A Work Project, presented as part of the requirements for the Award of a Master's degree in **Management** from the Nova School of Business and Economics.

UNLOCKIT FIELD LAB ON CREATING A GOVERNANCE FRAMEWORK TO FACILITATE THE FRACTIONALIZATION OF REAL ESTATE ASSETS USING WEB3-BASED BUSINESS MODELS IN PORTUGAL: LEGAL AND REGULATORY REFORMS NECESSARY TO SUPPORT THE FRACTIONAL OWNERSHIP OF REAL ESTATE ASSETS THROUGH DISTRIBUTED LEDGER TECHNOLOGIES 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. By addressing inefficiencies in traditional property management, such as bureaucracy and lack of transparency, it highlights the potential of distributed ledger technologies (DLTs) to enhance liquidity, streamline decision-making, and democratize property investment. This study evaluates blockchain compatibility for governance needs, compliance with EU regulations, and the implications of varying ownership structures. Analyzing legal, technical, and operational challenges, the thesis shows that tokenization coupled with regulatory alignment and further innovation will enable more efficient, transparent and equitable management of real estate assets.

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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

DHA - Decentralized Homeowner Association

DLT – Distributed Ledger Technology

EEA – European Economic Area

EMTs – Electronic Money Tokens

EU – European Union

GDPR - General Data Protection Regulation

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

REITs – Real Estate Investment Trusts

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, and offers a cloud-based platform that digitizes and streamlines property transactions, ensuring they are secure, transparent, and collaborative. By incorporating technologies such as smart contracts, document authentication, and identity validation, 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 work 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 where traditional intermediaries and restrictions are displaced by blockchain technology serving 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, in a context 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 types of tokenized assets 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, hindering decision-making and reducing 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 the challenge of 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 technologies such as smart contracts and decentralized voting systems as tools to streamline decision-making, promote transparency, and facilitate seamless ownership transfers. It explores how the 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 serves as the essential 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 properties 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 tokenization of assets, 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, centred 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 the context of this work project, Web3 serves as the technological foundation for enabling fractional ownership of real estate, 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 (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 the coordination of property licensing and permit requirements. This automation not only reduces the need for manual oversight but also 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 rules encoded in software. 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 the goals of stakeholders, promotes trust, and enhances the efficiency of systems, whether in public administration, corporate structures, or decentralized networks (World Economic Forum 2016). In the context of 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 through the creation of active secondary markets, addressing the illiquidity challenge traditionally associated with real estate investments. Baum (2020) adds that tokenization not only democratizes access to real estate but also 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 that represent ownership or investment in a real asset, company, or economic enterprise and are 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 provide holders with rights 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 a variety of 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 regulation is a critical consideration in the implementation of blockchain-enabled fractional ownership models. As these innovative systems operate within highly regulated environments, alignment with legal and regulatory frameworks is essential to ensure legitimacy, transparency, and protection for all stakeholders.

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). The relevant points of this regulation concerned with the fractionalization of real estate assets using web-3 business models, 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 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 but also 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 eIDAS Regulation (European Parliament and Council 2014b) establishes requirements for qualified electronic timestamps, which bind specific dates and times to data, preventing undetected changes to records. 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 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 but also facilitating

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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 the reporting of 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 must 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 are also required to 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 requirements for transparency and rules to limit high-frequency. Additionally, MiFID II 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, enabling stakeholders to seamlessly buy, sell, and transfer their ownership shares with minimal delays or disruptions.

High liquidity ensures that 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, thereby encouraging greater participation. It also ensures that financial systems remain robust, as liquid markets allow for smoother capital flows and reduce the risks associated with 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 quickly enter or exit their investment positions (Schmid, Truebestein and Aepli 2024).

4. Research Methodology (GROUP PART)

This study utilized a mixed-methods approach, integrating both primary and secondary data sources to gain a comprehensive understanding of governance models in fractional real estate ownership. The secondary 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 important insights into governance challenges and strategies related to different real estate ownership models.

Additionally, conversations were conducted with two attorneys who preferred to remain anonymous, offering crucial expert insights on legal and regulatory issues. These conversations provided 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 both the theoretical and practical aspects of real estate governance. This mixed-methods approach ensured the research not only identified existing governance challenges but also explored potential solutions and best practices proposed by industry experts.

