

A Work Project presented as part of the requirements for the Award of a Master's degree in
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UNLOCKIT FIELD LAB ON CREATING A GOVERNANCE FRAMEWORK TO
FACILITATE THE FRACTIONALIZATION OF REAL ESTATE ASSETS USING WEB3-
BASED BUSINESS MODELS IN PORTUGAL

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Abstract

This thesis explores the development of governance frameworks to facilitate fractional ownership of real estate assets using blockchain technology. Addressing inefficiencies in traditional property management, such as bureaucracy and lack of transparency, highlights the potential of distributed ledger technologies (DLTs) to enhance liquidity, streamline decision-making, and democratize property investment. The legal, technical, and operational challenges, the thesis shows that tokenization, regulatory alignment, and further innovation will enable more efficient, transparent, and equitable management of real estate assets. It also evaluates blockchain compatibility for governance needs, compliance with EU regulations, and the implications of varying ownership structures.

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Keywords: Blockchain, Real Estate, Tokenization, Fractional Ownership, Regulation, Distributed Ledger Technology (DLT), Web3, Liquidity, Smart Contracts, Governance Frameworks, Property Rights, Decentralized Autonomous Organizations (DAOs), Operational Management, Consensus-Building, Decision-Making Mechanisms

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List of Abbreviations

AMLD6 - 6th Anti-Money Laundering Directive

API – Application Programming Interface

ARI - Residence Permit for Investment Activity

ARTs – Asset-Referenced Tokens

DAOs – Decentralized Autonomous Organizations

DApps – Decentralized Applications

DeFi – Decentralized Finance

DHA - Decentralized Homeowner Association

DLT – Distributed Ledger Technology

EEA – European Economic Area

EMTs – Electronic Money Tokens

EU – European Union

EVM - Ethereum Virtual Machine

GDPR - General Data Protection Regulation

HOA – Homeowners’ Association

IMI – Municipal Property Tax

IMT – Municipal Property Transfer Tax

KYC – Know Your Customer

LLCs – Limited Liability Companies

MiCA – Markets in Crypto-Assets Regulation

MiFID II - Markets in Financial Instruments Directive II

PoS – Proof of Stake

PoW – Proof of Work

REITs – Real Estate Investment Trusts

TPS – Transactions Per Second

VAT – Value Added Tax

1. Introduction (GROUP PART)

Fractional real estate ownership is gaining traction as a model that democratizes access to property investment by allowing multiple individuals to own shares of a single asset. This work project studies Unlockit, a Portuguese PropTech and GovTech company dedicated to transforming the real estate sector by leveraging blockchain and distributed ledger technologies (DLT). The company addresses critical inefficiencies in traditional real estate mediation, such as high costs, lack of transparency, and fragmented processes. It also offers a cloud-based platform that digitizes and streamlines property transactions, ensuring they are secure, transparent, and collaborative. By incorporating smart contracts, document authentication, and identity validation technologies, Unlockit ensures compliance with European Union regulations, including eIDAS, AMLD6, and GDPR. Their solution fosters trust, automates processes, and reduces costs, risks, and carbon emissions while creating a seamless environment for real estate transactions.

This project aims to develop a governance framework tailored specifically for Unlockit, enabling the company to facilitate fractional ownership of real estate assets through blockchain technology. By addressing key governance and regulatory challenges, the framework will support Unlockit's mission to democratize property ownership, enhance accessibility, and improve the liquidity of real estate markets. The governance framework will focus on aligning Unlockit's operations with regulatory frameworks and addressing issues in co-ownership governance, such as decision-making processes and collective management.

To build this framework, the work project begins with a comprehensive literature review that defines key concepts such as fractional ownership, blockchain technology, and governance in multi-owner real estate. The subsequent chapters are organized around four key areas of analysis: examining existing fractional ownership models, exploring regulatory challenges in Portugal, evaluating blockchain compatibility for real estate tokenization, and investigating

mechanisms to enhance liquidity and governance in multi-owner properties. The work Project concludes by proposing the governance framework specifically designed for Unlockit.

2. Objective and Relevance of the Study (GROUP PART)

This work project aims to develop a governance framework for fractional real estate ownership, in which traditional intermediaries and restrictions are displaced by blockchain technology, which serves as the operational system for real estate transactions.

To achieve this, the initial section will explore different fractional ownership models and discuss the current state of governance in multi-owner real estate. A significant challenge in co-ownership arrangements is the "tragedy of the anti-commons," where excessive fragmentation of ownership leads to underuse and underinvestment in the property. Chang (2012) suggests that co-ownership can result in high decision-making costs, leaving properties underutilized due to difficulties in reaching consensus. Dagan and Heller (2000) argue that the higher the consensus needed for decisions, the greater the costs incurred, which can hinder effective property management. Inefficient governance models worsen the problem by granting individual owners exclusive rights over others, creating obstacles to collective action. Hastings, Wong, and Walters (2006) observe that such institutional arrangements often lead to inaction, poor maintenance standards, and declining asset values.

The second section will address critical regulatory challenges in the Portuguese real estate sector, focusing on the insufficiencies of the current legal framework to support blockchain-enabled fractional ownership of real estate assets. The Portuguese Civil Code, while robust for traditional transactions, lacks provisions for accommodating smart contracts and tokenization. This legal barrier constrains efforts to democratize real estate investments, particularly by limiting access for smaller investors, where housing affordability remains a significant societal concern (Banco de Portugal, 2024). Portugal has initiated efforts such as regulatory sandboxes, the National Blockchain Strategy, and the alignment with the Markets in Crypto-Assets Regulation (MiCA) of the European Parliament and of the European Council to address the presented challenges. However, the legal infrastructure remains insufficient to integrate

blockchain technology in the real estate sector (Global Legal Insights, 2024). This subject is particularly relevant because it seeks to bridge the regulatory gaps by investigating how Portugal can adapt its legal framework to accommodate blockchain-based fractional ownership models.

The next section will explore the alignment of blockchain technology with the specific needs of tokenized property rights by reviewing the most popular blockchain technologies and analyzing their characteristics. Then, the further objective is to develop a preliminary theoretical framework for matching blockchains to specific asset types. While regulatory advancements in the European Union, such as MiCA, prepare the ground for the tokenization of property rights, the practical implementation of this technology requires an in-depth understanding of the interaction between blockchain characteristics and asset-specific requirements. Different tokenized asset types present unique challenges in property management and governance, including requirements for transparency, transaction speed, cost-efficiency, and scalability. Similarly, blockchains exhibit distinct technical features—such as consensus mechanisms, transaction throughput, and levels of decentralization—that impact their suitability for specific asset types. By tailoring blockchain technology to the unique demands of property management and governance, Unlockit can address critical challenges such as cost optimization, maintaining transparency, and ensuring scalability in its tokenized real estate model. Hastings, Wong, and Walters (2006) emphasize that governance mismatches in co-ownership arrangements exacerbate inefficiencies, hinder decision-making, and reduce asset value. Applying this principle to blockchain selection, a poorly matched technology could amplify inefficiencies and undermine the tokenization process.

The final section focuses on enhancing liquidity and governance in the traditionally illiquid real estate market. Real estate transactions are often slow, costly, and predominantly available to investors with considerable financial resources, creating significant barriers to entry for smaller

stakeholders. By investigating solutions like blockchain-based platforms and tokenization, this section aims to identify mechanisms that enable efficient buying, selling, and trading of fractional real estate shares, thereby democratizing access to a more dynamic and inclusive market. Fractional ownership, while promising, introduces complexities in governance that must be addressed to maintain stability and investor confidence. This section explores smart contracts and decentralized voting systems as tools to streamline decision-making, promote transparency, and facilitate seamless ownership transfers. It explores how technology can enhance liquidity through peer-to-peer transfers, secondary markets, and decentralized exchanges, all while implementing strong compliance measures to adhere to regulatory standards.

This work project will address these challenges by proposing a blockchain-based governance model designed to streamline decision-making, reduce costs associated with consensus-building, and promote optimal use and investment in fractional real estate assets.

3. Literature Review (GROUP PART)

3.1 The Blockchain Technology

Blockchain technology is the foundation for fractional ownership in real estate, enabling secure, transparent, and efficient transactions. Understanding the components of blockchain is crucial, as consensus mechanisms and smart contracts work together to facilitate the creation and management of decentralized systems. These technological elements are core to the governance framework outlined in this project, guaranteeing reliability, automation, and trust in multi-owner property arrangements.

3.1.1 Blockchain

Blockchain is a decentralized, distributed ledger technology that records transactions across a network of computers securely and transparently (Fill, Härer, and Meier, 2020), through a chain of cryptographically linked blocks. It operates through five key components: distribution, where the ledger is shared across multiple participants to ensure data availability and resilience; immutability, ensuring that once a transaction is recorded, it cannot be altered without network consensus; encryption, using cryptographic algorithms to secure data and maintain privacy; tokenization, representing physical or digital assets as tokens for seamless transfer of value; and decentralization, eliminating the need for central authorities and fostering collaborative governance (Baum, Saull, and Braesemann, 2020). In the context of this work project, blockchain enables fractional real estate ownership by facilitating secure asset tokenization, transparent governance mechanisms, and efficient management of ownership records without reliance on centralized intermediaries.

3.1.2 Distributed Ledger Technology (DLT)

Distributed Ledger Technology (DLT) is a decentralized digital system in which transactions are recorded and shared across multiple nodes in a network. Unlike centralized systems, DLT eliminates the need for a central authority, ensuring that all participants maintain synchronized

copies of the ledger (Baum, Saull, and Braesemann, 2020). Blockchain is a specific form of DLT, with other variations that may not rely on block structures.

3.1.3 Web3

Web3 represents a new iteration of the internet, centered on decentralization, blockchain technology, and enhanced user control over data, leveraging blockchain to create decentralized applications (dApps) and protocols that operate without intermediaries. This shift allows users to own and control their digital identities, assets, and data, promoting a more open, equitable, and secure digital ecosystem (Stackpole, 2022). In this work project, Web3 is the technological foundation for enabling fractional real estate ownership, facilitating decentralized governance, tokenized asset management, and peer-to-peer transactions.

