

TOKENIZED PROPERTY OWNERSHIP: LEGAL RECOGNITION AND COMPLIANCE FRAMEWORK

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Abstract

Fractional ownership of real estate using the issuance of a token or cryptocurrency is possible due to the blockchain technology known as tokenized real estate. This innovation increases the liquidity of the market, increases access by its investors, and decreasing traditional barriers to entry. Nonetheless, the majority of jurisdictions do not have a formal legal acceptance or established compliance arrangements on such resources. The issue that will hinder decentralized ledger and smart contract adoption is the lack of harmonized legal instruments even after the technical maturity has been achieved. Other problems like the controversy of suspicion, identity verification, and registration of the title are in need of immediate regulatory intervention. This paper suggests Although there have been these technological advancements, there have been a lack respectively behind the idea of legal-tech of compliance to harmonize the tokenized real estate with its current property law regimes. Based on the comparative legal studies and technical guidelines like ERC-3643, the framework touches four main areas, (1) applying the legal status of tokens as property, (2) the enforceability of smart contracts in real estate deals, (3) the implementation of Know Your Customer (KYC), and Anti-Money Laundering (AML) regulations, and (4) enabling the cross-chain interoperability of blockchains and the national land registry. The paper recommends specific policy actions based on pilot projects conducted in nations such as Australia, Serbia and Bahrain that have been outlined to aid the creation of a well-organized, secure and legally viable digital property environment that is also scalable.

Keywords: Tokenization, Real Estate, Blockchain, Compliance, Legal Framework, Smart Contracts, Aml/Kyc, Digital Ownership, Land Registry Interoperability.

1. INTRODUCTION

As the blockchain technology has been developed, it has made significant changes to the way an asset is represented and the ways in which property can be transferred and the system of trustless verification can be achieved. One of the most promising of these uses is tokenized real estate - a physical property can be split up into tokens and then can be purchased, sold or exchanged in blockchain-enabled marketplaces. They are tokens, most frequently issued with smart contracts, and can be full or partial ownership, right to rental income, or equity in real estate property. The core system is an indelible blockchain-based record keeping, programmable compliance, and peer-to-peer transactions that are safe. These characteristics go a long way toward diminishing use of intermediaries and also decreasing transaction costs that are normally observed in real estate investment. There is the possibility of democratization of property markets with the help of tokenization as it reduces the entry level into investing and introduces liquidity into otherwise illiquid asset classes. A 2022 report of Deloitte estimated that fractional ownership and subsequent trading of tokenized property has the potential to release access to more than a trillion dollars of capital across the globe, with almost a third of the code being launched in China. New technical conventions (like ERC-721 (non-fungible tokens) and ERC-3643 (permissioned tokens) would provide models on how to encode assets in a decentralized,

but regulated setting. Although there have been these technological advancements, there lagged behind in the legal and regulatory frameworks. The tokenized property is formally not covered by the established property law in most jurisdictions or registered in national land systems. Legal issues of enforceability, list of tokens, adherence procedures and association with the existing registries need further investigation. Example: the ownership transaction on the smart contract may be legally invalid because the ownership change can only be digital and will not have weight in the court of law without the necessary paperwork and legal procedure. This paper aims to fill these gaps through the introduction of a regulatory compliance framework through which blockchain-based tokenization could be reconciled with the current legal frameworks. It is aimed at making the tokenized real estate an executable form of property right with smart legal contracts and meeting global identity verification and anti-money laundering compliance standards. The paper is based on the principle of cross-jurisdictional comparison of legal formalism between two countries like Australia and Serbia, as well as Bahrain. This paper provides practical suggestions that can be used to fill a gap between tradition and computer technology. In conclusion, this study also leads to constructing a lawful, extensible, and safe structure of token-based property ownership, to promotes investment, right of interlocutors and establishes institutional trust in online property markets.

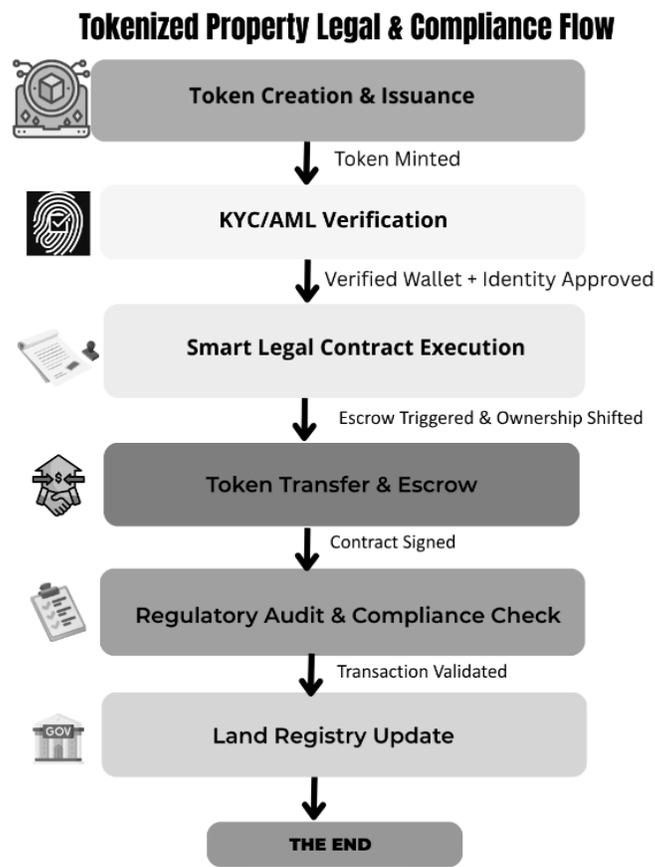


Figure 1: Tokenized property legal & compliance flow

2. PROBLEM STATEMENT

Even though the technical infrastructure to use tokens to own property has already become very robust, there are still a few fundamental obstacles to the mainstream adoption of this legal and institutional reality. Such barriers include legal ambiguity, technical gaps, and administrative fragmentation, and all those impede the process of acknowledging tokenized assets as genuine descriptions of real-world property rights.

2.1 Token Classification Ambiguity

Among the most urgent issues, there is the lack of legal certainty of the status of tokens stored as real estate. Tokens are not clearly considered as objects of ownership in culture according to property law in the majority of jurisdictions. The classification of a token as a security, certificate of ownership or a utility asset is dependent upon how the regulators, courts, or administration interpret the token.

Such uncertainty not only discourages any institutional involvement but it also makes taxation, inheritance, and transnational enforcement of rights hard to enforce. The legal scholars have expressed concerns about whether a record on blockchain, without official legal support, can grant the same legal value as a land title deed or a notarized treaty or none.

2.2 Smart Contract Enforceability

Smart contracts present an automation mechanism of transacting a transaction, but they are not universally accepted in national legal frameworks. Smart contracts have not been widely accepted by the courts and regulatory bodies in most jurisdictions, and their legality is not considered sufficient without a conventional legal document. Moreover, it is not clearly specified what, or indeed whether, a valid digital signature is, how disputes that arise as a result of the transfers that rely on the smart contracts are supposed to be handled, and how the violations are to be adjudicated. Consequently, there is a possible legal gray zone in which tokenized property transfer functions in practice due to legal deficiency (Moringiello & Odinet, 2022).

2.3 KYC/AML Fragmentation

Compliance with the Know Your Customer (KYC) and Anti-Money Laundering (AML) regulations continues to be a major blocker in adoption of tokenized real estate. The standard KYC/AML operations are face-to-face, document-heavy and are more or less centralized. By contrast, the blockchain transactions can be anonymous, pseudonymous, or cross-jurisdictional. Such inconsistency leads to massive compliance issues-especially when tokens can be bought and sold on secondary markets or decentralized exchanges. Although the technical answers in the form of zero-knowledge proofs and oracle-based identity verification are available, they are fragmented, inconsistent, or in experimental stages when regulated (Ioannou et al., 2025).

2.4 Land Registry Integration Failure

Among the least discussed problems lies the fact that the current land registry systems are incompatible with the blockchain-based systems. Majority of land titles are still kept in a paper form or a legacy digitalized system, which without real-time integration into the blockchain systems. In many cases (even when blockchain is utilized to mediate property transactions), there exists no formal relationship between the on-chain ownership of tokens and the off-chain legal title. Such disconnect brings great legal risks of title rivalry, dual ownership issues, and even fraud, endangering the reputation and trustworthiness of tokenized real estate platforms (Garcia-Teruel & Simón-Moreno, 2021).