5. Legal and Regulatory Reforms Necessary to Support the Fractional Ownership of Real Estate Assets Through Distributed Ledger Technologies in Portugal (INDIVIDUAL PART)

5.1 Introduction

The current landscape of the real estate market in Portugal is characterized by a competitive legal and tax framework that attracts a diverse range of investor profiles , from institutional players to individuals seeking promising opportunities. The Portuguese real estate market is characterized by a complex but well-defined legal framework where comprehensive due diligence practices ensure a secure environment for both national and international investors. These due diligence processes provide a review of legal, financial, and physical aspects of properties and they help identifying any potential risks or liabilities concerning the sale of the properties (Lopes da Silva - Advogados 2024), ensuring transparency throughout the process of buying and selling real estate.

In addition to the competitive legal and tax frameworks, the Portuguese Government offers a strategic initiative called Residence Permit for Investment Activity (*Autorização de Residência para Actividade de Investimento – ARI*), commonly known as the Golden Visa program, that allows foreign investors to apply for a residence permit for investment activities (Ministério dos Negócios Estrangeiros n.d.). The ARI regime offers, to nationals outside of EU and EEA, a Portuguese residency option if they meet the eligible investment paths, which are creating at least 10 jobs, investing over 500.00€ in research, contributing 250.000€ or more to artistic or cultural heritage, investing at least 500.000€ in venture capital funds or company shares, or investing 500.000€ to start or fund a company with five permanent positions (Serviço de Estrangeiros e Fronteiras n.d.). With these initiatives, Portugal positions itself as an appealing

destination for those looking to invest in real estate while gaining access to the Schengen Area, without a visa (Ministério dos Negócios Estrangeiros n.d.).

5.2 Legal and Regulatory Framework for Property Acquisition in Portugal

The process of buying a property in Portugal involves different pieces of legislation, including the Civil Code, the Notary Code, and the Land Registry Code (Lopes da Silva - Advogados 2024). The process demands, in the first place, for the foreign investors, obtaining a Portuguese Tax Identification Number (*NIF – Número de Identificação Fiscal*). According to Autoridade Tributária e Aduaneira (n.d.), the Portuguese Tax Identification Number is mandatory for any citizen, national or foreign, resident or non-resident, who, under the terms of law, are subject to the fulfilment of obligations or wish to exercise their rights with the Portuguese tax authorities. This means that this Number is mandatory for all financial transactions in Portugal, which includes property purchases.

Concerning the process of due diligence described above, it is imperative to check if all the legal documentation is valid, including the Property Tax Record (*Caderneta Predial*), which is a document that, according to the Municipal Property Tax Code (*Código do Imposto Municipal sobre Imóveis*) (2003), originates from a Property Matrix, a registry detailing the characteristics of the property, its location and taxable value, the identity of the owners and, where applicable, the usufructuaries and surface right holders. In the case of horizontal property, each floor or part of the building that can be used independently is considered separately in the Property Tax Record, which also specifies its corresponding taxable value, as described in Article 12 of the Municipal Property Tax (*Código do Imposto Municipal sobre Imóveis*) (2003).

It is also necessary to check the Land Registry Certificate (*Certidão Permanente do Registo Predial*), which is issued by the Land Registry Office and contains detailed information about

the property, the history of the house in terms of its constitution and location, confirms its ownership, identifies the existence of associated charges, such as mortgages, and confirms pending registrations, allowing full knowledge of its legal situation (Portal Central de Serviços Públicos da República Portuguesa n.d.).

Other necessary document is the Licence and Use Permit (*Licença e Alvará de Utilização*), which according to Decree-Law no. 250/94 (1994), its purpose is to prove that the completed work complies with the approved project, with the licensing conditions and with the use provided for in the building permit. The same Decree-Law also states that, in the case of horizontal property, the License and Use Permit may be granted for the building as a whole or for each of its autonomous fractions; the issue of this document for autonomous fractions presupposes permission to use the common parts of the building (Diário da República 1994). This License and Use Permit certifies that the property meets the conditions for its intended purpose, being issued by the Local Council in the area where the property is situated.

Similar to this document, it is necessary to have a Housing License (*Licença de Habitação*), a Municipal License, that proves that a property is habitable because it complies with all the legal requirements, where it is mandatory to have an inspection of the property by the Town Hall to obtain the License. This document is essential because without one is impossible to apply for a home loan or draw up the Deed of Sale (Diário da República 1951).