3.1.4 Smart Contracts

Smart contracts, often used alongside tokenization, serve as self-executing agreements programmed into the blockchain. They automate transactions by executing specific actions once predefined conditions are met (Chiaranda and Dubrovina, 2023). In real estate, smart contracts can take over tasks typically managed by intermediaries, including automating payment processes, validating essential property acquisition documents, ensuring accurate tax compliance, and streamlining property licensing and permit requirements coordination. This automation reduces the need for manual oversight, improves transaction speed, and lowers costs. In this work project, smart contracts facilitate transparent, efficient governance and management in blockchain-based fractional real estate ownership (Ullah and Al-Turjman, 2023).

3.1.5 Decentralized Autonomous Organizations (DAOs)

Decentralized Autonomous Organizations (DAOs) are organizations governed by smart contracts on a blockchain, operating without centralized control. They enable participants to

coordinate and make decisions collectively through transparent, automated software-encoded rules. DAOs facilitate decentralized governance, allowing stakeholders to manage assets and operations collaboratively and democratically (Santana and Albareda, 2022).

3.1.6 Consensus

Consensus is a crucial process in blockchain networks that enables all participating nodes to agree on a single, consistent state of the ledger, ensuring security and integrity. It determines which blocks are added to the chain and validates nodes, helping the network maintain a unified source of truth (Lashkari and Musilek, 2021).

Proof-of-work is a consensus mechanism where miners solve complex computational problems to validate transactions and produce new blocks. This process is resource-intensive, making it difficult to alter the blockchain's history, thus securing the network against tampering (Lashkari and Musilek, 2021).

Proof-of-Stake is a consensus mechanism where the ability to produce new blocks is proportional to the amount of cryptocurrency an actor holds and is willing to "stake" or lock up. Validators are chosen based on their stake, promoting network security by aligning participants' interests with the network's success (Lashkari and Musilek, 2021).

3.2 Governance and Tokenization

Governance and tokenization are interdependent pillars of blockchain-enabled fractional ownership, each reinforcing the other to create an efficient system. Together, governance provides the rules and decision-making structures of the business model, while tokenization serves as the medium through which those structures operate effectively.

3.2.1 Governance

Governance refers to the frameworks, processes, and institutions that regulate social behavior, manage resources, and enable collective decision-making. It involves the mechanisms through

which authority is exercised, decisions are implemented, and accountability is maintained, often in complex systems where multiple actors—state, private, and civil society—share responsibilities (Fukuyama, 2016). Governance matters because it sets the rules and expectations for managing resources and interactions, ensuring equity, accountability, and transparency. Good governance aligns stakeholders' goals, promotes trust, and enhances the efficiency of systems, whether in public administration, corporate structures, or decentralized networks (World Economic Forum, 2016). In this work project, governance relates to how multiple stakeholders in fractional real estate ownership coordinate, manage assets and ensure transparent, equitable decision-making.

3.2.2 Tokenization

Tokenization is the process of digitally representing ownership rights in an asset, such as real estate, using blockchain technology. This process divides an asset into smaller, tradeable units called tokens, enabling fractional ownership and making high-value assets more accessible to a broader range of investors (Avci and Erzurumlu, 2023). Tokenization also facilitates seamless transactions through blockchain, which provides immutable records and ensures transparency. By enabling direct peer-to-peer exchanges, tokenization reduces the need for intermediaries and lowers transaction costs (Baum, 2020). Avci and Erzurumlu (2023) highlight tokenization's ability to enhance liquidity by creating active secondary markets, addressing the illiquidity challenges traditionally associated with real estate investments. Baum (2020) adds that tokenization democratizes access to real estate and ensures operational efficiency by integrating digital wallets and smart contracts into the transaction process, further improving accessibility and reducing barriers.

3.2.3 Utility Tokens

Utility Tokens are digital tokens that grant holders access to specific services, functionalities, or rights within a blockchain-based platform or ecosystem (Marin et al., 2023). In the context

of this thesis, utility tokens may provide owners in a fractional real estate platform with privileges such as property usage rights, voting power in governance decisions, or access to exclusive services and features (Baum, 2020).

3.2.4 Security Tokens

Security Tokens are digital tokens representing ownership or investment in a real asset, company, or economic enterprise subject to securities regulations. In this thesis, security tokens enable fractional real estate ownership by legally binding token holders to the underlying property, ensuring compliance with financial laws and regulations (Garcia-Teruel and Simón-Moreno, 2021).

3.2.5 Governance tokens

Governance Tokens are digital tokens that give holders the right to participate in the governance of a blockchain-based platform or decentralized organization. They typically enable token holders to vote on proposals, influence decisions, and shape the development and policies of the platform, facilitating collective management and decision-making (Jensen, Wachter, and Ross, 2021).

3.3 Fractional Ownership Models in Real Estate

Multi-owner real estate ventures include various ownership structures such as fractional ownership, real estate investment trusts (REITs), cooperatives, and condominiums. Fractional ownership allows multiple unrelated individuals to hold shares in a property, allowing them to invest in valuable assets like vacation homes (Lowies et al., 2018). REITs enable collective ownership through legal entities such as corporations or limited liability companies (LLCs), which support pooled investments across various real estate projects (Oh and Verstein, 2023). Cooperatives involve collective ownership by a corporation or association, where members hold shares, occupy designated units, and participate in democratic governance (Lawton, 2014).

Condominiums combine individual ownership of separate units with joint ownership of common spaces, managed by homeowners' associations (Treffers and Lippert, 2020). These various models provide unique methods for resource sharing, responsibility distribution, and decision-making authority. Each model will be explored in detail later in the thesis to aid in creating a solid governance framework for Unlockit.

3.4 Compliance with Existing Regulation

Compliance with existing regulations is critical in implementing blockchain-enabled fractional ownership models. As these innovative systems operate within highly regulated environments, alignment with legal and regulatory frameworks is essential to ensure stakeholders' legitimacy, transparency, and protection.

3.4.1 Markets in Crypto-Assets Regulation (MiCA)

The Markets in Crypto-Assets (MiCA) Regulation, formally known as Regulation (EU) 2023/1114, establishes a comprehensive legal framework for crypto-assets within the European Union. MiCA aims to enhance legal certainty for crypto-asset issuers and service providers, foster innovation, ensure consumer and investor protection, and maintain financial stability. The regulation introduces uniform requirements for transparency, disclosure, authorization, and supervision of crypto-asset services and issuers, including provisions to prevent market abuse. MiCA applies to entities involved in the issuance, offering, and trading of crypto-assets not already covered by existing EU financial services legislation (European Parliament and Council 2023). This regulation concerns the fractionalization of real estate assets using web-3 business models, and the relevant points will be further developed.

3.4.2 eIDAS Regulation

The eIDAS Regulation establishes a standardized legal framework for electronic identification, authentication, and trust services within the European Union. Its key provisions guarantee that

electronic signatures, seals, and timestamps are afforded the same legal validity as traditional paper-based methods (European Parliament and Council, 2014b), which is especially critical for platforms that enable digital transactions, such as those operating in the real estate sector. According to Article 25 of the eIDAS Regulation (European Parliament and Council, 2014b), qualified electronic signatures are equivalent in legal standing to handwritten signatures, making them admissible as evidence in legal proceedings throughout the EU. For Unlockit, this provision establishes that electronic signatures possess full legal validity in property transactions, affirming ownership and purchase agreements and facilitating smooth cross-border real estate investment. Article 35 of eIDAS (European Parliament and Council, 2014b) addresses that qualified electronic seals provide strong assurances regarding the authenticity and integrity of the data they protect. For Unlockit, electronic seals enhance the integrity and security of ownership records stored on the ledger. Article 42 of the eIDAS Regulation (European Parliament and Council, 2014b) establishes requirements for qualified electronic timestamps, which bind specific dates and times to data, preventing undetected record changes. This timestamping is essential for Unlockit because it maintains accurate historical transaction records. The eIDAS Regulation establishes a standardized legal framework for electronic identification, authentication, and trust services within the European Union. Its key provisions guarantee that electronic signatures, seals, and timestamps are afforded the same legal validity as traditional paper-based methods (European Parliament and Council, 2014b), which is especially critical for platforms that enable digital transactions, such as those operating in the real estate sector. According to Article 25 of the eIDAS Regulation (European Parliament and Council, 2014b), qualified electronic signatures are equivalent in legal standing to handwritten signatures, making them admissible as evidence in legal proceedings throughout the EU. For Unlockit, this provision establishes that electronic signatures possess full legal validity in property transactions, affirming ownership and purchase agreements and facilitating smooth

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3.4.3 6th Anti-Money Laundering Directive (AMLD6)

The 6th Anti-Money Laundering Directive establishes enhanced measures to combat money laundering and terrorist financing across the European Union, with provisions highly relevant to the real estate sector and platforms using Distributed Ledger Technologies, such as Unlockit. The Directive requires entities to conduct comprehensive customer due diligence, which entails verifying client identities, understanding the purpose of transactions, and monitoring ongoing relationships, meaning that Unlockit must implement customer due diligence procedures to validate investors (European Parliament and Council, 2024). AMLD6 requires Member States to maintain accurate registers of beneficial ownership, ensuring transparency and traceability of individuals holding shares in tokenized assets. This is crucial for Unlockit, addressing privacy and compliance in fractional ownership. Additionally, the Directive mandates reporting suspicious transactions to Financial Intelligence Units, obligating Unlockit to implement monitoring systems to detect and prevent money laundering.