To summarize, the table below outlines the core legal and technical challenges currently obstructing the mainstream adoption of tokenized real estate ownership:

Table 1: Key Legal and Technical Challenges in Tokenized Property Ownership

Challenge Category	Description	Example Jurisdictions	Real-World Case / Use Case	Tech/Legal Response
Regulatory Ambiguity	Conflicting laws around tokenized asset classification	USA, India, Nigeria	SEC vs. RealT (USA); SEBI delay (India); Nigeria SEC halting trials	MAS (Singapore) sandbox guidance; UAE VARA whitepapers; FINMA token framework (CH)
Smart Contract Validity	Courts don't recognize or enforce blockchain-based contracts	Germany, Brazil, Indonesia	German courts omit Ethereum rulings; Brazil needs deed notarization	Tezos smart legal templates (France); UNCITRAL Model Law on E-Commerce pilots
Land Registry Incompatibility	Legacy registries lack blockchain integration or API layers	Kenya, Mexico, Philippines	Kenya's paper records; Philippines lacks digitized title systems	Estonia's X-Road blockchain land API; Dubai Land Department blockchain integration
Cross-Border Ownership	National laws block foreign tokenized ownership	Thailand, UAE, South Korea	Foreigners blocked by UAE & Thai real estate law	Algorand's identity-gated tokens (UAE); RegD/RegS gating on Polymesh
KYC/AML Compliance	Pseudonymous chain's complicate identity verification	EU, Singapore, Canada	Brickblock (EU) hit by FATF rule; RealtyBits added centralized KYC	ZKPs (e.g., zkKYC on Polygon); Verifiable Credentials (Germany ID Wallet project)
Data Privacy & Security	Risk of exposure on public ledgers	France, Malaysia, South Africa	GDPR violations (France); off-chain storage required (Malaysia)	SSI wallets (Netherlands); Selective disclosure using Hyperledger Indy

3. METHODOLOGY

This paper entails multi-method research design, which also incorporates a doctrinal legal analysis, technical analysis of the blockchain standards, comparative regulatory analysis, and synthesis of the international best practices. The doctrinal part investigates in a thorough manner the statutory and case law relating to digital transfer and ownership of property, which gives tokenization a legal basis. Technical analysis of such latest blockchain standards like ERC-3643 and ERC-1400 is being done upon in the technical assessment due to the increased usage of these strict standards in the regulatory token issuance (Interwork Alliance, 2021). The regulatory comparisons rely on the jurisdiction of Australia, Serbia, and Bahrain, in which they have already started the legal-technical experimentation of the tokenized real estate (OECD, 2022; World Bank, 2023). The cross-functional approach maintains legality and technical viability of the proposed framework in the process of compliance setting- up in light of the overlapping fields of law, financing, information technology, and citizens governance (Ioannou et al., 2025).

3.1 Doctrinal Legal Review and Regulatory Analysis

The given research applies mainly doctrinal approach of legal research to ascertain the premise legal principles that are involved in ownership of property, asset representation, and execution of a contract. It provides progressive critique on statutory instruments, case law and legal principles of the following areas:

- The right of real estate and registration of title
- Smart contracts and validity of digital signature
- Civil law jurisdiction of tokenized assets and common law jurisdiction of tokenized assets

The paper relies on some stipulated laws even in different jurisdictions, and recommendations provided by world bodies. These are the Model Law on Electronic Transferable Records (MLETR) formulated by UNCITRAL and the Markets in Crypto-Assets Regulation (MiCA) of EU respectively in addition to compliance requirements published by the Financial Action Task Force (FATF). These tools establish legal validity in the usage of electronically supported records and set conditions in the management of tokenized assets when crossing borders (UNCITRAL, 2022; FATF, 2023; European Commission, 2023).

Besides, the reflection on the regulatory sandbox programs and the publication of the consultation papers by the jurisdiction authorities (i.e., the UAE, Singapore and Switzerland) is obtained. These sources are useful in evaluating how the experimentation of law is designed in a way that it enables innovation under the risk-averse conditions of experimentation (OECD, 2022; World Bank, 2023).

3.2 Technical Standard Evaluation

In order to enhance a legal analysis, this paper conducts a technical review of the token standards, specifically the ERC-3643 norm of the permissioned chain that allows regulatory-compliant transfer and issue of tokens. Of further concern are:

- **ERC-1400:** A hybrid standard allowing partial fungibility for real estate instruments,
- **ERC-721:** Widely used in NFT-based property applications,
- **Oracle mechanisms and identity protocols** (e.g., Chainlink, Polygon ID, W3C Decentralized Identifiers).

This evaluation examines how the emerging blockchain standards are being brought to pertinent regulatory aspects include enforceability, traceability, Know Your Customer (KYC) and Anti-Money Laundering (AML) compliance and registry interoperability. The analysis outlines technical attributes to an extent that it finds itself in the smart contract protocols to facilitate the legally compliant activity of the secondary market. These are modular compliance rules, role-based access control and token locks, which limit unauthorized transfers. They are part of the next generation protocols such as the ERC-3643, which enables the transferring of identity-linked, permissioned tokens that have on-chain regulatory limitations (ERC3643 Association, 2023; InterWork Alliance, 2022; European Commission, 2023). The standards are necessary in harmonizing smart contracts with the legal enforcement in real life as per jurisdictions.

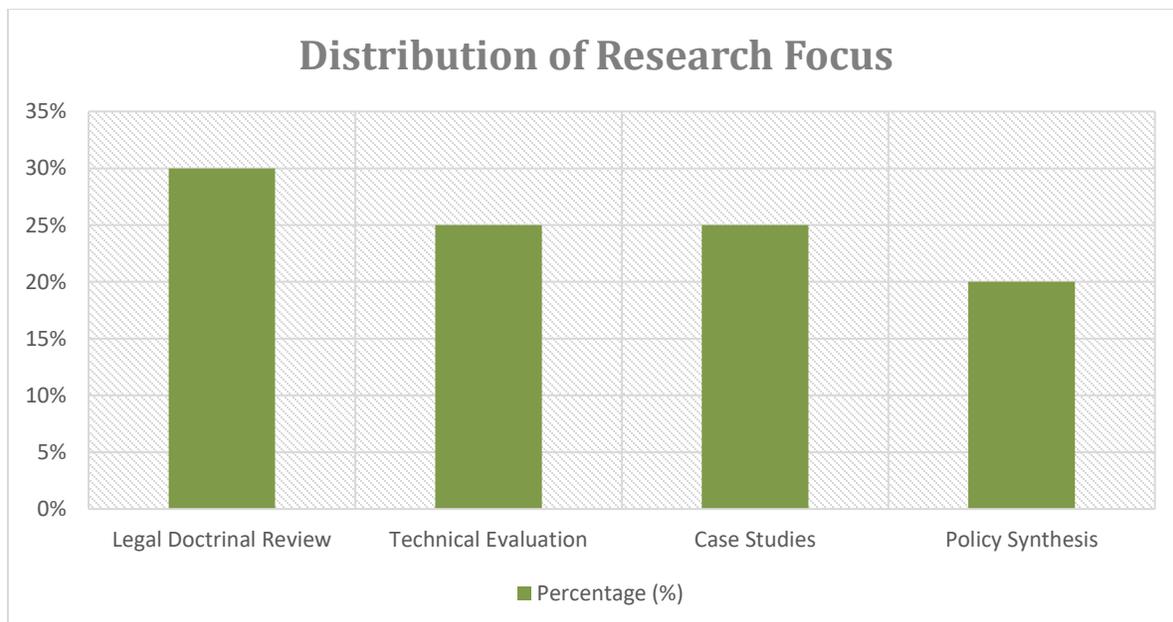


Figure 2: Distribution of Research Focus in Tokenized Real Estate Framework

This model helps to explain how the layered interaction of issuing tokens, checking KYC/AML information, smart contract execution and synchronizing labels on the registry occurs.

3.3 Comparative Jurisdictional Case Analysis

A critical element of this research is the comparative analysis of regulatory initiatives in **three jurisdictions** with differing legal systems and blockchain adoption levels:

- **Australia (Common Law):** It is the first to gain recognition with integration of blockchain into the Torrens system of land titling and electronic conveyancing legislation. The legislation like the Electronic Transactions Act and New South Wales initiatives supply tokenized real estate in terms of early-stage infrastructure.
- **Serbia (Civil Law):** Has made blockchain-based pilot registers with property notarial authentication of the sales. Still being developed, the attempts in Serbia demonstrate the adaptability of the country to the law to include the smart contracts into the civil property law.
- **Bahrain (Hybrid/Shariah-compliant):** Home to a developed regulatory sandbox managed by the Central Bank of Bahrain that allows tokenized real estate models that are compatible with the principles of Islamic finance. It shows that there is a policy-level cooperation between fintech innovation and property regulation.

The choice of these case studies was to study the different reactions of different legal traditions to the innovations in digital property, and to draw practices that can be translated to the development of universal frameworks.

3.4 Global Framework Synthesis

Lastly, the results of the doctrinal, technical and comparative elements are combined in the formation of a jurisdiction-neutral concern framework. This synthesis matches executable legal principles to programmable features available with blockchain technology, providing a framework of step-by-step steps to the goal of:

- Token classification reforms,
- Smart contract validation,
- Embedded compliance mechanisms (KYC/AML),
- Interoperability with national land registries via APIs and oracles.

The presented framework is made flexible: it may be adapted to servicing of high-capacity digital economies or jurisdictions of developing countries that are interested in the modernization of land administration.

Such stratification of approach makes the proposed legal model of recognition of tokenized property not only theoretically viable but also technically implementable, and the approach can be used by the lawmaker, blockchain developers, and legal theorists alike.