In the process of buying a property, it is also possible to sign a Promissory Contract of Purchase and Sale (*Contrato de Promessa Compra e Venda*), which corresponds to a document that stipulates the rights and duties of the seller and the buyer, and it must contain personal data about both parties - full name, marital status, civil identification number, tax identification number, and address -, property details, details of any encumbrances on the property, purchase price, sale price and method of payment, maximum deadline for signing the Deed Sale,

information on penalties if the Promissory Contract of Purchase and Sale is not honoured, and the stipulation of an amount given as a deposit (Portal Central de Serviços Públicos da República Portuguesa n.d.).

Upon purchasing a property, it is mandatory to obtain insurance coverage to protect against risks, such as fire, flooding, theft, and other potential damages, where, in the case of horizontal property, the monthly condominium fee may include the cost of this insurance (Portal Central de Serviços Públicos da República Portuguesa n.d.).

According to the Municipal Property Transfer Tax Code (*Código do Imposto Municipal sobre as Transmissões Onerosas de Imóveis*) (2003b), it is necessary to pay a Municipal Property Transfer Tax (IMT), which applies to the transfer, for consideration, of property rights or partial interests in such rights, on real estate located within national territory. In line with the Municipal Property Tax Code (*Código do Imposto Municipal sobre Imóveis*) (2003c), it may be necessary to pay the Municipal Property Tax (IMI), which is levied on the taxable value of rural and urban properties located in Portuguese territory, constituting revenue for the municipalities where they are located. Additionally, the buyer needs to pay a Stamp Duty that applies to acts and contracts occurring in Portugal that are not subject to Value Added Tax (VAT), which applies to real estate acquisitions (Autoridade Tributária e Aduaneira 2003a).

In order to finalize the property transaction, it is necessary to sign the Deed of Sale, which is a legal contract that transfers the ownership of the property to the buyer. The transaction may be executed at a Notary Office, through a Lawyer, or at the Land Registry Office (Portal Central de Serviços Públicos da República Portuguesa n.d.). At any of these venues, all the required documentation listed above, along with proof of tax payment, must be presented and validated.

5.3 Fundamental Property Rights for Real Estate Transactions in Portugal

5.3.1 Right of Ownership (Direito de Propriedade)

The Portuguese Civil Code (*Código Civil Português*) (1966) defines ownership in Article 1305 as the full and exclusive right to use, enjoy, and dispose of property, in accordance with the law and any applicable legal restrictions. Ownership encompasses three fundamental rights: the right to utilize the property for personal or commercial purposes, the right to benefit from it, such as receiving rental income or profits from natural resources, and the right to transfer, encumber, or alter the property, including the ability to sell or donate it (Diário da República 1966). According to Article 1316 of the Portuguese Civil Code (1966), ownership can be acquired through various legal means, including contractual agreements like purchase, donation, or exchange; succession, whereby ownership is passed through inheritance; and usucapion, where continuous and uncontested possession of property over a legally specified duration confers ownership rights. Additionally, the same Article states that ownership can be obtained through occupation, which pertains to unclaimed or abandoned property, and accession, which extends ownership to anything naturally or artificially attached to the property (Diário da República 1966).

5.3.2 Right of Usufruct (Direito de Usufruto)

The Portuguese Civil Code (1966) defines, in article 1439, usufruct as a legal right that allows one party, the usufructuary, to fully enjoy and benefit from the property or rights of another party, without altering its form or substance. Article 1440 of the Portuguese Civil Code (1966) states that usufruct can be established through various means, including a contractual agreement, will, usucaption, or legal determination, and, according to Article 1443, its duration is typically tied to the lifetime of the usufructuary, but may also be established for a specific term (Diário da República 1966). The usufructuary holds several rights, including the use of

the property and the ability to derive its benefits, such as renting it out or collecting its fruits or earnings, as mentioned in Articles 1446 to 1467 of the Portuguese Civil Code (1966). Accompanying these rights are specific obligations: the usufructuary is responsible for maintaining the property, performing necessary repairs, and covering costs such as taxes and insurance premiums (Diário da República 1966).

5.3.3 Right of Use and Habitation (Direito de Uso e Habitação)

The Portuguese Civil Code (1966) establishes, in Article 1484, the right of use and habitation as a legal mechanism granting an individual the ability to utilize property owned by another, either for personal needs or as a residence. These rights are divided into two distinct categories: Right of Use, allowing the holder to use the property and, if applicable, collect its fruits, to the extent necessary for their personal sustenance and that of their family; and Right of Habitation, granting the beneficiary the ability to reside in the property, strictly for housing purposes (Diário da República 1966). In line with the stated in Article 1488 of the Portuguese Civil Code (1966), the rights are personal, meaning they cannot be transferred or leased to others.

