KLEROS

Introducing Kleros & Blockchain Technology in the Real Estate Transactions from Spain

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About the Author

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He studied law at the Catholic University of Córdoba, Argentina, and later earned both a Law Degree and a Master of Laws (LL.M.) from the University of Málaga. Throughout his academic journey, he combined his studies with various professional experiences.

A strong enthusiast of blockchain technology since 2018, he first delved into the field by completing Federico Ast's Coursera course "The Disruption of Blockchain." He has practiced law in three different countries—Argentina, Spain, and Germany—working at various law firms such as Toscanolex Legal Boutique (his current firm), Martínez-Echevarría, and SGP Schneider Geiwitz, among others.
In addition to his private-sector experience, he has worked in several areas of public administration, including the Consumer Protection for the Government of Córdoba (Argentina), the Office for Women and Gender Violence for the Government of Córdoba (Argentina), and the Consumer Arbitration Board for the Provincial Council of Málaga (Spain).

Thanks to his extensive international legal experience and his fluency in English, Spanish, and German, he has, in recent years, specialized in urban planning and real estate law, with a focus on both national and international real estate transactions.

Index

Abstract

This paper examines the integration of blockchain-based smart contracts and decentralized arbitration—specifically through the Kleros Escrow Dapp—into the early stages of real estate transactions in Spain. These stages, typically governed by private agreements such as reservation contracts and contratos de arras (private purchase contracts), often lack institutional oversight and legal standardization, creating significant exposure to disputes, financial risk, and procedural inefficiencies. Within this context, the study explores how smart contracts can be deployed to autonomously manage deposit obligations and how the Kleros decentralized dispute resolution protocol can serve as a neutral and legally viable alternative to conventional judicial mechanisms.

Drawing on the Spanish Civil Code, AML legislation (Law 10/2010), the European Union's regulatory framework—including the Transfer of Funds Regulation—and the recently enacted **Ley Orgánica 1/2025**, which formally recognized Medios Adecuados de Solución de Controversias (MASCs - Appropriate Means of Dispute Resolution), the paper concludes that blockchain-based contractual infrastructure is legally compatible with existing Spanish norms when properly structured.

A dual implementation model is proposed: one for blockchain-native users conducting peer-to-peer (P2P) transactions autonomously between unhosted wallets, without any VASP involvement, and another for traditional users supported by a law firm, which assumes responsibility for deploying the contract and fulfilling AML/KYC obligations. The smart contract structure is outlined in detail, including its coding, condition triggers, dispute escalation, and autonomous enforcement through the Kleros protocol. The proposed system enhances legal certainty, cost efficiency, and procedural transparency without disrupting the foundational legal functions of the notary or the Land Registry.
While not seeking to replace existing legal institutions, the study argues that blockchain tools can significantly strengthen the pre-notarial stages of real estate acquisition. The findings suggest that **Kleros Escrow** offers a legally sound and technologically scalable solution to longstanding procedural deficiencies in the Spanish real estate market, setting the foundation for broader adoption of decentralized legal infrastructure in civil law jurisdictions.

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Section 1. Introduction

A. Explaining the Basics of Real Estate Transactions in Spain

Real estate transactions are complex legal and financial processes involving multiple steps designed to ensure a secure and transparent transfer of property ownership. While European countries follow similar core procedures—such as ownership verification, contractual agreements, and land registration—each jurisdiction adds its own legal and administrative practices. This paper focuses on the **Spanish real estate transaction process**, which is emphasized by the **prevalence of private agreements** in the early stages.

Real estate transactions in Spain are structured around a multi-phase process designed to formalize the transfer of property ownership. While legally sound and deeply institutionalized, the process begins with a series of informal, privately negotiated agreements. These early steps frequently lack legal oversight and often occur without the assistance of legal professionals. This structure leaves room for misunderstanding, legal uncertainty, and disputes—especially in the context of Spain's dynamic secondary property market, which is popular among domestic and international buyers alike.

Typically, the process starts with the ***"contrato de reserva"*** (reservation contract), a very simple private agreement between the buyer and either the seller or a real estate agent. This document, often informal and non-standardized, is used to temporarily take the property off the market in exchange for a **reservation deposit** (commonly around € 3,000 - € 6,000). The purpose of this step is to grant the buyer time to carry out financial arrangements or basic checks. However, this stage usually occurs before any due diligence is performed. As such, buyers often proceed without having verified the legal status of the property, leading to potential legal risks. It is common that neither party is represented by a lawyer at this stage, further compounding these risks due to the lack of expert legal interpretation or safeguards.