4. LEGAL AND TECHNICAL FOUNDATIONS

The idea behind tokenized real estate is quite technological, except that it requires a very stable base of legality and functional stability. The section presents the essential pillars on which the tokenized property ownership can operate in the legal and the blockchain environments. There are four areas of discussion, including (1) token legal classification, (2) enforceability of smart contracts, (3) compliance integration, and (4) land registry interoperability. These elements establish the infrastructure that should be put in place to create an enforceable and credible system of digital property rights (FATF, 2021).

4.1 Token Legal Classification

The act of legalizing the use of blockchain real estate tokens as legally accepted property titles is still unsettled in the majority of jurisdictions. Although technically sound, such tokens may not have explicit legislative support and therefore is left in a legally dubious gray area (OECD, 2022; FATF, 2023; World Bank, 2023). Tokens cannot be used in legal proceedings as traditional deeds leaving the statutory provisions to define what token is and what is its status as an ownership instrument.

In order to fill the gap, the paper presents a tokenized property certificate (TPC) a cryptographic document embedded into a smart contract that should be recognized by the law as a title to a concrete piece of real estate. The TPC would be like any normal property title, except that its validity would have blockchain signatures, and be connected to a verified digital wallet that would meet identity and KYC/AML standards. The issuance and transfer would be regulated with the help of specific legislation, and would be fully legally enforceable within the current legal frameworks (ERC3643 Association, 2023; European Commission, 2023; Ioannou et al., 2025).

Table 2: Comparative Overview of Token Legal Classifications

Jurisdiction	Token Classification	Regulatory Authority	Enforceability Level
United States	Security or Commodity (based on SEC's Howey Test or CFTC view)	SEC, CFTC	Medium – determined case-by-case; increasing SEC scrutiny
Singapore	Digital Payment Token / Capital Markets Product	MAS	High – regulated under Payment Services Act and sandbox-tested
Germany	Crypto Asset / Electronic Security (under eWpG)	BaFin	High – full legal recognition of digital securities
UAE	Virtual Asset (property tokens under VARA & ADGM regimes)	VARA, ADGM	Medium – strong legal base but evolving enforcement
Japan	Crypto Asset / Security Token (under PSA & FIEA)	FSA	High – clearly defined and supported by dual legislation
Switzerland	Payment, Utility, and Asset Tokens (under FINMA taxonomy)	FINMA	High – mature classification framework used globally
Nigeria	Utility Token (sandbox stage, pending broader classification)	SEC Nigeria	Low – pilot-stage enforcement with limited legal backing

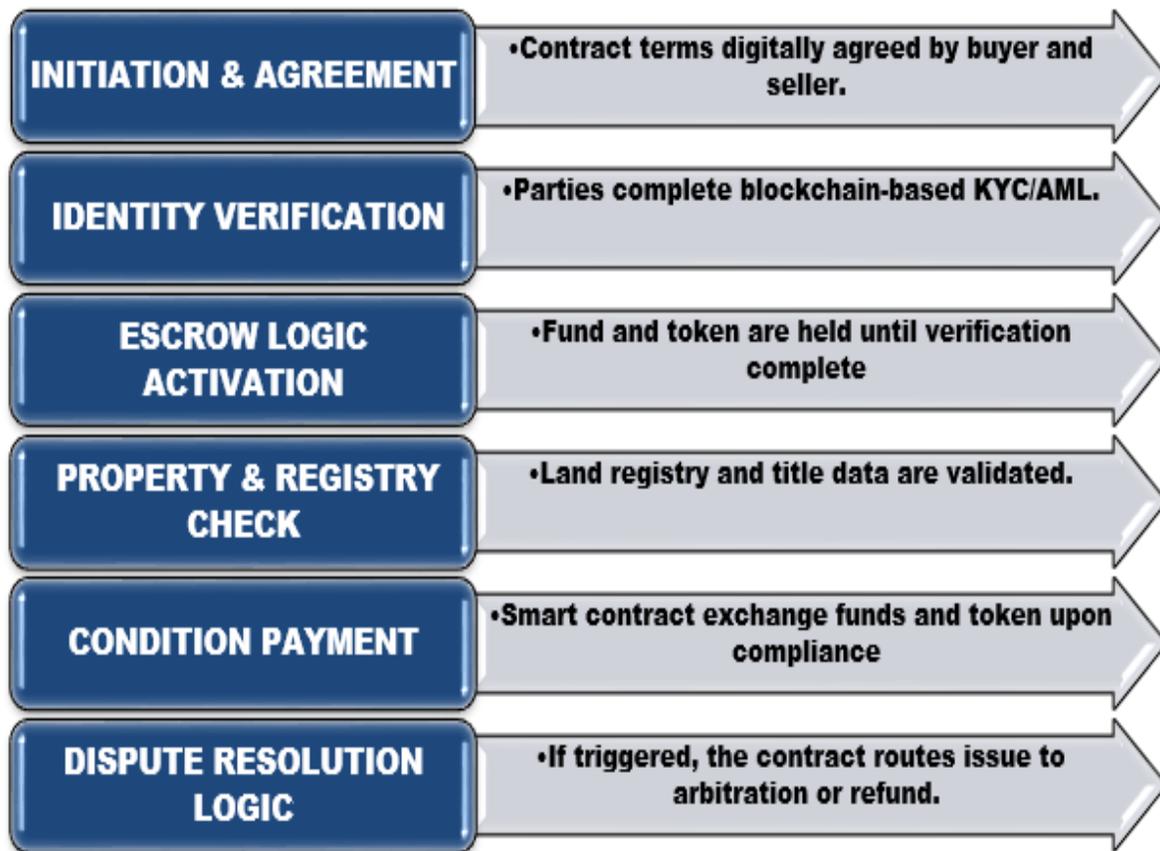


Figure 3: Smart Legal Contract Structure for Property Tokenization

4.2 Smart Contract Enforceability

Smart contracts bring automatization and efficiency in the process of tokenizing; after all, their enforceability is questionable in most jurisdictions. Smart contracts can also be legally non-binding unless they are subject to specific legal clauses and inclusion of established contractual standards by legal institutions and jurisdictions (Kaisto, Juutilainen, & Kauranen, 2024; Moringiello & Odinet, 2022).

A legally binding smart contract, sometimes known as a smart legal contract is a legally compliant executable computer code incorporating specified legal provisions, specifying important aspects like buyer and seller rights, tax liabilities and dispute resolution processes (Le et al., 2025).

To increase the legal enforceability a uniform contract flow is advisable. The components that should be involved in this structure are identity verification, live updating of the ownership, conditional payment activation, and embedded arbitration/escrow protocols. All these characteristics make it possible to realize the reliability of the contract functioning in both legal and technical spheres (Razi et al., 2024; Abualhamayl et al., 2023).