5.4. Fractional Ownership Models and the Potential of DLT in the Portuguese Real Estate Market

The Portuguese real estate market has shown resilience, with an 8,2% increase on real estate prices in 2023 (Banco de Portugal 2024), supported by a continuous buyer interest, particularly in high-demand regions such as Lisbon, Porto and Algarve. The August 2024 Portuguese Housing Market Survey (Confidencial Imobiliário & RICS 2024) tells us that non-resident buyers account for 8% of the transactions on the Portuguese market, driving demand and contributing to upward price trends. These indicators point to potential overvaluation, with the ratio of the house price index to household income 23% above its long-term average (Banco de

Portugal 2024), leading to affordability challenges to low-income investors. These low-income investors are a big portion of the Portuguese population, with Portugal being one of the lowest paid countries in Europe, with 20,3% of workers paid the national minimum wage in the second quarter of 2023 (Governo de Portugal 2023). This highlights the need for innovative solutions that allow low-income investors, and especially the Portuguese citizens, to invest in the real estate market.

Considering the need to democratize real estate investment, by expanding access to the market, the approach of fractional ownership emerges as a solution in which multiple investors can own a portion of a single asset, breaking down large indivisible assets into manageable shares (Baum 2020). The main advantages include the possibility of smaller investors to access more properties and diversify their portfolios, without the constraints of owning entire properties, and the improved liquidity of the asset (Baum 2020), an advantage that will be further developed in this research.

With respect to the fractional ownership of real estate, the Portuguese legal framework does not explicitly define the concept, but the principles of co-ownership can be applied. The Article 1403 of the Portuguese Civil Code (1966) defines that there is co-ownership when two or more people simultaneously hold ownership rights over the same thing. It defines that the rights of the co-owners over the common property are qualitatively equal, but they may vary in share, according to the co-owner defined quota, that determines its share of the property's costs and benefits (Diário da República 1966). This can be applied to fractional ownership as they both involve multiple individuals holding different rights to the same asset, where each participant has a defined share, or quota, of the asset. The model of co-ownership, where the quota defines the percentage of costs and benefits of the asset can be translated into the fractions of the

fractional ownership model, where an ownership percentage is in proportion with the costs and benefits of the investment, defined through a legal document.

The need for innovation that accompanies the real estate investment process is largely driven by the current state of the real estate market in Portugal. Despite having a well-defined legal framework, we can find a paper-based, fragmented market with non-interoperable software, leading to slow transactions, a lack of transparency and high transaction costs (Unlockit 2024). These conditions need to change, and the solution is the introduction of Distributed Ledger Technologies (DLT's) on the real estate market. Distributed Ledger is an approach to recording and sharing data across multiple data stores, allowing for transactions and data to be recorded, shared, and synchronized across a distributed network of different participants (World Bank Group 2017). A famous DLT-based technology is the blockchain, which corresponds to a business practice built on peer-to-peer transaction data held in a block, allowing systems to create and develop a permanent ledger of historical transactions and power a current ownership register (Baum, Saull and Braesemann 2020).

The adoption of Distributed Ledger Technologies, and specifically blockchain, provides the framework for tokenization, which is the process of representing fractional ownership interest in an asset with a blockchain-based digital token (Baum 2020). Tokenization allows real estate assets to be divided into smaller and tradable units (Baum 2020), addressing the challenges of high transaction costs, illiquidity, fragmentation of the market and slow transactions.

Unlockit appears to offer a business model that employs blockchain technology to improve transparency, efficiency, and compliance on the real estate market, while also offering opportunities for fractional ownership through tokenization. Unlockit's platform optimizes real estate transactions, making them quicker and more cost-effective by eliminating many of the manual, paper-based processes inherent to the process of buying a house, allowing transactions

to be recorded, verified, and shared in real-time across a secure and decentralized network. The platform distinguishes itself through a high commitment to regulatory compliance, aligning with essential EU regulations, such as eIDAS for electronic identification, the 6th Anti-Money Laundering Directive, and GDPR for data protection, enabling secure ownership transfers and mitigating the risk of fraud.