3.4.4 General Data Protection Regulation (GDPR)

The General Data Protection Regulation (GDPR), formally known as Regulation (EU) 2016/679, is a legal framework adopted by the European Union to protect individuals' personal data and regulate its processing and movement across member states. The regulation aims to

enhance individuals' control over their personal data while ensuring a harmonized approach to data protection within the EU's single market (European Parliament and Council, 2016). The GDPR outlines several key provisions to achieve its objectives. First, it mandates that personal data be processed lawfully, fairly, and transparently, with explicit conditions such as consent, contractual necessity, or compliance with legal obligations as legal bases for processing. Additionally, the regulation grants individuals significant rights over their data, including access, rectification, erasure, and data portability (European Parliament and Council, 2016). Organizations must also integrate data protection principles into their operations, ensuring that privacy safeguards are embedded into processing activities and that only the necessary data is processed. Additionally, it restricts international data transfers to countries outside the EU unless those countries ensure adequate data protection measures or appropriate safeguards are in place (European Parliament and Council, 2016).

3.4.5 Markets in Financial Instruments Directive II (MiFID II)

The Markets in Financial Instruments Directive II (MiFID II), formally Directive 2014/65/EU, is a regulatory framework adopted by the European Union to enhance transparency, efficiency, and investor protection in financial markets. MiFID II governs the provision of investment services and activities across the EU, focusing on ensuring fair competition, safeguarding investors, and promoting the integrity of financial markets (European Parliament and Council, 2014a). Key features of MiFID II include stricter transparency requirements and rules to limit high-frequency trading. Additionally, it regulates market structures by establishing frameworks for organized trading facilities and improving access to regulated markets.

3.5 Liquidity and Market Dynamics

Liquidity is a cornerstone of efficient fractional ownership models. It enables stakeholders to seamlessly buy, sell, and transfer their ownership shares with minimal delays or disruptions.

High liquidity ensures investors can readily enter or exit their positions, fostering a dynamic and accessible market environment.

3.5.1 Liquidity

Liquidity describes the ability of participants to execute transactions, such as buying or selling assets, quickly and without significantly impacting market prices. The European Central Bank (2007) identifies three critical dimensions of liquidity that define its effectiveness: tightness, which relates to transaction costs, including the bid-ask spread that indicates how cheaply trades can be executed; depth, which measures the capacity of the market to absorb large orders without considerable price changes; and resiliency, the market's ability to recover rapidly from price fluctuations caused by trades (European Central Bank, 2007). High liquidity facilitates market efficiency by reducing transaction costs and promoting price stability, encouraging greater participation. It also ensures that financial systems remain robust, as liquid markets allow smoother capital flows and reduce the risks of holding or trading assets. In this work project, liquidity pertains to the ability of fractional real estate ownership shares or tokens to be readily traded, enabling investors to enter or exit their investment positions quickly (Schmid, Truebestein and Aepli, 2024).

4. Research Methodology (GROUP PART)

This study utilized a mixed-methods approach, integrating primary and secondary data sources to understand governance models in fractional real estate ownership comprehensively. The research consisted of a detailed literature review that evaluated existing frameworks and regulations concerning real estate asset transactions, including academic articles, industry reports, and legal documents. This strategy established a theoretical framework while highlighting existing practices and challenges in real estate governance and blockchain technology.

Primary data were collected via a case study and semi-structured interviews with key experts to gain practical insights and real-world perspectives. The experts interviewed included Jan, the founder and CEO of TTI Gruppe, a real estate development firm specializing in multi-owner projects; Benjamin, a solo entrepreneur focused on purchasing, renovating, and selling apartments in multi-unit buildings; and David from MYNE Homes, a company that sells and manages fractional vacation properties. These discussions provided insights into governance challenges and strategies related to different real estate ownership models.

Additionally, interviews were conducted with two attorneys who preferred to remain anonymous. These attorneys offered crucial expert insights on legal and regulatory issues, providing vital perspectives on the legal frameworks, compliance hurdles, and technological applications of blockchain in fractional real estate ownership.

Combining literature reviews, case studies, and expert interviews enabled a thorough analysis of real estate governance's theoretical and practical aspects. This mixed-methods approach ensured that the research identified existing governance challenges and explored potential solutions and best practices proposed by industry experts.

5. Exit Strategies and Liquidity Options in Fractional Real Estate Ownership (INDIVIDUAL PART)

5.1 Introduction

Fractional real estate ownership offers a flexible and accessible avenue for individuals to invest in property with a lower capital input. However, its widespread adoption relies on overcoming key challenges, particularly in terms of liquidity and the smooth ownership transition. Addressing these issues is vital for fostering investor confidence and maintaining market stability.

5.1.1 Importance of Liquidity

Liquidity plays a crucial role in the success of fractional real estate investments, allowing investors to enter or exit positions swiftly without incurring substantial losses in value. In contrast, traditional real estate markets tend to be illiquid, characterized by high transaction costs and protracted procedures. Innovative solutions like fractional ownership and secondary trading platforms can enhance accessibility and dynamism in real estate investments.

5.1.2 Tokenization as a Catalyst for Change

Tokenization, facilitated by blockchain technology, partitions real estate into digital units, thereby enhancing liquidity and democratizing access to high-value assets. This innovation significantly transforms a traditionally static market into a more inclusive and dynamic investment landscape.

5.1.3 Objectives

This study investigates effective strategies for enhancing liquidity and ensuring seamless ownership transitions within the realm of fractional real estate. The primary areas of focus include the formulation of robust exit strategies, the application of tokenization and smart

contracts, and the adherence to regulatory frameworks, all aimed at establishing sustainable and transparent investment models.

5.2 Traditional Exit Strategies in Real Estate

5.2.1 Current Practices

In Portugal, traditional exit strategies in real estate are based on established legal mechanisms, including the sale of ownership, buy-sell agreements, and the right of first refusal. The transfer of ownership is the most prevalent exit strategy, which entails transferring property rights from the seller to the buyer. This process is governed by the Portuguese Civil Code (Diário da República, 1966). According to Article 874 Portuguese Civil Code (1966), a sales contract is defined as an agreement whereby one party commits to transferring ownership of an item (such as real estate) to another party in exchange for monetary compensation. To ensure that these transactions are legally binding, they must be formalized through a public deed (*Escritura Pública*), as specified in Article 875 of the Portuguese Civil Code (1966).

Buy-sell agreements are designed to formalize the conditions under which a property transaction will take place. Governed by Articles 410 and 879 of the Portuguese Civil Code (1966), these contracts delineate the fundamental requirements for contractual validity, including a lawful object, mutual consent, and other essential elements. Such agreements enhance clarity and enforceability in real estate transactions, particularly in cases where the conditions of sale are complex.

The right of first refusal is a significant legal mechanism that grants certain parties priority in purchasing a property before making it available to others. Articles 1091 and 1409 of the Portuguese Civil Code (1966) govern the application of this right. For instance, tenants who have occupied a property for more than two years have the right to purchase it before its sale to a third party. Similarly, co-owners of a jointly owned property must be given the opportunity

to acquire any shares that another co-owner intends to sell. Public entities, such as municipalities, can also exercise the right of first refusal in designated urban rehabilitation zones. This process is regulated by the Housing Framework Law (*Lei de Bases da Habitação*) and Decree-Law No. 89/2021. These laws impose specific obligations on property owners in these areas, including a mandatory notification of intent to sell, which provides public entities with a defined timeframe to exercise their pre-emptive right.

These legal mechanisms collectively create a structured framework for real estate transactions, balancing the interests of property owners, tenants, co-owners, and public entities. They also emphasize the importance of adhering to legal requirements to ensure the enforceability and fairness of property sales.

5.2.2 Key Challenges

Liquidity is an essential component of asset markets, commonly assessed through key parameters such as tightness (measured by the bid-ask spread), depth, resilience, breadth, and immediacy (Smith et al., 2019). Nevertheless, traditional real estate investments often fail to adequately consider these parameters, leading to significant liquidity challenges.

A key challenge in real estate transactions is their inherent complexity. These deals typically involve multiple parties and extensive manual documentation. The processes of structuring offers, securing financing, and conducting due diligence can span weeks or even months, significantly hindering the speed of transactions (Smith et al., 2019). This complexity creates obstacles for investors seeking to buy or sell properties swiftly, ultimately reducing market liquidity.

Another challenge is the substantial minimum capital requirements. Transactions in commercial real estate frequently require significant capital contributions from equity and debt sources. This prolongs the transaction process and restricts participation to investors with considerable

financial resources. During the property's operational phase, equity holders may find it difficult to locate buyers for their shares, while lenders often impose covenants that limit financial management, further impeding liquidity (Smith et al., 2019).

The absence of public markets for most real estate transactions exacerbates liquidity challenges. Typically, these deals are conducted within private markets, which do not offer daily pricing or comprehensive asset information. Operating on an "as-needed" basis, these markets present limited transparency and accessibility. This lack of openness can deter potential investors and complicate the process of asset valuation (Smith et al., 2019)

Extended lock-up periods significantly contribute to illiquidity in investment options. For example, private equity real estate funds may establish lock-up periods lasting up to seven years, restricting investors' ability to withdraw capital. While Real Estate Investment Trusts (REITs) provide a certain level of indirect investment exposure and often feature shorter lock-up periods, they still encounter regulatory and tax complexities. Non-traded REITs continue to present liquidity challenges, even though they offer some advantages over direct real estate investments (Smith et al., 2019).

Legal and regulatory restrictions can pose significant challenges to liquidity in real estate markets. In certain countries, stringent foreign ownership regulations can greatly reduce the pool of potential investors, impacting market liquidity.

These obstacles contribute to the relative illiquidity of the real estate market when compared to other asset classes. However, one promising solution to these liquidity challenges is real estate tokenization. By addressing these issues through tokenization, the landscape of real estate investment could transform fundamentally, becoming more inclusive and dynamic.

5.3 Blockchain-Enabled Exit Strategies

Blockchain technology introduces innovative exit strategies in real estate by offering secure, efficient, and accessible methods for asset liquidity and secondary market trading. By leveraging tokenization and smart contracts, blockchain enables more seamless and adaptable ownership transitions. This advancement improves flexibility, transparency, and accessibility within the traditionally illiquid real estate market.