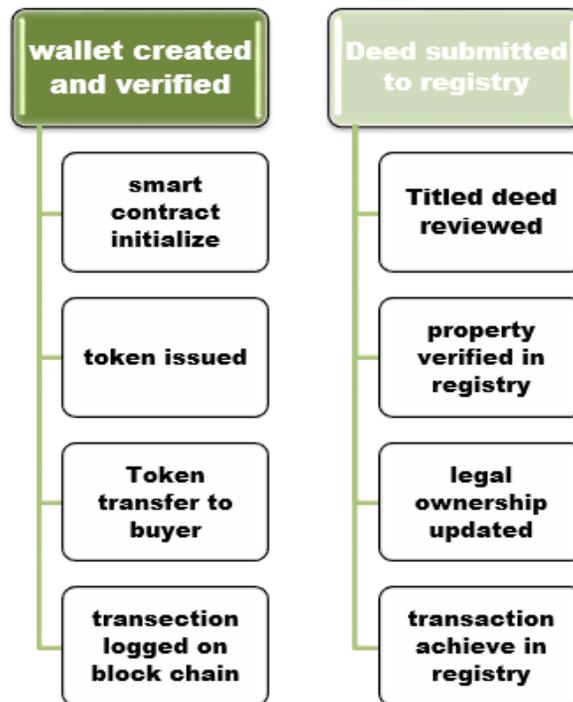


Figure 4: Stakeholder Map in Tokenized Real Estate Transactions

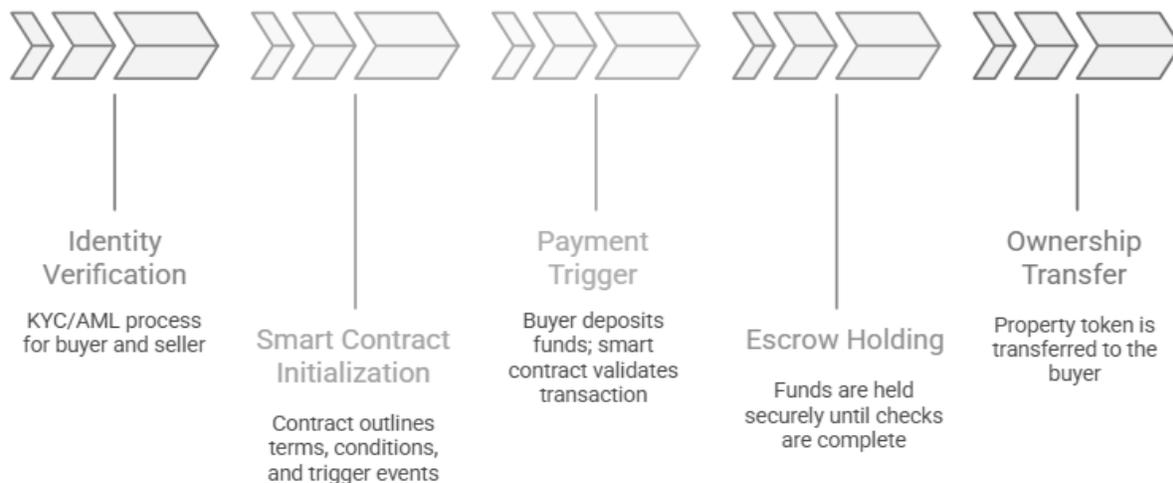


Figure 5: Smart Legal Contract Structure for Property Transfer

4.3 Compliance Integration

Regulatory compliance in transferring the tokens is achieved by having tokens that hold legal defensibility, mainly in relation to the Know Your Customer (KYC) and Anti-Money Laundering (AML) requirements. By default, on-chain transactions cannot create confidence to be compliant with it, unless accompanied by a solid identity verification and

screening transaction mechanism (FATF, 2023; European Commission, 2023). Lack of native integration with KYC/AML procedures makes tokenized real estate at risk of increased risks of regulatory arbitrage, financial malpractices, and enforcement difficulties. In order to mitigate these vulnerabilities, a number of technical solutions have been created: whitelisting, zero-knowledge proof (ZKP), and oracle-based identity systems. Nonetheless, they are only valuable as long as they are supported by laws and included into national regulatory systems (ERC3643 Association, 2023; OECD, 2022). To have full regulatory compliance, verifiable digital, identity and profiling of risk and continuous checking of compliance must be implemented across the lifecycle of the issuance, transfer and ownership of tokens. Such necessity is particularly acute in transnational terms, where standards of law are nowhere harmonized to a significant degree. This framework proposes embedding compliance technologies within the token lifecycle:

- **Identity oracles** link blockchain wallets to government-issued IDs.
- **Smart contract logic** reports suspicious activity using AML protocols such as GoAML.
- **Zero-Knowledge Proofs (ZKPs)** ensure privacy-preserving compliance.

Table 3: Compliance Integration Technologies

Technology	Function	Jurisdiction(s)	Legal Basis / Regulation Referenced
Zero-Knowledge Proofs	Enables identity verification without exposing personal data	Switzerland, Estonia, EU	GDPR Art. 5 (Data Minimization); FATF Travel Rule
Smart Contracts	Automates escrow, KYC/AML checks, and payment release	USA, Singapore	SEC Digital Asset Framework (USA); UNCITRAL Model Law on E-Commerce
Digital Identity Wallets	Stores verifiable credentials with selective access	Germany, Netherlands	eIDAS 2.0 (EU Regulation); NIST SP 800-63 (USA Digital Identity Guidelines)
On-Chain Audit Trails	Provides immutable logs for audits and regulatory transparency	UAE, United Kingdom	Basel III (Financial Transparency); ISO/TC 307 Blockchain Governance
Token Gating / Whitelists	Restricts token transfers to compliant, verified participants	France, USA	EU MiCA Regulation; SEC Rule 506 (Reg D Transfer Restrictions)

Through the adoption of these layers, tokens can be transferred in a compliant and regulatory-resistant manner and hence can be eligible to be moved across borders in real estate transactions.

4.4 Land Registry Interoperability

Although many blockchain ledgers have come up, there is no alteration in that the status of land ownership is legally actualized by the government records. To have legal standing

of tokens, there should be interoperability between blockchain-based ones and centralized land registries.

- **Token transactions** automatically trigger updates in registry records.
- **Registries** validate blockchain signatures via public-private oracles.
- **Audit logs** record every state change, ensuring traceability.

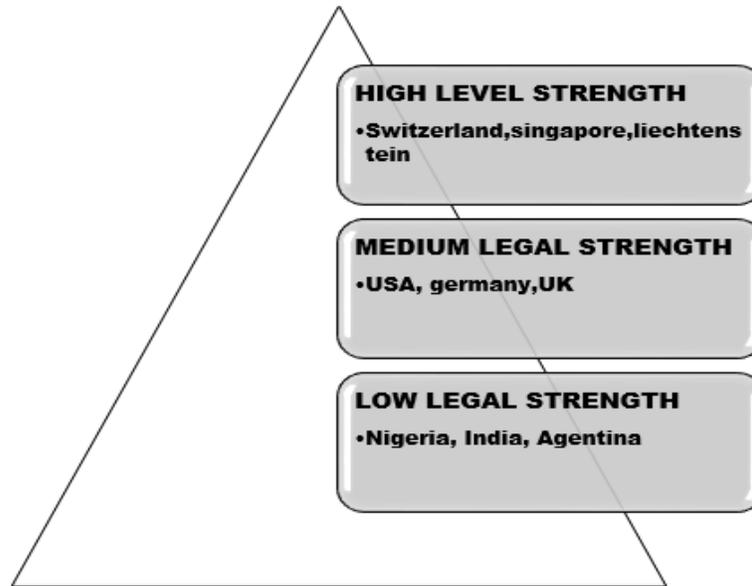


Figure 6: Token Classification Pyramid by Legal Strength Across Jurisdictions

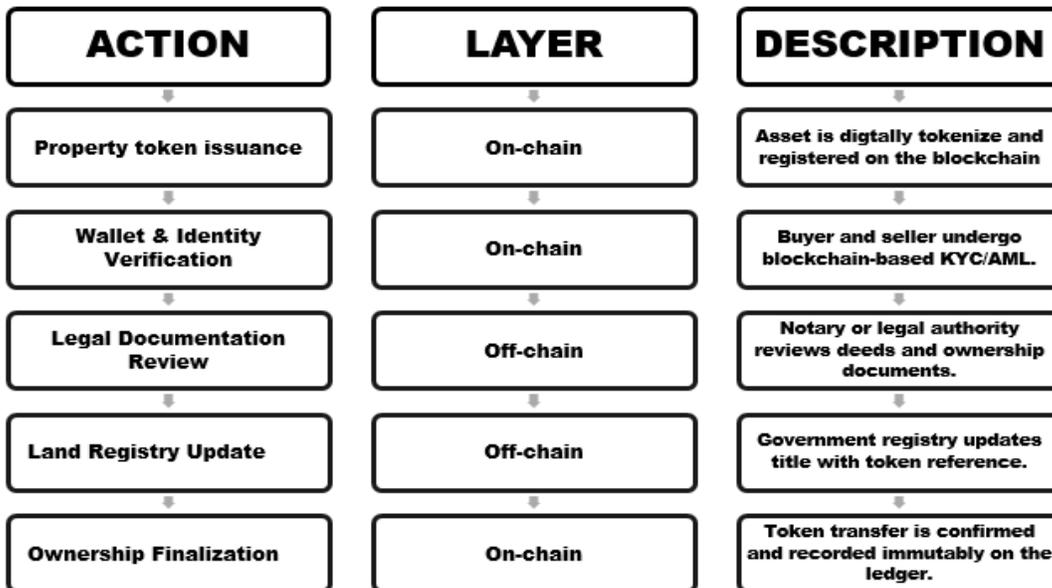


Figure7: Blockchain–Land Registry Interoperability Model

Such an in-depth foundation covers the gap between the legal acceptance and technical application, providing a realistic way to implement tokenized property on a large scale. The following chapter will be an exploration of real-life applications in comparative case studies, providing useful information on methodologies of adaptations and ways of reform within jurisdictions.