5.5 Markets in Crypto-Assets Regulation (MiCA)

The Markets in Crypto-Assets Regulation (MiCA), established as Regulation (EU) 2023/1114 of the European Parliament and of the Council of 31 May 2023, provides a legal framework aimed at regulating crypto-assets across the European Union (European Parliament and Council 2023). It introduces essential provisions that address transparency, market stability, consumer protection, and the integration of innovative technologies such as Distributed Ledger Technologies, playing a crucial role in supporting the tokenization of real estate assets and fostering the development of fractional ownership models in Portugal.

A major challenge for tokenization is the lack of regulatory clarity, which creates uncertainty for issuers, investors, and service providers. MiCA provides legal certainty by defining and categorizing crypto-assets as Asset-Referenced Tokens (ARTs), Electronic Money Tokens (EMTs), and others, which include utility tokens. Under Article 3 of the Markets in Crypto-Assets Regulation, ARTs are defined as tokens that aim to maintain a stable value by referencing a basket of assets such as currencies, commodities, or financial instruments (European Parliament and Council 2023). These could be used in real estate tokenization to represent fractional ownership of properties tied to a mix of underlying assets, such as rental income or property value. The same Article defines EMTs as tokens tied to a single fiat currency, such as the Euro (European Parliament and Council 2023). In real estate, EMTs could

serve as stable units of exchange for transactions within tokenized property ecosystems, ensuring ease of valuation and trading.

MiCA imposes requirements to safeguard investors and ensure stability as stated under Article 36, which says that ARTs must maintain sufficient reserves of their underlying assets, ensuring that the tokens are fully backed, and their value remains stable (European Parliament and Council 2023). Similarly, Articles 48 and 49 mandate that EMTs maintain fiat reserves in segregated accounts and guarantee redemption at the equivalent value (European Parliament and Council 2023). MiCA also introduces dispute resolution mechanisms and safeguards against market manipulation under Article 15, which are critical for maintaining trust in tokenized real estate ecosystems (European Parliament and Council 2023). The same regulation enables secondary trading of real estate tokens, supporting the creation of liquid markets.

The Regulation situates smart contracts within the broader technological context of distributed ledger technology (DLT), highlighting that those innovative technologies, such as DLT, have enabled new forms of financial activities, including "the use of smart contracts for order executions and the concentration of mining pools" (European Parliament and Council 2023).

The regulation establishes a harmonized regulatory framework across the European Union, making cross-border real estate tokenization more feasible and eliminating the complexities of navigating inconsistent national rules. This harmonization benefits real estate tokenization by enabling cross-border investment, where investors from any EU Member State can participate in tokenized real estate offerings without regulatory barriers; and enabling foreign capital attraction, making the EU an attractive destination for global investors seeking opportunities in tokenized real estate (European Parliament and Council 2023).

5.6 Key Legal Reforms for Tokenization in Portuguese Real Estate Transactions

Unlockit's business model depends on clear regulatory guidelines to achieve full compliance with Portugal's legal framework. It is crucial for smart contracts to be recognized as legally binding under the Portuguese Civil Code, as this recognition facilitates the automation of transactions and ensures their enforceability. Additionally, the integration of fractional ownership within the Land Registry is essential for allowing blockchain-based ownership transfers to be officially recorded, thereby maintaining the legal validity of property transactions. Furthermore, the system must ensure that tax automation aligns with existing regulations regarding the Municipal Property Transfer Tax (IMT) and Stamp Duty, in order to achieve accurate calculations and seamless payments within the blockchain framework.

5.6.1 Legal Recognition of Smart Contracts

Smart Contracts are self-executing agreements that automatically enforce and execute contractual clauses when predefined conditions are met, eliminating the need for intermediaries. In real estate, smart contracts can automate tasks such as processing payments, verifying key property acquisition documents like the Property Tax Record, Land Registry Certificate, and Housing License, ensuring compliance with Municipal Property Transfer Tax (IMT) calculations, and facilitating the integration of property licensing and permit requirements. For instance, a smart contract might automatically transfer property ownership once the buyer’s payment is verified on the blockchain, ensuring that all parties meet their contractual obligations without requiring third-party involvement, streamlining the transaction process and enhancing security (Baum 2020; Saari, Junnila and Vimpari 2022).

In the context of Portugal, MiCA’s automatic applicability ensures that smart contracts receive recognition within the national framework, aligning with EU-wide regulatory principles.