5.3.1 Tokenization and Smart Contracts in Real Estate

Tokenization refers to the process of transforming a real-world asset, such as real estate, into a digital token on a blockchain. This innovation allows for fractional ownership, facilitating the division of assets into smaller, tradable units that can be bought and sold on digital platforms. By converting physical and intangible assets into blockchain-based tokens, tokenization effectively represents ownership and enables secure transfers without intermediaries (Hileman and Rauchs, 2017). This method allows real estate to be segmented into smaller, more manageable shares, which broadens access to asset ownership and enhances liquidity, making it easier for investors to enter or exit their investments.

Smart contracts enhance blockchain-based real estate transactions by streamlining and automating essential processes that typically involve intermediaries. They handle specific tasks such as verifying payments, ensuring compliance with legal and tax requirements, and managing property documentation. For example, ownership transfers can be executed automatically once payment is confirmed on the blockchain, which lowers costs and improves efficiency (Baum, 2020; Dubrovina, 2023).

Beyond facilitating transactions, smart contracts are crucial for governance and compliance in fractional real estate ownership. By embedding legal standards and investor protections directly

within the blockchain, they promote transparency, accountability, and efficient decision-making, making real estate investment both more accessible and secure.

5.3.2 Enhancing Liquidity and Secondary Markets

One of the most transformative features of blockchain technology in real estate is its ability to enhance asset liquidity through tokenization. Traditionally, real estate is considered a highly illiquid asset class, with transactions often necessitating considerable time, expense, and capital. However, tokenization allows assets to be segmented into smaller, tradable units, substantially reducing the entry barriers for investors and promoting more flexible, diversified investment portfolios (Smith et al., 2019).

Through tokenization, investors can acquire fractional shares of high-value properties, thereby opening the market to retail investors who may lack the necessary capital for traditional real estate investments. This democratization of investment opportunities is a significant advantage, allowing a wider demographic to engage in real estate, including smaller investors who can now access previously exclusive, high-value assets. As a result, tokenization expands market access and enhances liquidity by providing investors with more straightforward entry and exit points (Baum, 2020; Dubrovina, 2023).

Secondary markets are essential in enhancing liquidity for tokenized real estate assets. Unlike conventional real estate transactions, which often entail lengthy procedures and significant fees, tokenized assets can be traded on digital exchanges, facilitating swift and cost-effective transactions. Each transaction on a blockchain is inscribed on an immutable ledger, enhancing transparency, security, and traceability. This heightened visibility into transaction histories and ownership records fosters greater investor trust, as individuals can independently verify asset authenticity and ownership, thus mitigating the risks of fraud and misrepresentation. Consequently, tokenization promotes more frequent trading of real estate assets and bolsters

investor confidence by providing a transparent and secure investment environment (Jan Veuger, 2017).

Secondary markets for tokenized real estate enable investors to trade fractional ownership of properties similarly to stocks on an exchange, introducing a level of liquidity that has traditionally been absent in real estate transactions. A notable example is the Aspen Coin, a tokenized real estate initiative allowing investors to purchase St. Regis Aspen Resort shares. This model permits investors to freely trade their ownership shares on a secondary market, providing flexibility in their exit strategies and enhancing liquidity for those who favor shorter-term commitments (Kreppmeier et al., 2023).

Moreover, smart contracts enhance the efficiency of secondary markets by automating transactions and decreasing the reliance on intermediaries, such as brokers and notaries. This automation reduces transaction fees and accelerates the trading process, making it simpler for investors to buy and sell their shares. For example, when an investor wishes to sell their interest in a property, a smart contract can automatically initiate the sale and transfer funds as soon as a buyer is identified, and the terms of the sale are fulfilled. This degree of automation facilitates quicker transactions, minimizes the potential for human error, and lowers administrative costs, thereby fostering a more efficient and accessible marketplace for tokenized assets (Dubrovina, 2023).

In addition to improving liquidity and facilitating access to secondary markets, blockchain technology enables various exit strategies by integrating global access and cross-border investment opportunities. Real estate tokenization platforms empower investors to participate in international properties, as the decentralized nature of blockchain facilitates seamless global transactions. This cross-border accessibility enhances liquidity by expanding the pool of potential investors and presents diverse exit strategies, as investors can engage with a

worldwide audience rather than being confined to local buyers. The global reach of tokenization attracts international capital to real estate investments and provides investors with greater flexibility in managing their portfolios (OECD, 2020).

Despite their benefits, regulatory challenges continue to be a significant concern in real estate transactions. Various jurisdictions impose different requirements, necessitating careful planning and compliance to navigate these complex regulatory landscapes. Many tokenized real estate projects utilize "permissioned" blockchains to ensure alignment with local laws and effectively manage access. For example, the incorporation of Know Your Customer (KYC) and Anti-Money Laundering (AML) processes within permissioned blockchain platforms facilitates the protection of investor interests while meeting regulatory standards (Jan Veuger, 2017).

Blockchain-based exit strategies, empowered by tokenization and smart contracts, signify a significant advancement in the real estate sector. By offering flexible and efficient pathways to liquidity and secondary markets, blockchain technology enables investors to enter and exit investments easily. Through decentralized marketplaces, automated processes, and global accessibility, blockchain is transforming real estate investment, making it more inclusive, liquid, and responsive to the needs of contemporary investors. The ongoing development of blockchain infrastructure, along with the evolution of regulatory frameworks, is poised to enhance the potential of these exit strategies further, positioning tokenized real estate as an attractive and accessible investment option in global markets.

5.4 Liquidity Options

Real estate investments have often been characterized by illiquidity, primarily due to high transaction costs, lengthy processes, and limited exit strategies. However, blockchain technology offers new opportunities to enhance liquidity through mechanisms such as peer-to-peer (P2P) transfers, marketplaces, and token exchanges. These innovations streamline asset

transfers, facilitate fractional ownership, and enable more frequent trading, making real estate investments both more accessible and dynamic. This section examines liquidity options through direct P2P transfers, tokenized marketplaces and exchanges, and insights gleaned from Harbor's implementation. Additionally, it provides suggestions on how Unlockit could utilize these strategies to bolster liquidity.

5.4.1 Peer-to-Peer Transfers

Peer-to-peer (P2P) transfers on blockchain platforms empower investors to trade real estate assets directly, circumventing intermediaries and traditional limitations. These transactions are facilitated by smart contracts, which automate the execution of agreements and uphold contractual terms without requiring manual intervention. Schär (2021) characterizes decentralized finance (DeFi) as a financial infrastructure that eliminates reliance on centralized institutions. Instead, it utilizes open protocols and smart contracts to ensure secure and verifiable transactions (Schär, 2021). This aspect of DeFi is especially significant for P2P transfers in real estate, as smart contracts offer a secure and automated means of transferring tokenized assets directly between investors, ultimately lowering transaction costs and enhancing liquidity.

P2P transfers simplify fractional ownership of real estate, as each token represents a share of the asset that can be traded directly between investors. This decentralized approach democratizes access to real estate by allowing smaller investors to participate and transfer ownership with ease. Moreover, the automated nature of smart contracts minimizes the time and cost traditionally associated with transferring real estate, addressing long-standing liquidity challenges. By facilitating a P2P transfer model, Unlockit could offer a decentralized environment where investors can freely trade property shares, improving liquidity and attracting a broader investor base.

5.4.2 Marketplaces and Exchanges

The listing of tokenized real estate assets on digital marketplaces and decentralized exchanges (DEXs) enhances liquidity by providing a structured venue for trading. These exchanges operate without a central authority and leverage blockchain technology to ensure transparent, secure transactions. In contrast to traditional real estate markets, which are constrained by limited accessibility and high fees, DEXs allow for global access and lower transaction costs, enabling a wider pool of investors to participate. DEXs provide an environment where assets can be traded continuously, improving liquidity and allowing more frequent price adjustments based on supply and demand (Makridis et al., 2023).

Tokenized real estate assets on DEXs benefit from features like automated market makers (AMMs), which maintain continuous liquidity by algorithmically balancing asset supply and demand. Although traditional real estate lacks immediate liquidity, the tokenization of assets enables a structure where tokens can be readily traded on marketplaces. As Chen and Bellavitis, (2020) discuss, blockchain's decentralized nature not only increases liquidity but also enhances transparency and efficiency, making it suitable for real estate markets where trust and transaction speed are critical (Chen and Bellavitis, 2020). Unlockit can leverage these marketplace models to broaden investor access, reduce barriers, and encourage active trading of its tokenized properties.

Exchanges also utilize incentive mechanisms like governance tokens and airdrops, which can further enhance liquidity by engaging users and fostering community. Governance tokens grant voting rights on platform decisions, incentivizing long-term user involvement and loyalty. Airdrops—distributing tokens to users as a promotional strategy—introduce new participants to the marketplace, boosting trading activity and liquidity. For Unlockit, integrating such marketplace features could attract both institutional and retail investors, strengthening the platform's trading volume and supporting a vibrant, liquid market.

5.4.3 Case Study: Harbor

Harbor serves as a key case study for understanding how tokenization and blockchain can address liquidity issues in real estate. Harbor's platform was among the first to tokenize real estate assets, allowing investors to buy fractional shares of properties. By transforming real estate assets into tradable tokens, Harbor enables liquidity for a traditionally illiquid asset class, offering a more accessible entry point for smaller investors. Investors can buy, hold, and sell fractional shares, making it easier to enter or exit investments according to market conditions, a flexibility that aligns well with the goals of Unlockit (Baum, 2020).

Harbor's approach to secondary markets provides another significant advantage. By creating a platform for the secondary trading of real estate tokens, Harbor offers liquidity akin to public markets, where tokens representing real estate shares can be freely traded among investors. This secondary market feature allows investors to exit their positions without needing a complete asset sale, addressing a common liquidity bottleneck in real estate. Unlockit can benefit from Harbor's model by developing its own secondary market infrastructure, giving investors more flexibility and reducing the lock-in periods that typically limit liquidity in real estate.