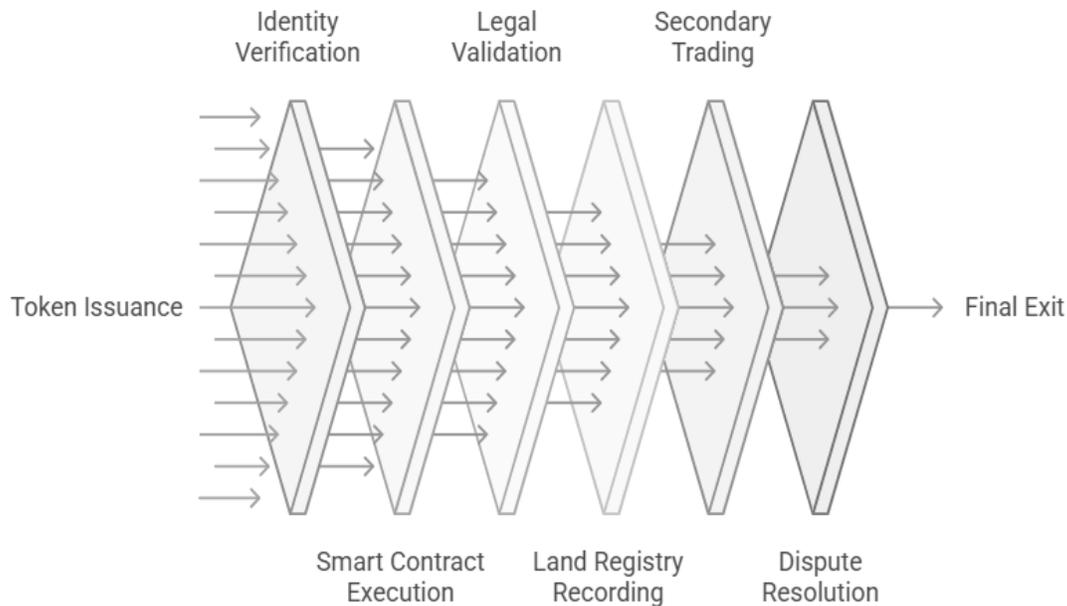


Figure 8: Lifecycle of Tokenized Property Transaction with Legal and Compliance Checkpoints

5. CASE STUDIES IN LEGAL REFORM

In order to contextualize the proposed framework, this section will present case studies of the jurisdictions that actively experiment or are implementing legal changes involving tokenized real estate. These illustrate that the level of legal-technical integration also varies, including regulatory sandboxes, solutions where a digitalized notarial service is used, and operational blockchain platforms to register land.

Various legal cultures in nations like Australia, Serbia, Bahrain, the UAE, Estonia, and Switzerland provide good comparative information on how to incorporate the tokenization system into national laws and regulations of the real estate market.

5.1 Australia: Torrens Title Meets Blockchain

The Torrens title system developed by Australia offers an advanced environment in achieving blockchain integration with the real estate market, in the sense that, it is already digitized with records of property ownership. The New South Wales and Queensland have

launched pilot projects to automate title transfer and register mortgages based on blockchain technology (Australian Property Institute, 2021).

Blockchain's experimental uses have been identified in e-conveyancing with Land Use Victoria and private sector participants besides preparation of various reports. Such initiatives demonstrate the importance of revising the current Electronic Conveyancing National Law (ECNL) and introducing its policies to accept not only digital signatures but also blockchain-enabled changes in titles that can be performed via smart contracts.

The reforms will take the form of legal compliance in tokenized property, which would undergo KYC (Know Your Customer) and escrow processes.

5.2 Serbia: Smart Notarial Contract Enforcement

Serbia provides a fresh pattern of blockchain transactions legal recognition in East Europe. Government has rolled out pilot programs that have enabled smart notarial contracts more so in civil action. Such contracts are regarded as binding, provided that they comply with the principles which are accepted by the community and that such contracts are notarized (Radovanovic & Bjelica, 2022).

Even though the land registry is still a centralized system dominated by manual records, the condition of accepting smart contracts and digital signatures as valid legal evidence creates a significant precedent in civil law jurisdictions in which the legal blockchain solution has been piloted as a hybrid of the legal and blockchain domains.

5.3 Bahrain: Sharia-Compliant Regulatory Sandbox

CBB has approved a regulatory sandbox highly specific to blockchain-powered tokenization of real estate issued in accordance with the principles of the Sharia law transparency, asset-based-backing and the fact that interest (riba) is not permitted (CBB, 2021). In this sandbox, the tokenization platforms have to undergo the tests not only to check whether they are technologically sound but also whether they are religiously compliant. Notable applications include blockchain enabled sukuk (Islamic bonds), and leasing contracts. Such a combination of validations (legal and religious) ensures that the system is acceptable as far as Islamic finance is concerned and morally strong.

5.4 UAE: Progressive Frameworks in Dubai and Abu Dhabi

The United Arab Emirates (UAE) provides one of the most advanced legal frameworks in regard to blockchain and tokenized property. Registration of smart contracts and blockchain-based title records has been possible with the help of both Dubai Land Department and Abu Dhabi Global Market (ADGM, 2022).

Key reforms include:

- Legal recognition of smart contracts under Federal Law No.
- Use of regulatory sandboxes to pilot fintech innovations
- Public private partnership for automated Land Registry (Dubai Land Department, 2021)

These top-down governmental innovations mirror a top-official attempt to modernize lawful structures, introduce tokenization, and prompt foreign investment.

5.5 Additional Jurisdictions: Estonia and Switzerland

- Estonia is considering the use of tokenization in its land titles, and has yet to roll it out, however they use blockchain as part of its e-government and land registry reviews. Its e-Residency program and its municipal blockchain applications provide a base that can be built on to use tokenized property (Estonian Land Board, 2021).
- Switzerland In the DLT Act of 2021 and FINMA 2022 guidance, will permit tokenization's of securities and require licensed custodians and wallets to comply with KYC regulations. Although tokenized real estate is not regulated yet directly, such platforms as Bloc Kimmo work within such a legal framework (FINMA, 2021).

Table 4: Summary of National Legal Approaches to Tokenized Real Estate

Country	Legal Framework Type	Pilot Status	Blockchain Platform Used	Token Standard
Switzerland	FINMA-regulated DLT Act for digital assets	Completed (2022)	Ethereum	ERC-1400
Germany	Electronic Securities Act (eWpG)	Ongoing (2025)	Polygon	ERC-3643
Singapore	MAS Sandbox for real estate tokenization	Completed (2023)	Tezos	FA2
UAE	ADGM framework under Virtual Assets Regulations (VARA)	Ongoing (Phase II)	Hyperledger Fabric	Custom
USA	SEC-compliant offerings (Reg D / Reg A+)	Mixed status	Ethereum / Stellar	ERC-20 / ST-20
Japan	PSA & FIEA-regulated tokenization via JV platforms	In development	Private Consortium Blockchain	ERC-1400 variant

These case studies demonstrate that, although no jurisdictions have yet managed to build a fully autonomous tokenized property ecosystem, several jurisdictions have been putting laying down the legal and technical foundations. The strength and cultural sensitivity of tokenized real estate are demonstrated by the legal pluralism, given through common law in Australia and the principles of Sharia in Bahrain.

6. PROPOSED COMPLIANCE FRAMEWORK

Considering the gaps in the legal and technical aspects explained in the above sections, the current paper offers the basis of an incremental compliance system aimed at achieving that blockchain-based tokenized real estate will be successfully bound to the current legal frameworks.

The system will be designed on four pillars namely token law, contract law, regulatory compliance and land registry interoperability. All pillars discuss key requirements in terms of the legalization of tokenized ownership and realization of property and its secure execution.

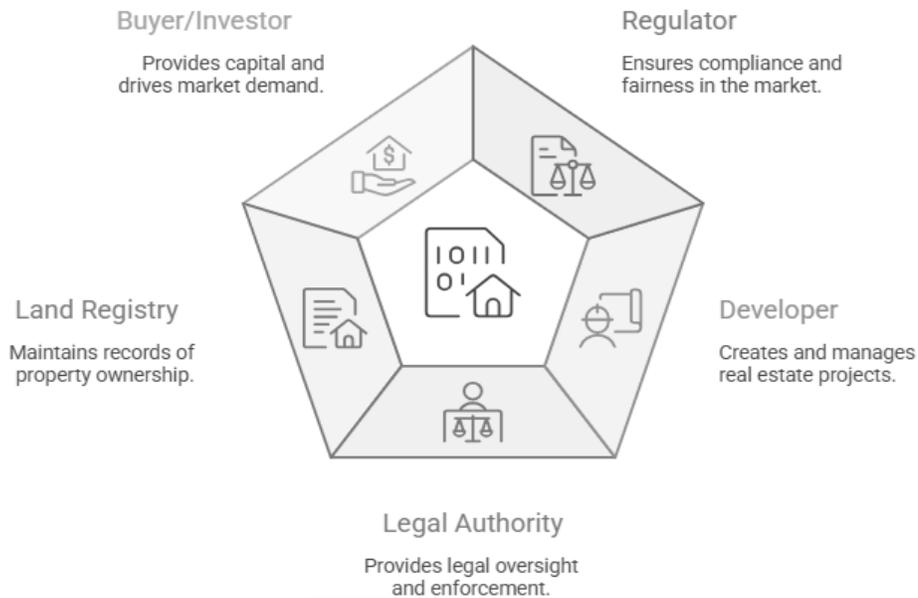


Figure 9: Stakeholder Map for Tokenized Real Estate Ecosystem

This is a cross-cutting framework that facilitates legal legitimacy, technology reliability and institutional acceptable jurisdictions thus facilitating the ability of either reforming individually or collectively. It is aimed at developing a model that can be scaled and adjusted to the national legal traditions and at the same time corresponds to global best practice.