However, integrating smart contracts into specific sectors like real estate transactions requires adapting existing national legal frameworks. To enable the legal recognition of smart contracts in real estate transactions, it is essential to undertake comprehensive regulatory reforms that will adapt the current legal framework established in the Portuguese Civil Code, especially concerning the Promissory Contract of Purchase and Sale and the Deed of Sale. These contracts, as specified in Article 410 of the Portuguese Civil Code (1966), govern the transfer or establishment of rights over buildings or parts of buildings. The Article stipulates that such contracts must undergo the authentication of signatures in person, along with the certification of relevant licenses by an authentication authority, including the License and Use Permit (Diário da República 1966). Moreover, according to Article 875 of the Portuguese Civil Code (1966), a contract for the purchase and sale of real estate is only valid if formalized through a public deed or an authenticated private document.

To accommodate smart contracts in the context of the Promissory Contract of Purchase and Sale, it is crucial to explore how existing digital signature mechanisms, such as *Chave Móvel Digital*, which is legally recognized in Portugal as a valid form of authentication and compliant with eIDAS, can be the basis for authenticating digital agreements and parties' commitments executed on blockchain. Since Promissory Contracts of Purchase and Sale require authenticated signatures, *Chave Móvel Digital* has the potential to facilitate the digital authentication of parties, as the smart contract would log these authenticated signatures on the blockchain, ensuring compliance with Article 410 of the Portuguese Civil Code while eliminating the necessity for in-person authentication. Additionally, smart contracts can automate the transfer of deposits specified in the Promissory Contract of Purchase and Sale, ensuring payments without manual oversight.

In the context of the Deed of Sale, smart contracts can automate the transfer of ownership by updating the Land Registry Certificate once the specified transaction conditions are fulfilled, ensuring adherence to property registration requirements. For the process to work effectively, the Land Registry Code and the Portuguese Civil Code must allow blockchain transactions to directly update ownership records. Furthermore, municipal licensing systems could integrate with blockchain platforms through an API, enabling the smart contract to verify the existence of the required licenses, such as the License and Use Permit, while legislative reforms should explicitly acknowledge that these automated verifications satisfy the certification requirements under Article 410 of the Portuguese Civil Code. Additionally, smart contracts could calculate and automatically transfer applicable taxes, such as IMT and Stamp Duty, directly to the tax authorities.

The incorporation of smart contracts into real estate transactions in Portugal calls for legal reforms to align blockchain-based processes with the stipulations of Articles 410 and 875 of the Portuguese Civil Code. By recognizing digital signatures, enabling the automated certification of licenses, and allowing blockchain transactions to update the Land Registry Certificate, smart contracts can facilitate more efficient property transactions, reducing costs and enhancing transparency.

5.6.2 The Swiss Case: A New Approach to Property Rights Through Tokenization

The Federal Act on the Adaptation of Federal Law to Developments in Distributed Ledger Technology (DLT Act) establishes a comprehensive legal framework in Switzerland for the tokenization of real estate assets, facilitating their incorporation into blockchain-based systems. The DLT Act introduces ledger-based securities, defined and regulated under Article 973 of the Swiss Code of Obligations (Federal Assembly of the Swiss Confederation 2023), as amended by this legislation, allowing rights and claims, including those related to real estate, to be

represented digitally on a blockchain (State Secretariat for International Finance 2021). These ledger-based securities are recognized as legally binding and transferable, thereby laying the groundwork for tokenizing ownership in real estate.

While the full legal ownership of real estate must still be registered in the Swiss Land Register, as required under Articles 942 and 943 of the Swiss Civil Code (1907), the DLT Act enables the tokenization and transfer of certain rights or claims linked to real estate. Tokenized claims, such as co-ownership shares or distinct and permanent rights, adhere to the requirements specified in Article 943 of the Swiss Civil Code (1907). Additionally, Article 942 permits the electronic maintenance of the Land Register (Federal Assembly of the Swiss Confederation 1907), granting legal validity to properly stored digital data, and facilitating the integration of blockchain-based systems with the Land Register, while preserving the integrity of official property records.

The DLT Act further promotes the establishment of secondary markets for tokenized assets through amendments to the Financial Market Infrastructure Act. These modifications regulate the functioning of DLT-based trading facilities, enabling the efficient exchange of tokenized real estate shares while ensuring adherence to Swiss regulations (State Secretariat for International Finance 2021).