Compliance is a core component of Harbor's platform, integrating regulatory adherence into the token structure itself. Harbor's tokens are designed to meet regulatory requirements, ensuring that each transaction complies with applicable laws. By embedding compliance mechanisms within the blockchain infrastructure, Harbor reduces the risk of legal issues and builds investor trust. This compliance strategy is crucial for Unlockit as it looks to expand its market. By incorporating compliance measures directly into the platform's architecture, Unlockit can create a secure and legally compliant marketplace, which could improve liquidity by attracting risk-averse investors who might otherwise avoid blockchain-based investments due to regulatory concerns.

5.5 Regulatory Considerations

The integration of blockchain technology into the real estate sector through tokenization brings significant regulatory challenges. These revolve around the classification of tokens under EU securities laws and ensuring compliance with Anti-Money Laundering (AML) and Know Your Customer (KYC) requirements. This section delves into these regulatory considerations to ensure a robust framework for Unlockit's operations.

8.5.1 Security Laws

The tokenization of real estate brings forth the need to evaluate whether fractional ownership tokens should be classified as securities under EU law. Two principal regulatory frameworks, MiFID II (Markets in Financial Instruments Directive) and MiCA (Markets in Crypto-Assets Regulation), address this matter.

MiFID II, which governs financial instruments, establishes stringent guidelines for investor protection, market transparency, and fair competition within financial markets. If tokens that represent ownership shares in real estate are determined to be comparable to traditional securities, they would fall within the purview of MiFID II. Such a classification would impose various obligations on issuers and platforms, including the necessity for investor disclosures, transaction reporting, and adherence to conduct of business rules (European Parliament and Council 2014a). In contrast, the Markets in Crypto-Assets Regulation (MiCA) strives to standardize regulations throughout the EU for crypto-assets that fall outside traditional financial frameworks. It classifies crypto-assets into three categories: e-money tokens, which are linked to a single official currency; asset-referenced tokens, which maintain their value by referencing multiple assets or currencies; and other crypto-assets, including utility tokens (European Parliament and Council, 2023). Fractional real estate tokens may be classified as "asset-referenced tokens" under MiCA if their value is supported by underlying real estate. MiCA necessitates a clear differentiation between crypto assets that are deemed financial instruments

under the Markets in Financial Instruments Directive (MiFID II) and those governed solely by MiCA. Furthermore, it imposes stringent transparency requirements to protect investors and uphold market integrity. Importantly, MiCA excludes non-fungible and unique assets, such as specific real estate guarantees, from its regulatory scope. However, fractionalized tokens based on fungible real estate shares are likely to be subject to the provisions of MiCA (European Parliament and Council, 2023).

For Unlockit, it is crucial to assess whether its token offerings comply with the requirements of MiFID II or MiCA. Adopting a "substance-over-form" approach is recommended, where the functionality of the tokens, rather than their label, dictates their regulatory classification. By aligning its governance structures with the provisions of MiCA, the platform can ensure scalability across EU jurisdictions (European Parliament and Council, 2023).

5.5.2 Anti-Money Laundering (AML) and Know-Your-Customer (KYC)

Tokenized real estate platforms face stringent anti-money laundering (AML) and know-your-customer (KYC) obligations under the evolving regulatory framework of the European Union. These measures are vital for ensuring transparency and trust while mitigating the risks of blockchain misuse for illegal activities. Directive (EU) 2024/1640 expands and enhances the Union's AML framework, building upon the earlier Directive (EU) 2018/843, which extended AML requirements to virtual currency exchanges and custodian wallet providers. Under the current directive, entities must implement robust customer due diligence processes and ensure transparency by enabling Financial Intelligence Units (FIUs) to link virtual currency transactions with identifiable individuals (European Parliament and Council, 2024). The pseudonymous nature of blockchain technology continues to pose challenges, as while transactions on public ledgers can be traced, establishing connections to real-world identities often remains complex.

Given these challenges, Unlockit must adopt a comprehensive compliance framework to mitigate the risks associated with blockchain's decentralized nature and ensure alignment with EU regulations. This includes implementing thorough KYC processes, deploying advanced analytics tools to monitor transaction patterns, and reporting suspicious activities to the relevant authorities (European Parliament and Council, 2024). Additionally, the inherent vulnerabilities of decentralized systems, such as the potential for misuse by unregulated platforms and privacy coins, necessitate proactive measures to address these risks. Surveillance tools for crypto-to-fiat transactions are indispensable for identifying and mitigating suspicious activity, as emphasized by Manninen, who advocates for strict controls within decentralized systems (Manninen, 2023).

To strengthen compliance, Unlockit should consider adopting permissioned blockchain systems that embed regulatory safeguards into their architecture. These systems facilitate adherence to AML requirements without compromising operational efficiency. Aligning technological strategies with regulatory mandates ensures that Unlockit not only complies with EU directives but also fortifies its operational integrity and trustworthiness (European Parliament and Council, 2024).

5.6 Conclusion

5.6.1 Developing Exit Strategies

Unlockit has the potential to transform real estate exit strategies by harnessing tokenization and blockchain technology. By enabling fractional ownership, investors can trade property shares with greater ease, thereby reducing lock-up periods and enhancing liquidity. Moreover, smart contracts can automate transactions, ensuring compliance while minimizing manual intervention. Establishing a secondary market or a peer-to-peer trading platform would further streamline exits and draw in more investors, as illustrated by successful models such as Harbor.

5.6.2 Navigating Regulation

Adhering to EU regulations such as MiFID II and MiCA is crucial for scaling Unlockit's solutions. Clearly identifying the classification of tokenized assets and integrating AML and KYC processes directly into the platform will ensure compliance with regulatory standards. Additionally, collaborating with regulators through initiatives like regulatory sandboxes can facilitate Unlockit in testing and refining its platform while ensuring compliance, fostering trust, and promoting adoption.

5.6.3 Ownership Stability

Ownership stability can be achieved by leveraging the immutability of blockchain to securely record and verify transactions. Smart contracts can facilitate automated ownership transitions and enforce governance rules, including co-owner rights and pre-emptive purchase agreements. A well-developed secondary market will enable changes in fractional ownership without disturbing the overall structure, promoting both stability and liquidity.

5.6.4 Unlockit's Path Forward

Unlockit's forthcoming initiatives should be directed towards enhancing its blockchain-based ecosystem and reinforcing its leadership in the fractional real estate market. The establishment of secondary markets and peer-to-peer trading platforms will be vital for increasing liquidity and providing investors with flexible exit strategies. Moreover, fostering partnerships with regulators and institutional stakeholders will facilitate the creation of a compliant and reliable framework that encourages widespread adoption and scalability. In addition, the expansion of its technology infrastructure—particularly through the refinement of smart contracts and the integration of secure, permissioned blockchain solutions—will further boost operational efficiency and transparency.

6. Outlooks on Real Estate and Property Rights Tokenization: Legislative Enablement vs. Innovation-Driven Either Allowed by the Legislator or Enabled through Innovation (GROUP PART)

6.1 Introduction

As real estate investments adapt to incorporate fractional ownership and multi-owner models, the complexities and governance challenges associated with these ventures have become more evident. Earlier chapters addressed problems such as conflicting interests, inefficiencies in decision-making, and operational challenges that undermine collaboration, trust, and long-term asset value in multi-owner environments. These observations emphasize the need for governance that is more transparent, efficient, and inclusive mechanisms.

Given these challenges, this chapter takes a forward-looking approach by exploring how blockchain technology could revolutionize real estate governance. By increasing transparency, automating processes, and enhancing market access, blockchain can simplify decision-making, promote fair participation, and strengthen trust among stakeholders. Based on the limitations and opportunities identified earlier, this concluding section outlines a strategy for tokenized property rights and the incorporation of decentralized governance models.

The following sections outline both incremental and ideal scenarios, examining gradual integration within current frameworks alongside a complete legislative adoption of tokenization. This chapter ultimately presents an optimal governance model for condominiums—driven by blockchain technology, adherent to regulatory standards, and supported by decentralized systems—illustrating how real estate management might transform into a more efficient, transparent, and democratized process system.

6.2 Blockchain as a Solution to Governance Challenges

Blockchain technology can tackle governance issues in multi-owner real estate projects by enhancing transparency, automating tasks, and improving efficiency in property management. It decentralizes decision-making, guarantees secure transactions, and facilitates real-time communication, transforming interactions and collaboration among co-owners.

6.2.1 Enhancing Transparency and Trust

A major challenge in multi-owner governance is the lack of transparency, which results in information asymmetries and distrust among stakeholders. Blockchain addresses this issue by providing a shared, unchangeable ledger that all participants can access. Every transaction is logged on to the blockchain, guaranteeing that all stakeholders receive the same information in real time. This transparency clears up uncertainties, diminishes conflicts, and builds trust among co-owners.

6.2.2 Streamlining Decision-Making

Voting mechanisms powered by blockchain facilitate efficient and democratic decision-making in multi-owner ventures. Smart contracts streamline the voting process, guaranteeing secure vote recording, instant documentation of outcomes, and their enforcement. Utilizing proportional or quadratic voting systems allows the consideration of all stakeholders' interests and avoids dominance by any single party in decision-making. This approach minimizes delays and gridlocks, especially in situations that need unanimous or supermajority agreement.

6.2.3 Automating Operational Processes

Smart contracts, a fundamental aspect of blockchain technology, automate regular tasks like collecting fees, scheduling maintenance, and processing vendor payments. For instance, maintenance charges can be automatically computed and allocated to owners according to their

ownership stakes, with payments initiated upon the completion of tasks. This process removes administrative delays, decreases human error, and lowers operational expenses.