Table 5: Multi-Domain Legal-Technical Reform Matrix

Reform Domain	Description	Legal/Technical Components	Responsible Stakeholders
Token Legislation	Establishing legal recognition of tokenized property rights	Smart contract enforceability, digital asset classification	National legislators, regulatory bodies
Contract Law Reform	Updating property transfer and escrow procedures to support automation	Self-executing agreements, AI-triggered performance clauses	Legal councils, bar associations, developers
Data Privacy & Compliance	Aligning tokenization processes with GDPR, HIPAA, etc.	On-chain anonymization, selective disclosure protocols	Data protection agencies, privacy consultants
Registry Integration	Enabling land registries to record token-based property ownership	API development, blockchain-record validation	Land registry authorities, tech vendors
Interoperability Standards	Harmonizing systems across jurisdictions and platforms	Use of oracles, cross-chain bridges, unified APIs	ISO committees, blockchain consortiums
Consumer Protection	Safeguarding retail investors and buyers in token markets	Transparent disclosures, fraud prevention tools	Consumer watchdogs, FinTech regulators
Dispute Resolution	Developing legal frameworks for resolving on-chain/off-chain conflicts	Hybrid arbitration models, jurisdictional protocols	Arbitration forums, judiciary, legal tech firms

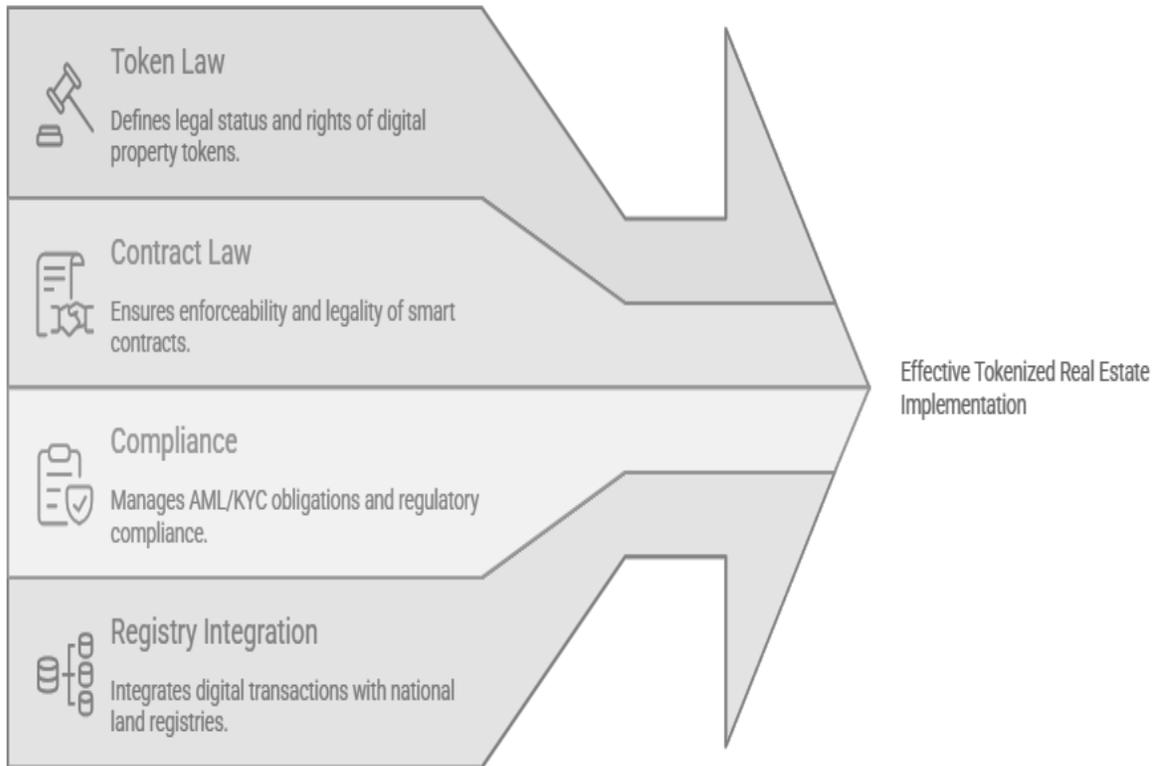


Figure 10: Pillars of Legal-Technical Reform for Tokenized Real Estate

This model of compliance is not rigid: jurisdictions based on common law can consider the enforceability of the contract, and jurisdictions based on the civil law can start with recognition, or with integration in the registry.

It is also globally future-proof and will be in line with the new world trends in regulatory developments, such as the EU MiCA Regulation, the Dual-Layered Model Law on Electronic Transferable Records (ULETR) and Model Law on Electronic Transferable Records (MLETR) by UNCITRAL, the FATF guidance on digital assets.

This model can complement the legal reformation modalities to meet the standards of technology and consequently close the gap between the conventional legal systems and those on blockchain-based property rights. It gives some sort of a guideline not only to the national governments but also to the developers of platform, real estates, and international laws institutions.

7. POLICY RECOMMENDATIONS

Strategic legal governance is also important in the effective implementation of the tokenized properties system in addition to critical readiness. Based on the comparative insights and proposed compliance model, this section provides the highlights of possible

policy measures that need to be taken by lawmakers, regulators, and real estate authorities to guarantee safe, scalable and legal-enforcing tokens-based real estate ecosystems.

1. Establish Regulatory Sandboxes

The government should develop regulatory sandboxes where legal-tech can be experimented on in real estates. In such sandboxes, innovators and regulators cooperate on developing smart contracts, testing interoperability APIs, and conducting tests of KYC/AML processes in an environment that does not expose them to the entire market.

Sandboxes also enable cross-sector cooperation between the stakeholders in the legal and financial technology, as well as land management sectors, and offer iterative feedback on official legislations.

2. Standardize Legal Templates and Investor Protections

Regulators should create standardized templates of smart contracts on real estate tokenization, including dispute resolving, taxation, and transferring conditions. No less significant will be the codification of investor rights such as transparency requirements, risk disclosures and protections of minority token-holders. Such actions decrease legal uncertainty, as well as foster institutional adoption.

3. Enable Decentralized Digital Identity Integration

The jurisdictions need to license decentralized identity systems so as to gain compliance without infringing on user privacy. Such technologies as oracles and zero-knowledge proofs (ZKP) provide a possibility to integrate self-sovereign identities (SSI) into smart contracts. This method of conclave gives users the capability to manage and disclose credentials selectively to support transparent KYC/AML to an open-access structure.

4. Promote Interoperability with National Registries

Governments are advised to integrate registry-agnostic APIs that enables authorized blockchain platforms to synchronize transactions into centralized or semi-decentralized land registries.

With both on-chain and off-chain consistency, this reform blocks any possibility of double ownership, fraud, or vagueness in titles. There can be the formation of public-private consortiums to pilot these synchronization mechanisms.

5. Facilitate International Legal Harmonization

With the international nature of the tokenized real estate, international legal convergence is paramount. Nations are to cooperate with the UNCITRAL, FATF, and World Bank institutions and harmonize the digital asset classification, identity provisions, and tax reporting principles. Bilateral pilot projects can be models of multilateral implementation.

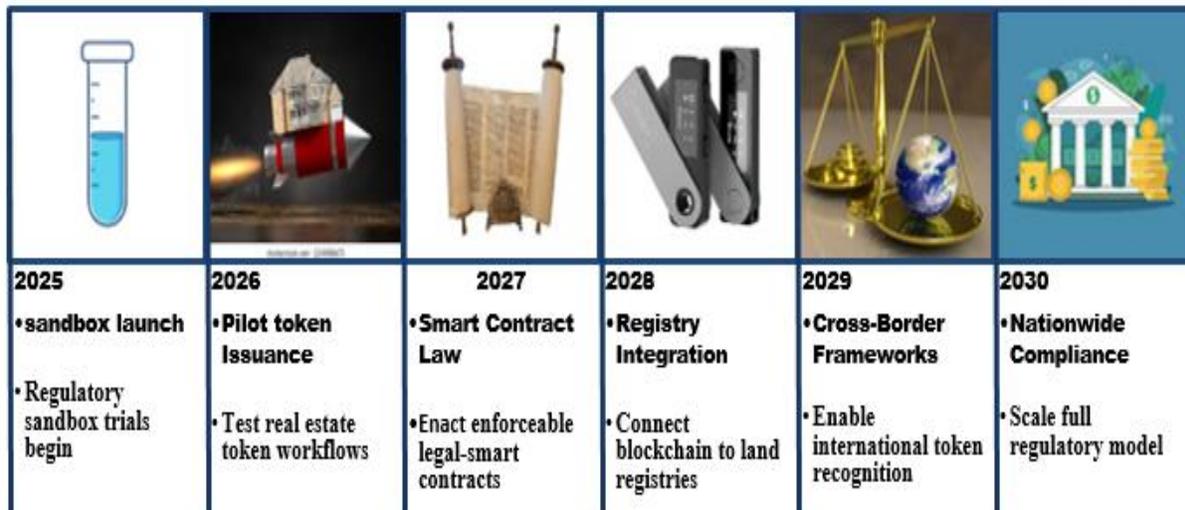


Figure 11: Roadmap for Legal Integration of Tokenized Real Estate (2025–2030)

8. IDENTIFIED GAPS AND RECOMMENDATIONS FOR FUTURE WORK

These are some of the major gaps that even with this research, will still need to be filled in order to be global in the legal reflection and technical staging of tokenized real estate of systems of systems of compliance.