5.6.3 Adapting the Swiss Tokenization Framework to Portuguese Property Rights

The framework established by the Swiss DLT Act serves as a model for modernizing property rights management in Portugal. By integrating blockchain technology and tokenization into the Portuguese Civil Code, Portugal could improve the transparency, efficiency, and liquidity of its real estate market while ensuring legal certainty. These changes would facilitate the tokenization of ownership, usufruct, and use and habitation rights.

Under Article 1305 of the Portuguese Civil Code (1966), ownership confers full and exclusive rights to use, enjoy, and dispose of property. Drawing inspiration from the Swiss concept of ledger-based securities, the ownership rights in Portugal could be tokenized, with each token representing a fractional share of the property, facilitating fractional ownership and specific claims, such as shares of rental income. To ensure compliance with Article 1316 of the Portuguese Civil Code (1966), which regulates ownership transfers through contracts, inheritance, or other legal means, it is essential that blockchain-based tokens are explicitly recognized as valid transfer mechanisms.

Usufruct rights, as outlined in Articles 1439–1475 of the Portuguese Civil Code (1966), enable the usufructuary to utilize and benefit from another party's property without altering its core substance, being particularly suitable for tokenization, as they can be subdivided into tradable units. For instance, a usufructuary might issue tokens representing shares of the rental income generated by the property, thereby facilitating broader investment opportunities. To enhance this model, Article 1440 of the Portuguese Civil Code could be revised to explicitly permit the digital representation of usufructuary rights, while ensuring that the duration and obligations of the usufruct are maintained, even when managed through blockchain systems.

The rights of use and habitation, as detailed in Articles 1484–1488 of the Portuguese Civil Code (1966), are defined by their non-transferable and personal nature, which poses distinct challenges. While these rights themselves cannot be directly tokenized, their financial value or the benefits derived from them can be symbolized through tokens. For instance, a token could represent the value of shared usage agreements or associated services, provided it adheres to the legal restrictions on transferability.

By adopting the Swiss framework, Portugal could create new investment opportunities in the real estate market while preserving the integrity of its property laws. Tokenization would enable

fractional ownership, efficient management of usufruct rights, and the development of financial derivatives related to use and habitation rights. This approach would ensure broader participation in property investments and align with global innovations in property management and transactions.

5.7. Conclusion

Unlockit, an innovative force in the real estate sector, may not have the power to alter legislation directly, but it plays an essential role in driving regulatory reforms and enhancing market awareness. Its business model holds the potential to modernize Portugal's real estate market through the use of blockchain technology. However, this advancement hinges on active engagement with key stakeholders and the promotion of educational initiatives.

To achieve regulatory alignment, Unlockit must work in close partnership with legislators, notaries, lawyers, and municipal authorities to advocate for amendments to the Portuguese Civil Code, the Notary Code, and the Land Registry Code. These amendments should explicitly recognize smart contracts and blockchain as valid mechanisms for conducting real estate transactions. Unlockit can foster trust among these stakeholders by showcasing the transparency, security, and efficiency of its technology.

It is vital for Unlockit to enhance awareness of tokenized real estate among investors, regulators, and the general public. By creating informative content, Unlockit can effectively illustrate how blockchain and tokenization democratize access to real estate, lower transaction costs, and improve market efficiency. Targeted campaigns for regulators can help clarify misconceptions surrounding blockchain technology and highlight Unlockit's adherence to established legal frameworks. For potential investors, emphasizing the advantages of fractional

ownership, such as portfolio diversification and increased liquidity, will encourage demand for Unlockit's platform and establish it as a leader in tokenized real estate solutions.

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 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 to consider 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.

6.3.4 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

If legislation eventually permits direct tokenization of real estate and property rights, blockchain-based land registries could serve as the backbone of these systems (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 continuous availability of buyers and sellers, facilitating fair pricing and potentially increasing speculation in the absence of 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, while 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 the majority of 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), operating as 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 therefore represent the ownership of individual units vs shared spaces. There could even be an integration with municipal licensing, tax authorities, and the national land registry, allowing real-time updates for ownership transfers, compliance checks, and tax obligations. On the other hand, smart contracts would automate tasks such as maintenance scheduling, fee collection, financial distribution, and voting processes. 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.