6.2.4 Increasing Liquidity

Tokenizing real estate enables fractional ownership and trading on regulated security token exchanges. This enhances liquidity, allowing co-owners to buy, sell, or transfer their stakes without affecting the overall ownership structure. Furthermore, rental income can be distributed in real-time through smart contracts, providing stakeholders with immediate access to financial returns and improving the overall value of tokenized ownership.

6.2.5 Ensuring Compliance

Integrating with legal and regulatory frameworks, blockchain systems guarantee compliance with property laws and anti-money laundering (AML) standards for all transactions. Tokenized ownership is directly associated with official land registries, providing full legal acknowledgment. Additionally, smart contracts can streamline tax compliance by automatically calculating and processing relevant taxes, thereby minimizing administrative burdens and ensuring adherence to regulations.

Although blockchain technology presents an appealing solution for governance issues in multi-owner real estate, widespread implementation is shaped by regulatory considerations, market readiness, and the speed of infrastructural development. Real-world limitations need to be resolved before these transformative solutions can be realized. This section explores a short to mid-term perspective where gradual adoption within the current legislative and market contexts emerges as a more feasible approach. It highlights how the industry might need to evolve step by step, integrate with legacy systems, and build trust before the transformative potential discussed earlier can be fully realized.

6.3 Short to Midterm Outlook: Incremental Adoption within Existing Frameworks

If the legislator does not envision the direct tokenization of property rights, and that to fractionalize properties, companies and investors would have to fractionalize SPVs, use REITs or use NFTs. In this scenario, the growth of tokenized property rights would be characterized by regulatory caution, institutional scepticism, risk aversion, and mixed-to-low user trust in the technology. This approach takes the assumption that innovation aligns with the comfort zones of established players – both public and private – and where changes are constrained by the need to mitigate risks and maintain market stability.

Therefore, the pace of adoption will largely depend on regulatory readiness and the willingness of institutions and users to adopt new technologies and processes. Historically, disruptive technologies face these challenges. For example, blockchain technology has often been criticized by financial services incumbents and legislators, with regulation in the U.S. and EU initially preventing banks from offering cryptocurrency-related products due to compliance concerns. Despite these barriers, the industry itself has worked to build infrastructure that complies with existing regulations, while retail investors have continued to adopt and utilize cryptocurrency independently.

This pattern suggests that, when sufficient market demand exists, the industry can innovate to overcome regulatory barriers (or also exploit underregulated markets of course), particularly in financial services. Adoption tends to accelerate only when compliant infrastructure or platforms becomes available.

For instance, to further develop the previous example, the main challenges were related with how crypto exchanges “stored” crypto assets, so if banks wanted to offer cryptocurrencies to their clients, they needed other custody solutions. One of the first Eurozone banks to do this was BBVA Switzerland, which implemented a bitcoin trading and custody service in 2021

using Metaco's infrastructure. Metaco was a FinTech that built an orchestration platform that offered bank-grade custody and trading on centralized and decentralized exchanges, which was acquired by Ripple in 2023. Platforms like Metaco (e.g. Coinbase, Zodia Custody) currently provide bank-grade crypto custody solutions for financial institutions such as Standard Chartered, Citi, BNP Paribas, and others. Since regulations did not permit these banks to act as crypto exchanges for their clients, they had to wait for solutions that allowed them to comply with banking laws before they could offer cryptocurrency services and enter the space.

However, even when such infrastructure exists, the risk of regulatory ambiguity remains. For instance, the 2020 SEC lawsuit against Ripple Labs highlighted this uncertainty, as the SEC alleged that Ripple violated securities laws by selling XRP tokens without proper registration. The case aimed to clarify the legal status of XRP and, by extension, establish broader regulatory guidelines for cryptocurrencies and digital tokens potentially stifling innovation and growth for the sector.

Similarly, even if the legislator does not allow for the tokenization of property rights, it did not anticipate that NFTs could tokenize property deeds. The issue with these is, like the name suggests, they are not fungible. This is just to say that, even if the legislator does not move towards allowing for the tokenization of property rights, there is a future where the industry might build infrastructure and solutions that indirectly allow for this. Given these dynamics, real estate tokenization would likely begin by addressing markets and use cases where blockchain provides immediate and tangible value, until either the legislator moves in favor of this, or the industry innovates itself past this barrier.

6.3.1 Regulatory Alignment as a Catalyst

Governments and regulators in the EU and Portugal would first need to amend existing frameworks, such as MiCA and eIDAS, to accommodate tokenized real estate and minimize

uncertainty. For example, property tokens might initially be classified as digital assets, drawing legal parallels with existing digital assets rather than redefining ownership structures. This highlights the primary challenge: the sector must "wait" for legislators to develop effective legal frameworks that enable innovation while safeguarding users.

6.3.2 Incremental Integration with Legacy Systems

If the primary barrier is regulatory, adoption would likely focus on integrating blockchain technology with existing real estate practices rather than replacing them. For instance, blockchain could be used to enhance property registries while maintaining ownership records within centralized entities, such as Special Purpose Vehicles (SPVs). Smart contracts could initially automate processes like rental income distribution and voting rights management. Property evaluations would continue to be conducted by licensed appraisers to ensure accurate assessments before tokenization. This step-by-step approach would lower barriers to institutional adoption by providing proof-of-concept use cases that demonstrate efficiency gains without necessitating radical systemic changes.

6.3.3 Targeting Institutional and Accredited Investors

Even though the primary goal of tokenization is to make the fractionalization of real estate practical and accessible, it is likely that, as seen in other financial services segments, large investors – such as institutions and high-net-worth individuals – will gain access first. These investors are typically better equipped to navigate novel asset classes and bear the associated risks. Meaning, maybe commercial properties will be the most popular asset class to be tokenized first, or expensive vacation homes. They are also more informed and have greater resources at their disposal. In contrast, retail investors often need to conduct extensive research and acquire technical expertise before feeling comfortable investing significant amounts in assets as important as real estate. As a result, retail investors may only gain broader access once

frameworks for KYC/AML compliance and investor protections have been thoroughly tested and established. Or if PropTech and Fintech companies create solutions with business models that grant the middle-class access to tokenized real estate.

9.3.4 Enhancing Liquidity and Access Gradually

Secondary market trading would initially be restricted to regulated exchanges with strict oversight, primarily to protect investors. As confidence in the system grows, the scope could expand to include more dynamic trading mechanisms and broader investor participation (with decentralized exchanges for example). Another critical consideration, given the unique characteristics of real estate, is the need for robust custody solutions for property rights tokens. For instance, issues could arise if an exchange faces operational challenges or if an investor loses access to their cold storage wallet. This underscores the argument that, in the case of property tokens, having bank-grade crypto custody infrastructure widely available might increase the likelihood of the legislator ruling in favour of the tokenization of property rights. Such infrastructure would allow banks to act as intermediaries, providing secure custody and facilitating token management for their clients, from safe storage to seamless trading on regulated exchanges.

6.4 Mid- to Long-Term Outlook on Governance Models with Tokenized Property Rights

Blockchain-based land registries could serve as the backbone of these systems if legislation eventually permits direct tokenization of real estate and property rights (Zhang and Chen, 2021). Property ownership records would migrate to a public blockchain, providing real-time, transparent access to asset information and automating processes like rent allocation or deed transfers via smart contracts. A universal token standard might emerge, enabling property tokens to be globally recognized and traded across jurisdictions with minimal friction, while DAOs could oversee governance. Integrating AI-driven analytics and other microservices could

further refine these models, analyzing market data and suggesting strategies for token holders, as seen in existing financial services (Santana and Albareda, 2022).

With these advancements, global marketplaces for property token trading may resemble current cryptocurrency exchanges, including decentralized platforms. Improved liquidity mechanisms, such as automated market makers, would ensure the continuous availability of buyers and sellers, facilitating fair pricing and potentially increasing speculation without robust institutional investment (Schmid, Truebestein, and Aepli, 2024). Tokenized mortgages and peer-to-peer financing models could emerge, making property loans more accessible and enabling swift refinancing. At the same time, smart contract integration with public entities could streamline the collection of property taxes (Baum, Saull, and Braesemann, 2020).

These mid- to long-term prospects point toward a future in which real estate transactions, governance, and finance become increasingly automated, transparent, and inclusive. The next section will explore a best-case scenario governance framework for condominiums once legislation fully embraces property rights tokenization, illustrating how a Decentralized Homeowner Association (DHA) and DAO structures could revolutionize the management and operations of multi-owner properties.

6.5 A Potential Governance Framework for a Condominium once the Legislator allows the Tokenization of Property Rights

Ideally, properties would eventually transition from traditional structures to a fully decentralized management and governance structure. This system would integrate the tokenization of property rights, the automation of most operations, regulatory compliance, and liquidity options, resulting in a participatory model for stakeholders.

6.5.1 Structural Components

The governance would be managed by a Decentralized Homeowner Association (DHA), a Decentralized Autonomous Organization (DAO). If property rights were allowed to be tokenized, then the Portuguese land registry could directly record security tokens tied to property rights and represent the ownership of individual units vs shared spaces. There could even be integration with municipal licensing, tax authorities, and the national land registry, allowing real-time updates for ownership transfers, compliance checks, and tax obligations. As shown in Diagram 3, this structure integrates token holders, the DHA/DAO, smart contracts, and the property manager into a transparent and automated governance system.