These gaps include scopes of empirical validations, synchronization of legislations, flexibility of platforms, privacy of the data, and coverage of the policies.

To encourage spreading of the concept of tokenization of property ownership, these loopholes are listed and divided in the following table, by the urgency and targeting. This strategic priority document is going to redirect the future on policy development, pilot testing and on reformation of regulation.

Experiments of regulatory sandbox may draw some early insights. As another scenario, during the Singapore MAS FinTech Sandbox, the sales of property tokens were tested with Tezos blockchain, indicating the problem of onboarding investors and verifying their KYC.

In the ADGM RegLab in Abu Dhabi, the tokens representing the leasing of real estate have been tested on smart contracts linked to notarized papers. Estonia undertook an experiment with its e-Governance sandbox that greatly investigated integration between tokens on blockchain with the country ID infrastructure.

These experiments explain the potential usefulness of real-world experimentation in areas of both design of law and technological preparedness.

Table 6: Identified Gaps and Recommendations for Future Work

Priority Level	Gap Area	Recommended Action
High	Lack of Unified Token Classification	Develop a cross-jurisdiction legal taxonomy for asset-backed token definitions
High	No Standard for Registry–Blockchain Interoperability	Design interoperable APIs and metadata schemas to link blockchain with land registries
High	Empirical Data Deficit	Support the framework with sandbox simulations, stakeholder interviews, or pilot case studies
Medium	Weak Protection of Token Holder Rights	Introduce governance, voting, and income distribution rules via smart legal contracts
Medium	Overreliance on Ethereum Standards	Incorporate non-EVM blockchains like Tezos, Cosmos, and Hyperledger into the model
Medium	Cross-Border Legal Conflicts	Address enforceability through legal scenarios and recognition protocols
Medium	Privacy and Ethical Risks in KYC/AML	Assess ZKP misuse, oracle vulnerabilities, and GDPR-aligned identity systems
Low	Lack of Economic Impact Modeling	Provide ROI models, liquidity forecasts, and cost-benefit analysis
Low	Insufficient Visual Communication	Improve diagrams for legal-technical flows, architecture, and jurisdictional logic

8.1 Empirical Data Deficit

Among the most significant failures within the existing compliance framework lies the lack of an empirical proof via live deployment. The model does not have any regulatory sandbox testing, simulation and pilot examples that it has been tested within even though it is a well-structured and theoretically sound way of regulations of a tokenized property realm. It is speculative without such empirical examples proving and would not want to argue that the framework can be legally and operationally acceptable especially in cross border areas where there are differences in institutions and jurisdictions.

There have however emerged world precedents that show how such frameworks are viable. As an example, the Monetary Authority of Singapore (MAS) FinTech Sandbox experimented with the use of tokenized property transactions on the Tezos blockchain with special attention to the compliance of smart contracts and onboarding procedures. Likewise, the Self Executable Token with Notarized PDFs: Blockchain-enabled Dual-Layered Tokenization of Leases presented by the Abu Dhabi Global Market (ADGM) RegLab considered blockchain, combined with notarized PDFs, to support a dual-layered tokenization of lease agreements, to proffer a hybrid form of enforceability.

Estonia in the meantime, the e-Governance Blockchain Testbed of Estonia has tested how to integrate tokenized ownership in the Estonian infrastructure (X-Road), associating the tokens of the property with the national ID and land registries. Although these experiments were promising, they also showed the shortcomings using the civil law systems to enforce smart contracts.

Recommendation: The framework in future should be advanced to have formal involvement in these sandbox environments so as to gain real and useful regulatory feedback. Also, one should gather empirical data via assessing specific stakeholders, related to registry, via interviewing or surveying these registry officials and legal practitioners, as well as, developers and regulators. The contributions will assist in the validation of the assumptions of the framework as well as establishing the procedural obstacles and adjusting the design to the realities of the jurisdiction. By filling in these empirical dimensions into the framework, not only will it enhance its legal validity and build the institutional confidence in it, but will also enhance cross-border adaptability, eventually converting the theoretical into an effective and functional compliance model.

8.2 Lack of Legal Taxonomy Across Jurisdictions

The absence of a legal taxonomy of basic concepts of ownership, title, and transferability of real estate to different jurisdiction and legal systems is one of the main hindrances of the cross-border bringing to life of the tokenized real estate. These terms vary greatly in interpretation and validity in a common law jurisdiction, civil law jurisdiction, and a Sharia-compliant jurisdiction. In the absence of a common framework of interpretations, legal interoperability is an issue of concern, as the result is the existence of fragmented compliance systems that are hard to streamline on the international levels.

Recommendation: Among the general principles of law is that, a comparative legal taxonomy matrix be formulated to bring uniformity regarding the legal concepts surrounding property across jurisdiction. This tool increases the transparency of legal situations and advances the capacity of the tokenized systems to continue functioning under the various legal cultures. The example of a taxonomy matrix which is to be used to associate the core property terms to the jurisdiction-specific terms, is presented below.

Table7: Comparative Legal Taxonomy of Property Terms Across Jurisdictions

Term	Common Law (UK, US)	Civil Law (Germany, France)	Sharia Law (UAE, Saudi Arabia)
Ownership	Legal right to exclusive possession and control	Codified ownership defined by state-managed civil codes	Stewardship concept; ownership as trust under divine law
Title	Evidenced through registered deed or title document	Registered via national notarial systems or land registries	Often informal or contractual; emphasis on witness and intent
Transferability	Freely transferable by legal conveyance or private agreement	Requires notarization and registry update for valid transfer	Conditional; governed by familial, ethical, and inheritance-based restrictions
Land Registry	Local or county-level public registries (e.g., county office)	Centralized and standardized national registries	Often informal, hybrid, or outside formal registry systems
Lien/Encumbrance	Legally enforceable claims (e.g., mortgages, judgments)	Encumbrances must be registered in civil land record systems	Must not conflict with Islamic finance principles (e.g., no interest-based liens)

8.3 Weak Protection of Token Holder Rights

The existing structure does not adequately safeguard the holders of the tokens, especially retail investors, in the fundamental fronts of distributing income, voting rights, dispute governance, and ownership recovery. Such omissions undermine investor confidence and leave legal loopholes that may be an obstacle to the mass usage of the tokenized system of real estate.

Recommendation: The compliance framework could make future development by incorporating a well-defined scope of rights that the token holders can have by following the forms of rights that the Real Estate Investment Trusts (REITs) exist on and the co-ownership forms. In the case of income distribution, it will be desirable to have smart contracts automate the frequent profit distributions just like REIT rules prescribe that they must distribute most of the income to investors.

Voting rights should also be coded to include on-chain governance methods in which the token holders will be able to vote in important strategic affairs like a shareholder in a traditional structure.

The enforcement of the smart contract should be reinforced by the implementation of hybrid dispute system models that can be split between the confirmed implementation of off-chain arbitration along with the correction of smart contracts. Also, the asset recovery protocols, e.g., buyback or liquidation triggers, should be coded to work in the event of platform failure, fraud, or insolvency. Redemption rights in the form of exit privileges to the investors under pre-agreed legal situations should also be favorable with offerings of flexibility and legality assured.

Collectively, these protective measures will ensure that the tokenization rule set complies with practices associated with investor protection, enhance transparency, trust and to some extent, enforceability in international property markets.

Table 8: Token Holder Rights Compared with Traditional Real Estate Investment Trusts (REITs)

Right Category	Tokenized Real Estate	Traditional REITs / Co-Ownership Models
Voting Rights	Often limited or embedded in smart contracts	Guaranteed via shareholder agreements or annual meetings
Income Distribution	Programmable via smart contracts (e.g., rental yield tokens)	Regular dividends based on income and board decisions
Dispute Resolution	Unclear jurisdiction; needs hybrid arbitration mechanisms	Formal legal process with court-recognized channels
Asset Recovery	Depends on contract design and jurisdictional law	Governed by insolvency law and fiduciary duties
Governance Participation	May be allowed through DAO-like structures	Formal board or trustee structure with fiduciary obligations
Legal Recourse	Varies by country; often lacks enforcement clarity	Clear legal protections under corporate or trust law

8.4 Overreliance on Ethereum Standards

The existing compliance system is overly dependent on Ethereum-based technical criteria such as ERC-3643, thus, limiting flexibility in various blockchain settings around the world. Although the ERC-3643 offers a powerful framework on permissioned tokens, its limitation to Ethereum Virtual Machine (EVM) limits its usage in jurisdictions that rely on different blockchain systems (ERC3643 Association, 2023). Numerous national digital asset strategies have transitioned to focus on non-EVM ecosystems that are better aligned to sovereign data control, regulators, customization and environmental sustainability objectives (Ciminelli et al., 2024; Mistrangelo et al., 2023). Subsequently, this excessive dependence can impact an impediment of interoperability and limit the use of legal systems that are not compatible with EVM-friendly networks and compromise the universality of the system.

Recommendation: The framework must have a wider technical base by adopting alternative blockchains solutions that have already integrated or are currently integrating their legal and regulatory framework. As an illustration, Tezos, which is used in a French real estate tokenization pilot supervised by the AMF, provides such features as the support of the FA2 standard and the ISO 20022 protocol, as well as the high speed of commitment time (Meinrath, 2025).