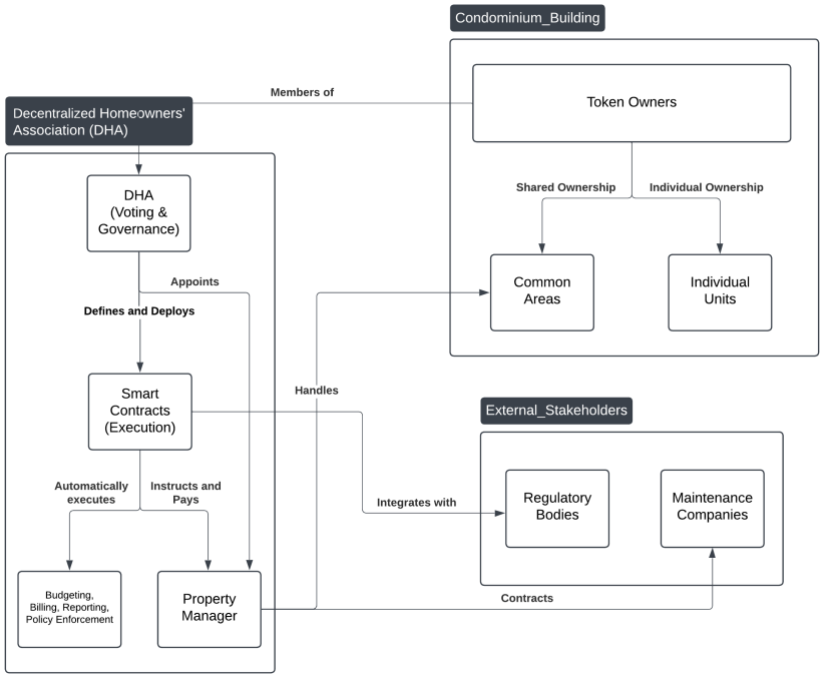

Diagram 1: DHA Condominium Structure

6.5.2 Governance Mechanisms

Governance within the DHA would be participatory and transparent, providing some sort of hierarchy to categorize decisions, with different requirements to act or not to act. The same way the state and companies do. Essentially marking a separation between decisions that impact the structure vs 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 would be able to schedule these tasks, allocate payments to vendors, and collect maintenance fees proportionate to ownership shares. Diagram 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.

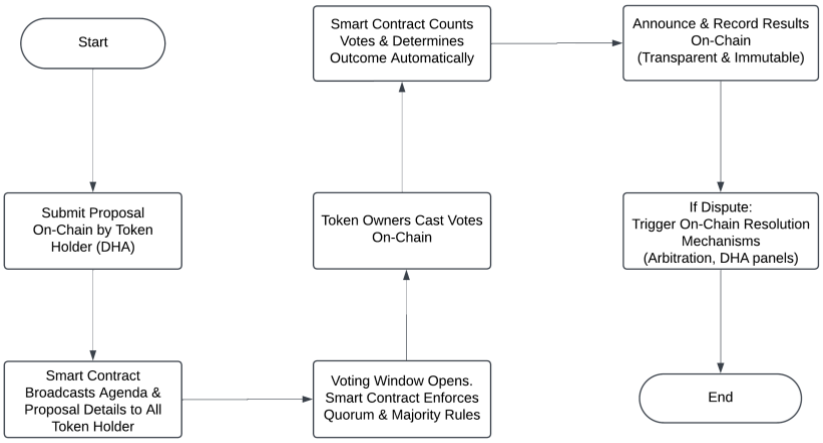

Diagram 2: On-Chain Decision-Making Process

Voting, conducted entirely on the blockchain, could utilize either a weighted system aligned with ownership shares or a quadratic system to prevent asymetries in favour 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, would be able to 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 probably only happen if legislators delay the legalization of property rights tokenization for too long. In such a case, market demand might drive companies to develop infrastructure that enables these transactions outside of traditional regulatory frameworks.

The development of 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 token (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, to ensure that tokenized ownership is enforceable. Also, by doing so, blockchain integration with the Portuguese land registry would also automate ownership updates upon token transfers, eliminating traditional documentation and reducing public spending.

KYC/AML processes could be automated through identity protocols to mitigate fraud and protect the consumer. Smart contracts need also to 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, 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, thereby redefining the intrinsic value and nature of real estate assets. 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 minimizes 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)

In conclusion, 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 both 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 fully accommodate tokenized property rights. 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. By leveraging smart contracts, decentralized voting mechanisms, and transparent record-keeping, the framework aims to align stakeholder interests, enhance operational efficiency, and ensure regulatory compliance. Looking ahead, 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, has the potential to 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.

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