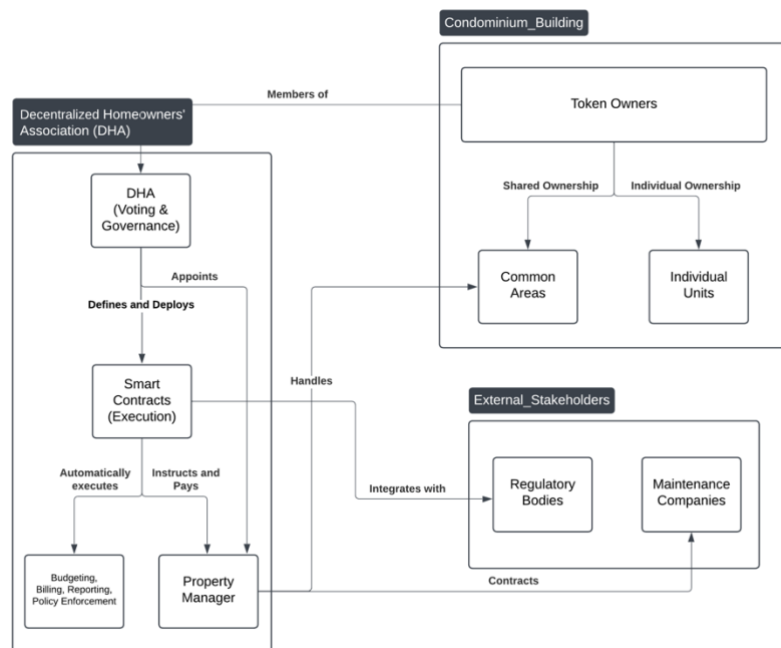


Figure 1: DHA Condominium Structure

6.5.2 Governance Mechanisms

Governance within the DHA would be participatory and transparent, providing some hierarchy to categorize decisions, with different requirements to act or not to act. The same way the state and companies do. Essentially, it marks a separation between decisions that impact the structure and decisions to ensure that operations run smoothly. Significant decisions, such as renovations,

major upgrades, budget approvals, changes to bylaws, and asset dispositions, should require higher participation thresholds or supermajority approvals. For example, a proposal to install energy-efficient infrastructure triggers a smart contract-based voting process where all token holders can transparently participate. The smart contract automatically executes the vote results, ensuring the implementation of the voting result. On the other hand, routine decisions, like cleaning schedules, repairs and maintenance, could be managed through automated workflows. Smart contracts could schedule these tasks, allocate payments to vendors, and collect maintenance fees proportionate to ownership shares. Figure 4 illustrates this on-chain decision-making process, showing how proposals are submitted, votes are cast and counted, and results are recorded and resolved transparently on the blockchain.

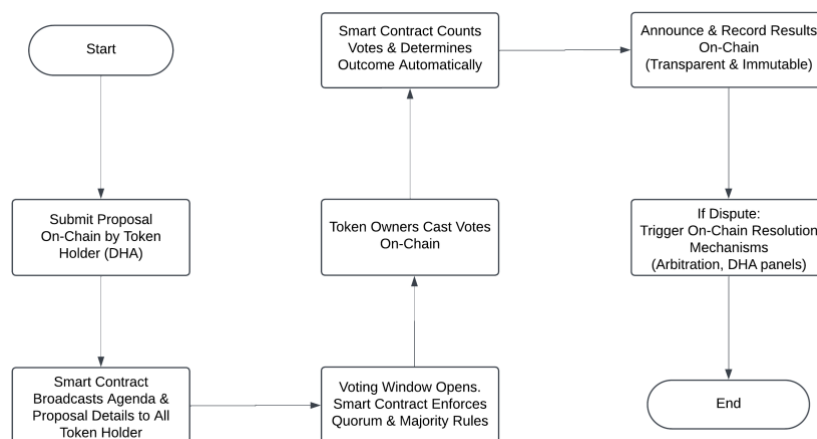


Figure 2: On-Chain Decision-Making Process

Voting, conducted entirely on the blockchain, could utilize either a weighted system aligned with ownership shares or a quadratic system to prevent asymmetries in favor of larger stakeholders. DLTs would provide real-time access to proposals, voting outcomes, and participation records.

6.5.3 Liquidity Options

Ownership tokens would be recognized under Portuguese property laws and comply with the EU's Markets in Crypto-Assets Regulation (MiCA). Tokens would have to be tradable on

regulated exchanges, enabling global access and real-time pricing. This is what would truly democratize real estate assets, and any other alternative and private market for that matter. Token holders, through P2P transfers, could transfer ownership through escrow smart contracts. These smart contracts would essentially act as a permissionless middleman, holding and releasing the asset after certain conditions are met (e.g., KYC, payment). Moreover, there could be a scenario where these tokens might even be traded on decentralized exchanges without KYC procedures, further reducing transaction times. However, this could only happen if legislators delay the legalization of tokenization of property rights for too long. In such a case, market demand might drive companies to develop infrastructure that enables these transactions outside traditional regulatory frameworks.

Developing secondary markets would enable token holders to assess real-time property values, making real estate investing more transparent and with fairer pricing. Additionally, smart contracts would automatically distribute rental income based on ownership tokens or maybe even a specific class of tokens (e.g., income tokens).

6.5.4 Compliance with Regulatory Standards

EU and Portuguese property laws would need to be amended and updated to legally recognize the digital representation of property rights and ensure that tokenized ownership is enforceable. By doing so, blockchain integration with the Portuguese land registry would automate ownership updates upon token transfers, eliminating traditional documentation and reducing public spending.

Through identity protocols, KYC/AML processes could be automated to mitigate fraud and protect the consumer. Smart contracts must also be legally enforceable, automating tax obligations with integrated payment processing.

6.5.5 Operational Efficiency

To expand on how a maintenance vendor could be hired and paid, the smart contract could request bids (i.e., or even do a tender), select the vendor, and execute the contract based on predefined milestones. The chosen blockchain would record all transactions, providing token holders with the financial performance of their investment, in this case, the condominium. A dashboard could offer insights into expenses, maintenance schedules, voting outcomes, and even investor and/or tenant activity. Smart contracts could have embedded arbitration mechanisms for minor disputes and DAO arbitration panels for more complex issues, reducing dependence on third parties for this.

6.5.6 Conclusion

The relationship between tenants and property investors would be fundamentally transformed, redefining real estate assets' intrinsic value and nature. By providing greater liquidity to the market, this asset class, whose rising value is increasingly out of reach for the middle class, would become truly democratized. Nevertheless, robust regulatory compliance would still be essential to maintaining trust and user protection.

Automation enabled by smart contracts would minimize administrative burdens and human error, reducing costs and improving operational efficiency. Real-time financial reporting and even dispute resolution mechanisms would enhance transparency and the tenant/investor experience.

7. Conclusion (GROUP PART)

This thesis explores the development of governance frameworks to facilitate fractional ownership of real estate assets using blockchain technology. By addressing inefficiencies in traditional property management and leveraging distributed ledger technologies (DLTs), we have highlighted the potential to enhance liquidity, streamline decision-making, and democratize property investment. Our analysis of existing multi-owner real estate models revealed common challenges, including misaligned interests, information asymmetry, and operational inefficiencies. These issues underscore the need for innovative governance solutions that blockchain technology can provide. The regulatory landscape in Portugal and the broader European Union context presents opportunities and challenges for implementing blockchain-based fractional ownership. While regulations like MiCA, eIDAS, and AMLD6 provide a foundation for crypto-asset management and digital transactions, further legal reforms are necessary to accommodate tokenized property rights fully. Our evaluation of various blockchain platforms demonstrated that different real estate scenarios require tailored technological solutions. Ethereum's robust ecosystem and security make it suitable for complex DAOs, while platforms like Solana and Avalanche offer advantages in speed and cost-efficiency for frequent transactions. The proposed governance framework for Unlockit integrates blockchain technology to address key challenges in fractional ownership. The framework aims to align stakeholder interests, enhance operational efficiency, and ensure regulatory compliance by leveraging smart contracts, decentralized voting mechanisms, and transparent record-keeping. The success of blockchain-enabled fractional ownership in real estate will depend on continued technological innovation, regulatory adaptation, and market acceptance. As the legal and technological landscapes evolve, frameworks like the one proposed for Unlockit will need to remain flexible and responsive to change. Ultimately, this thesis demonstrates that tokenization, coupled with well-designed governance structures and

regulatory alignment, can potentially transform real estate investment. By enabling more efficient, transparent, and equitable management of property assets, blockchain technology can open new avenues for democratizing access to real estate markets and enhancing overall market liquidity.

References

- Banco de Portugal. 'Financial Stability Report — May 2024', 2024. <https://www.bportugal.pt/en/publicacao/financial-stability-report-may-2024>
- Baum, Andrew, Andrew Saull, and Fabian Braesemann. 'PropTech 2020: The Future of Real Estate'. Oxford Future of Real Estate Initiative, Saïd Business School, University of Oxford, 2020. <https://www.sbs.ox.ac.uk/sites/default/files/2020-02/proptech2020.pdf>
- Baum, Andrew. 'Tokenisation – The Future of Real Estate Investment?'. Oxford Future of Real Estate Initiative, Saïd Business School, University of Oxford, 2020. <https://www.sbs.ox.ac.uk/sites/default/files/2020-01/tokenisation.pdf>
- Chang, Yun-chien. 2012. 'Tenancy In “Anticommons”? A Theoretical and Empirical Analysis of Co-Ownership'. *Journal of Legal Analysis* 4 (2): 515–53. <https://doi.org/10.1093/jla/las011>
- Chen, Yan, and Cristiano Bellavitis. 2020. 'Blockchain Disruption and Decentralized Finance: The Rise of Decentralized Business Models'. *Journal of Business Venturing Insights* 13 (June):e00151. <https://doi.org/10.1016/j.jbvi.2019.e00151>
- Creta, Fabio, and Jelena Mazaj. 2021. 'Can FinTech Progress the Real Estate Sector? The Disruptive Role of Crowdfunding & Blockchain: A Systematic Literature Review'. *European Journal of Islamic Finance* No 17 (April):2021. <https://doi.org/10.13135/2421-2172/5323> <https://doi.org/10.13135/2421-2172/5323>
- Dagan, Hanoch, and Michael A. Heller. 2000. 'The Liberal Commons'. *Yale Law Journal* 110:549. <https://www.yalelawjournal.org/article/the-liberal-commons>
- Diário da República. 'Código Civil Português', 1966. <https://diariodarepublica.pt/dr/legislacao-consolidada/decreto-lei/1966-34509075>