Algorand, which is applied to Italy in the pilot of digital guarantee, offers similar transaction speed and ISO compliance, whereas Hyperledger Fabric can be adopted in state-sponsored pilot in UAE and China, because of its permissioned nature, in-built compliance mechanisms (e.g., role-based access control), and compatibility with the national digital identity systems (World Bank, 2023; OECD, 2022).

These non-EVM blockchain bases make the compliance framework, both in terms of legal and geographical configuration, more flexible, and this enables regulators not to overhaul prior policy designs to adopt the blockchain technology. This will be a major diversification to maximize institutional acceptability, as well as, interoperability across various legal environments (Ioannou et al., 2025; Garcia-Teruel & Simón-Moreno, 2021).

8.5 Cross-Border Legal Conflicts

There are major law enforcement challenges experienced in cross border nature of tokenized systems of real estate systems. A valid token on property, issued in one jurisdiction (e.g., Bahrain under a digital asset sandbox) might be legally unenforceable or void in the other (: in some states of the EU), because of differing definitions of digital property ownership, contract validity or foreign investment prohibition. The property dealings across blockchain are subject to such a situation of regulatory fragmentation where businesses are facing a significant experiment to international transactions.

Recommendation: in order to overcome this type of conflicts, the compliance framework should set up principles of the private international law and consider options like the bilateral treaties, mutual assistance agreements and jurisdiction specific rules of smart contract enforceability. An illustrative example is the UNCITRAL Model Law on Electronic

Transferable Records (MLETR) in which a basic framework is set out on the recognition of digital assets to be accepted across borders. In the same way, the Hague Conference on Private International Law provides principles of the solution to a question of the applicable law and jurisdiction in cross-border contracts.

Inclusion in the framework must stipulate which circumstances permit smart contracts and tokenized property records to develop recognition and enforceability in different jurisdictions, particularly in situations that involve foreign investors, dispute arbitration, or dual registration systems. This would increase the international usefulness of the model and enable well-founded cross-border transfer of assets.

8.6 Lack of Economic Impact Modeling

The operative framework does not include quantitative economic models embedded to establish its assertions as to improving liquidity, expanding investor access, and efficiency of transactions. Though it claims that tokenization enhances the flexibility of real estate market with regard to fractional ownership possibilities and lowering transaction costs, most of the mentioned advantages have not been confirmed by either empirical or financial evidence (Bolandhemat, 2025; Ioannou et al., 2025). Without simulated performances or financial standards, the framework cannot become a useful tool in the direction of the ongoing public policy or even in raising institutional capital (Meinrath, 2025).

In order to overcome this gap, simple versions of the return-on-investment (ROI) models need to be built that can calculate the returns of the tokenized assets. In another instance, a tokenized property valued at 1 million can be divided into 10,000 tokens and may be sold at the price of 100 per token giving the investor a 6 percent result as an annualized rental yield (Ciminelli et al., 2024). Also, modeling liquidity is expected to measure how quickly the tokens are sold on the secondary markets like the RealT or Brickblock and compare it with the traditional sales cycles of the real estate market, which was notoriously illiquid (Alnabulsi, 2024; Sabuncuo o, 2024).

Probably more importantly, a cost-benefit analysis can also demonstrate operational efficiencies that can be realized through digitization, e.g., by paying less notary fees, quicker contract signing, and cheaper legal advice that get achieved based on the costs encountered in laying out blockchain infrastructures (e.g., smart contract auditing, obtaining compliance licenses). The study indicates that the fees charged in the traditional purchasing of real estate are usually 710%, whereas in blockchain-based tokenized solutions, it might be reduced to 23 (George, 2025; Avci & Erzurumlu, 2023).

Recommendation: The incorporation of simplified ROI models, liquidity simulations and comparative costs analyses incorporating real-world data on the platform will go a long way in confirming the efficiencies they have projected of tokenized real estate. This would make the framework more credible, draw regulator and investor support and also fill the existing theoretical gap in its economic rationale.

8.7 Privacy and Ethical Risks in KYC/AML Systems

The compliance framework proposed includes the technical aspects of compliance with Know Your Customer (KYC) and Anti-Money Laundering (AML); in its current version it does not include a thorough assessment of privacy risks and ethical weaknesses of decentralized identity systems. Although blockchain-based verification of the user identity has been renowned to be secure and immutable, it may, however, lead to the exposure of confidential personal information, especially when an off-chain identity document is not sufficiently stored, or when the data is transmitted through compromised oracles (Finck & Pallas, 2022; FATF, 2023). This kind of arrangement threatens the privacy of users, particularly in places where there are high statutes of data protection.

Recommendation: A separate sub-point should be added to the framework that is about data ethics and decentralized identity governance. This must also touch on the introduction of Zero-Knowledge Proofs (ZKPs) that enable identity verification without revealing their underlying personal information and Self-Sovereign Identity (SSI) protocols that bring back the control over digital identities to users (Finck & Pallas, 2022; UNIDROIT, 2023). Such solutions have to be compliant with the international regulations of data protection, including the General Data Protection Regulation (GDPR) of the European Union, adhering to the principles of data minimization and rights to erasure (European Commission, 2023).

Also, identity oracles employed to attest to KYC compliance by smart contracts will be carefully reviewed to be well-sealed against corruption, single points of failure and reliable (Sunyaev et al., 2021). The framework would be more resilient and regulatory-compliant with the integration of privacy-preserving identity wallets that would allow selective disclosure. Incorporation of these data protection measures is not only necessary as a legal requirement but also to instill trust in the users that the tokenized property systems are worthy of their trust within the realm of the credibility and ethical standard (Finck & Pallas, 2022; Schmidt & Gonzalez, 2022).

8.8 Insufficient Visual Communication

In spite of the multitier paradigm of legal interoperability and technical compliance presented in the framework, no visual model of the framework was used to complement another model and make it more understandable and acceptable by the users. The most important components, i.e., intelligent legal contract workflows, stakeholder relationship, token classes, and land registry integrations are only discussed verbally. Such textual dependence constrains cross-discipline participation, particularly amongst non-technical or non-legal beneficiaries including regulators, developers and institutional policymakers (Meinrath, 2025; Finck & Pallas, 2022). In the absence of definitive visuals, the framework would not be easy to decipher and implement in actual governance situations.

Recommendation: As a solution to this communication challenge, the framework must include some design elements such that visual design should help to simplify complex processes without jeopardizing the conceptual clear thinking.

Such visuals might be:

- Smart contract flow charts of steps to be followed during identity verification, dispute resolution and escrow operations;
- Stakeholder maps on the roles that the regulators, developers, investors, and the land registry authorities will play (World Bank, 2023);
- Classification pyramid of tokens on the basis of jurisdictional power and regulatory scope (Zetzsche et al., 2022);
- Interface models demonstrating interlocks between blockchain and the traditional models of land administration systems (OECD, 2022).

More transparent and, above all, more usable, especially to interdisciplinary audiences, would be the incorporation of intuitive visual formats, i.e., the use of icons, hierarchies, and simplified linguistic terms (Garcia-Teruel & Simón-Moreno, 2021).

Such visuals must be according to the goals and form of compliance to facilitate the implementation of the framework. Finally, the improved visual communication would foster institutional trust and integration of policies, and an overall adoption of tokenized real estate systems.

9. CONCLUSION

Property ownership in the form of tokens has become the point of technological development and legal change. Although the fractional real estate transactions in high-priced assets have been possible due to the maturation of blockchain infrastructure, legal frameworks have not kept up with the changes at the same rhythm. Consequently, tokenized real estate as a promise has, in most jurisdictions, not delivered as regulatory ambiguity, disparate compliance congruence, and failure to integrate land registries occur.

It has been suggested in this paper that such a compliance-based model is based on four pillars, namely, token legal classification, smart contract enforceability, embedded KYC/AML processes, and blockchain-registry interoperability.

The combination of doctrinal legal analysis, technical assessment, and case studies conducted in several jurisdictions internationally enables the framework to outline a way of converting token-based systems into legally binding tools of property ownership.

The scrutinized comparison between such countries as Australia, Serbia, Bahrain, the UAE, Estonia and Switzerland depicts that the process of legal changes is already in progress, but some at different levels of development. The above illustrations show that tokenization may be modified to different legal cultures such as common law jurisdiction, civil law jurisdiction and Sharia-compliant jurisdiction.

In the future, the most effective ones are modernization of legislative soil, the sandboxing of regulation and cross-border harmonization.

The model suggested above needs to be tested with pilot programs and law should be refined to create legal standards regarding Smart legal contracts in the future, and it is important to establish cooperation at the international level so that people could focus on global interoperability.

To sum it up, tokenized real estate is not just a financial product or a digital asset; it is a vision of redeveloping the concepts of ownership, value, and legal certainty in the 21 st century. It can become a game-changer in the real estate ecosystem and make property markets in every single country of the world more democratic with careful regulatory alignment and technical protections.

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