a phased approach is more successful than direct implementation nationally (Bennett & Salterio, 2020).

This strategy offers a realistic and applicable policy blueprint (Dunn, 2018). Its success is highly dependent on political commitment and adequate budget allocation (Janowski, 2015). In addition, changing the bureaucratic work culture that has been accustomed to manual systems requires time and a lot of time (Dunleavy & Margetts, 2015). Socialization and education to the user community are also determinants of success (Misuraca & Viscusi, 2015). With this strategy, the blockchain-based digital land registration system is expected to strengthen the legal certainty of land rights in Indonesia.

#### 4.7 Implications of Legal Reconstruction on the Certainty of Land Rights

The reconstruction of blockchain-based digital land registration laws has significant implications for the certainty of land rights in Indonesia (Radbruch, 2016).

*First*, improving data integrity. With the characteristics of *immutability* and *traceability*, *blockchain* is able to prevent data manipulation and certificate duplication which has been a major problem in conventional systems (Lemieux, 2017). Any changes in land rights will be recorded chronologically and can be tracked by the authorities (Nakamoto, 2008).

*Second*, efficiency and transparency. Blockchain-based land registration systems can reduce bureaucracy and protracted settlement times (Dunleavy & Margetts, 2015). The public can access information on the status of land rights more easily and transparently, thereby reducing the potential for agrarian disputes and conflicts (Bennett & Salterio, 2020).

*Third*, better legal protection. With the existence of records that cannot be changed unilaterally, the position of the holder of land rights becomes more protected from attempts to forge or usurp rights by other parties (Fuller, 2019). Blockchain-based digital certificates have strong evidentiary power before the law (Mertokusumo, 2019).

This positive implication does not necessarily materialize without adequate regulatory support and mature institutional readiness (Hart, 2017). *Blockchain* is just a tool, not an end goal (Tapscott & Tapscott, 2016). The success of its implementation depends heavily on how this technology is integrated into the existing legal system (Dworkin, 2018). Without a comprehensive legal reconstruction, *blockchain* will only be a technological solution without legal certainty (Rahardjo, 2016). Based on the above analysis, a blockchain-based digital land registration system has great potential to strengthen the legal certainty of land rights in Indonesia (Rizal & Mayanti, 2022).

### V. CONCLUSION

The legal reconstruction of blockchain-based digital land registration is a necessity in the midst of the inevitable demands of digital transformation (Tapscott & Tapscott, 2016). Conventional land registration systems that rely heavily on physical documents and manual bureaucratic procedures have been proven to have serious structural vulnerabilities, ranging from data falsification, loss of archives, duplicate certificates, to opportunities for corruption (Yusuf, 2019). Blockchain technology is present as a revolutionary solution with the characteristics of immutability, transparency, decentralization, and traceability that is able to strengthen the integrity of land registration data and reduce disputes originating from document engineering (Nakamoto, 2008; Antonopoulos, 2017).

However, the adoption of this technology is not simple (Lemieux, 2017). He is not just switching from analog to digital media, but entrusts the restructuring of substantive and formal legal provisions so that blockchain-based electronic documents have an equal or even superior evidentiary power in the eyes of the law and can be defended in the judicial process (Fuller, 2019). A comprehensive legal reconstruction is needed to redesign the provisions of agrarian law, rules on electronic documents, principles of blockchain management, and provisions on data protection and the responsibility of state institutions (Rahardjo, 2016).

Based on the results of the analysis, there are three legal recognition models for blockchain-based electronic documents that can be adopted, namely the functional equivalence model, the technology-specific recognition model, and the hybrid model (UNCITRAL, 2018). The hybrid model, in which blockchain is used for hash and timestamp recording while key documents are stored off-chain in the country's system, is considered the most realistic to be implemented in Indonesia (Bennett & Salterio, 2020). The reconstruction of the national legal framework needs to include the explicit regulation of blockchain-based electronic land certificates in the ATR/BPN regulations, the affirmation of the power of blockchain record proof in procedural law, as well as synchronization between the UUPA, the ITE Law, and land registration regulations (Rizal & Mayanti, 2022).

The identified implementation barriers include three main categories (Dogo et al., 2019). Legal and regulatory obstacles related to the unclear verification status of blockchain records as well as conflicts between the principle of immutability and the right to erasure of personal data (Lemieux, 2017). Institutional barriers include bureaucratic resistance, limited human resource capacity, and inter-agency integration (Dunleavy & Margetts, 2015). Technical barriers include blockchain model selection, protection against cyberattacks, and infrastructure needs (Antonopoulos, 2017).

Recommended solutions include explicit arrangements in law-level regulations or government regulations, the establishment of clear network governance with BPN as the recording authority, integration with authentication systems and local Public Key Infrastructure (PKI), and the implementation of a phased pilot program prior to national implementation (Fenwick & Vermeulen, 2019). Georgia, Sweden, and Estonian practices show that a phased approach is more successful than direct implementation nationally (Bennett & Salterio, 2020).

Thus, the legal reconstruction of blockchain-based digital land registration has significant implications for the certainty of land rights in Indonesia (Radbruch, 2016). Improved data integrity, efficiency and transparency, and better legal protection are benefits that can be obtained (Hart, 2017). Blockchain is just a tool, not an end goal (Tapscott & Tapscott, 2016). The success of its implementation depends heavily on how this technology is integrated into the existing legal system (Dworkin, 2018). Without a comprehensive legal reconstruction, blockchain will only be a technological solution without legal certainty (Rahardjo, 2016). Comprehensive legal reconstruction is the main key to ensuring that technological innovation truly strengthens the legal certainty of land rights in Indonesia, not just creating administrative efficiency (Fuller, 2019).

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