Diário da República. ‘Decreto-Lei n.º 250/94. Regime Jurídico Do Licenciamento Municipal de Obras Particulares’, 1994. <https://diariodarepublica.pt/dr/detalhe/decreto-lei/250-1994-618126>

Diário da República. ‘Decreto-Lei n.º 38382/51, de 7 de Agosto. Regulamento Geral Das Edificações Urbanas’, 1951. <https://diariodarepublica.pt/dr/legislacao-consolidada/decreto-lei/1951-120610500>

Diário da República. ‘Direito de Propriedade’. Accessed 20 October 2024. <https://diariodarepublica.pt/dr/lexionario/termo/direito-propriedade>

Dubrovina, Iuliia 2023. ‘Tokenization of Real Estate: The Future Trend in Investments’, October. <http://dspace.unive.it/handle/10579/25095> <http://dspace.unive.it/handle/10579/25095>

European Central Bank. ‘Understanding Financial Market Liquidity’, 2007. https://www.ecb.europa.eu/press/financial-stability-publications/fsr/focus/2007/pdf/ecb~cc3931849f.fsrbox200706_09.pdf

European Parliament and Council. Directive (EU) 2024/1640 of the European Parliament and of the Council of 31 May 2024 on the mechanisms to be put in place by Member States for the prevention of the use of the financial system for the purposes of money laundering or terrorist financing, amending Directive (EU) 2019/1937, and amending and repealing Directive (EU) 2015/849 (Text with EEA relevance). 2024. <http://data.europa.eu/eli/dir/2024/1640/oj/eng>

European Parliament and Council. Directive 2014/65/EU of the European Parliament and of the Council of 15 May 2014 on markets in financial instruments and amending Directive 2002/92/EC and Directive 2011/61/EU. 2014a. <http://data.europa.eu/eli/dir/2014/65/oj/eng>

European Parliament and Council. ‘Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the Protection of Natural Persons with Regard to the

Processing of Personal Data and on the Free Movement of Such Data (General Data Protection Regulation)’. 2016. <https://eur-lex.europa.eu/eli/reg/2016/679/oj>

European Parliament and Council. ‘Regulation (EU) 2023/1114 of the European Parliament and of the Council of 31 May 2023 on Markets in Crypto-Assets, and Amending Regulations (EU) No 1093/2010 and (EU) No 648/2012’. 2023. <https://eur-lex.europa.eu/eli/reg/2023/1114/oj>

European Parliament and Council. ‘Regulation (EU) No 910/2014 on Electronic Identification and Trust Services for Electronic Transactions in the Internal Market (eIDAS Regulation)’. 2014b. <https://eur-lex.europa.eu/eli/reg/2014/910/oj>

Fill, Hans-Georg, Felix Härer, and Andreas Meier. 2020. ‘Wie funktioniert die Blockchain?’ In Blockchain : Grundlagen, Anwendungsszenarien und Nutzungspotenziale, edited by Hans-Georg Fill and Andreas Meier, 3–19. Wiesbaden: Springer Fachmedien. https://doi.org/10.1007/978-3-658-28006-2_1

Fukuyama, Francis. ‘Governance: What Do We Know, and How Do We Know It?’, 2016. <https://www.annualreviews.org/content/journals/10.1146/annurev-polisci-042214-044240>

Garcia-Teruel, Rosa M., and Héctor Simón-Moreno. 2021. ‘The Digital Tokenization of Property Rights. A Comparative Perspective’. Computer Law & Security Review 41 (July):105543. <https://doi.org/10.1016/j.clsr.2021.105543>

Global Legal Insights. ‘Blockchain & Cryptocurrency Laws 2025 - Portugal’. 2024. <https://www.globallegalinsights.com/practice-areas/blockchain-cryptocurrency-laws-and-regulations/portugal/>

Hastings, Eileen M., Siu K. Wong, and Megan Walters. "Governance in a Co-Ownership Environment: The Management of Multiple-Ownership Property in Hong Kong." Property

Management 24, no. 3 (2006): 293–308.

<https://www.researchgate.net/publication/235300616> Governance in a co-ownership environment The management of multiple-ownership property in Hong Kong

Hileman, Garrick, and Michel Rauchs. 2017. ‘2017 Global Blockchain Benchmarking Study’. SSRN Electronic Journal. <https://doi.org/10.2139/ssrn.3040224>

Jan Veuger. 2017. ‘Attention to Disruption and Blockchain Creates a Viable Real Estate Economy’. Journal of US-China Public Administration 14 (5). <https://doi.org/10.17265/1548-6591/2017.05.003>

Jensen, Johannes Rude, Victor von Wachter, and Omri Ross. 2021. ‘How Decentralized Is the Governance of Blockchain-Based Finance: Empirical Evidence from Four Governance Token Distributions’. 2021. <https://doi.org/10.48550/arXiv.2102.10096>

Kreppmeier, Julia, Ralf Laschinger, Bertram I. Steininger, and Gregor Dorfleitner. 2023. ‘Real Estate Security Token Offerings and the Secondary Market: Driven by Crypto Hype or Fundamentals?’ Journal of Banking & Finance 154 (September):106940. <https://doi.org/10.1016/j.jbankfin.2023.106940>

Lashkari, Bahareh, and Petr Musilek. 2021. ‘A Comprehensive Review of Blockchain Consensus Mechanisms’. IEEE Access 9:43620–52. <https://doi.org/10.1109/ACCESS.2021.3065880>

Lawton, Julie D. 2014. ‘Unraveling the Legal Hybrid of Housing Cooperatives’. UMKC Law Review 83:117 https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2550521

Lowies, Braam, Robert Brenton Whit, Christa Viljoen, and Stanley McGreal. 2018. ‘Fractional Ownership – an Alternative Residential Property Investment Vehicle’. Journal of Property Investment & Finance 36 (6): 513–22. <https://doi.org/10.1108/JPIF-02-2018-0013>

Manninen, Heidimaria. 2023. 'The Anti-Money Laundering Challenges of FinTech and Cryptocurrencies'. *Nordic Journal of Legal Studies* 2 (1): 7–19. <https://doi.org/10.51421/njls-2023-0026>.<https://doi.org/10.51421/njls-2023-0026>

Marin, Oana, Tudor Cioara, Liana Todorean, Dan Mitrea, and Ionut Anghel. 2023. 'Review of Blockchain Tokens Creation and Valuation'. *Future Internet* 15 (12): 382. <https://doi.org/10.3390/fi15120382>

Mazurczak, Anna. 2011. 'Development of Real Estate Investment Trust (REIT) Regimes in Europe'. *Journal of International Studies* 4 (1): 115–23. <https://doi.org/10.14254/2071-8330.2011/4-1/12>

'MYNE Homes'. 2024. 2024. <https://www.myne-homes.com/>

OECD (2020), *The Tokenisation of Assets and Potential Implications for Financial Markets*, OECD Blockchain Policy Series, www.oecd.org/finance/The-Tokenisation-of-Assets-and-Potential-Implications-for-Financial-Markets.htm

Oh, Jason S., and Andrew Verstein. 2023. 'A Theory of the REIT'. *Yale Law Journal* 133:755. <https://www.yalelawjournal.org/article/a-theory-of-the-reit>

Saari, Anniina, Seppo Junnila, and Jussi Vimpari. 2022. 'Blockchain's Grand Promise for the Real Estate Sector: A Systematic Review'. *Applied Sciences* 12 (23): 11940. <https://doi.org/10.3390/app122311940>

Santana, Carlos, and Laura Albareda. 2022. 'Blockchain and the Emergence of Decentralized Autonomous Organizations (DAOs): An Integrative Model and Research Agenda'. *Technological Forecasting and Social Change* 182 (September):121806. <https://doi.org/10.1016/j.techfore.2022.121806>

Schär, Fabian. 2021. 'Decentralized Finance: On Blockchain- and Smart Contract-Based Financial Markets'. Review 103 (2). <https://doi.org/10.20955/r.103.153-74>

Schmid, Elena, Michael Truebestein, and Matthias Daniel Aepli. 2024. Tokenization in Real Estate: Opportunities and Challenges. Springer Nature. <https://link.springer.com/book/10.1007/978-3-031-55810-8>

Smith, Julie, Manasi Vora, Dr Hugo Benedetti, Kenta Yoshida, and Zev Vogel. 2019. 'Tokenized Securities & Commercial Real Estate'. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3438286

Stackpole, Thomas. 'What Is Web3?' Harvard Business Review, 2022. <https://hbr.org/2022/05/what-is-web3>

Swinkels, Laurens. 2023. 'Empirical Evidence on the Ownership and Liquidity of Real Estate Tokens'. Financial Innovation 9 (1): 45. <https://doi.org/10.1186/s40854-022-00427-5>

Treffers, Stefan R., and Randy K. Lippert. 2020. 'Condominium Self-Governance? Issues, External Interests, and the Limits of Statutory Reform'. Housing Studies 35 (6): 1025–49. <https://doi.org/10.1080/02673037.2019.1646217>

Ullah, Fahim, and Fadi Al-Turjman. 2023. 'A Conceptual Framework for Blockchain Smart Contract Adoption to Manage Real Estate Deals in Smart Cities'. Neural Computing and Applications 35 (7): 5033–54. <https://doi.org/10.1007/s00521-021-05800-6>

Unlockit. 'The Most Innovative Real Estate Project in Portugal: A Web3 Platform for Real Estate Tokenization and Services'. LinkedIn, 2024. https://www.linkedin.com/posts/tiagorrdias_the-most-innovative-real-estate-project-in-activity-7260610761142484994-tps0/?utm_source=share&utm_medium=member_desktop

Zhang, Yi, and Jiaheng Chen. "Avalanche: A Novel Consensus Protocol for High Throughput."

Accessed December 2024. <https://docs.avax.network/protocol/avalanche-consensus>.