Should the buyer wish to continue, the process moves on to the ***"contrato de arras penitenciales"*** (private purchase contract - regulated under Article 1454 of the Spanish Civil Code), a more detailed private agreement between buyer and seller. This contract stipulates the terms and penalties of the eventual sale and involves the transfer of approximately 10% of the purchase price (less the reservation deposit). Yet, like the reservation contract, it remains a **private, non-notarized agreement**, and is often drafted without legal counsel. The *arras* contract outlines the conditions of the future sale and includes penalty clauses: if the buyer withdraws, they forfeit the deposit; if the seller defaults, they must return double the amount received. Despite its legal weight, this contract is still private and is

concluded without notarial involvement or public registration.

This stage is particularly problematic, as it legally binds the buyer even though complete legal or technical due diligence may still be pending. Disputes that arise at this point—concerning debts, title defects, non-qualification of the property to be rented out for tourist purposes, inheritance claims, or urban planning violations—can be extremely difficult to resolve efficiently, especially if funds have already been transferred to the seller or agent.

The transaction becomes legally formalized only when the **escritura pública de compraventa** (public deed of sale) is executed before a **notary**, a mandatory legal step under Spanish law. The notary confirms the identities of the parties, verifies the ownership and legal status of the property, and ensures tax and regulatory compliance. This notarized deed is then eligible for inscription in the **Registro de la Propiedad** (Land Registry). Although inscription is not legally mandatory for the transfer to be valid *inter partes*, it is strongly recommended, as it ensures the property's legal enforceability against third parties and offers protection against subsequent encumbrances or claims.

This early, contract-heavy, and lawyer-optional structure—where financial commitments precede legal formalities—makes Spain particularly vulnerable to transaction failures, opportunistic behavior, and legal ambiguity. Buyers may unknowingly enter binding commitments without the legal certainty typically expected in other jurisdictions, and dispute resolution is often expensive, slow, and unpredictable.

However, it should be noted as well, that very often, especially in property resales, the seller forces the buyer to go directly to the private purchase contract or even to the public title deed of sale. This tends to happen in times when properties are highly desirable, and the selling party takes advantage of this to force the sale and purchase as soon as possible, and thus receive the full payment as soon as possible. As we see, this puts the buyer in a difficult situation, as in practice, almost no legal due diligence is carried out on the property.

B. The Need for Innovation in Spanish Real Estate Transactions

The problems inherent in Spain's early-stage property transaction practices underscore the need for innovation that enhances **transparency, procedural fairness, and legal efficiency**. The overreliance on informal contracts, the frequent absence of legal counsel, and the lack of centralized supervision until the notarization stage create a legal vacuum at the most critical moments of financial commitment. In this legal void, trust is often replaced by risk, especially for non-resident or first-time buyers.

In practice, this means that **buyers commit funds and become contractually bound** before confirming whether the property is affected by charges, irregularities, or legal disputes. Although there is always given a ***'nota simple'*** (information extract) from the **Land Registry** where it can be checked if the property has charges, or if the meters of the property match both in the Cadastre and in the Registry or if the seller is the real owner; there are certain legal aspects that can not usually be checked with this simple document. Such as the rules of the community, if the community has banned the use of the properties for holiday rentals, if there is any debt with respect to any tax, if there is any urban infraction in the Town Hall, or if the property has the licence of first occupation granted; among other legal checks that should be done before the Public Deed of Sale. If such issues are discovered later—after a deposit has already been paid—the buyer may find it difficult to recover their funds. The seller, who holds the deposit under the terms of a reservation or private purchase contract, which are often drafted without legal oversight, may refuse reimbursement. Since there is no institutional mechanism to intervene at this stage, **the only formal recourse is litigation**, which is time-consuming, expensive, and often inaccessible, particularly for foreign buyers.

Moreover, the transaction process is marked by a **lack of integration** among the various actors involved. Real estate agents, lawyers, notaries, and financial institutions operate independently, often leading to communication breakdowns, procedural delays, and inconsistent documentation. This fragmentation opens the door to errors, manipulation, or even outright fraud—especially in markets with high demand or limited regulatory supervision.

Blockchain technology, and particularly the use of **smart contracts**, offers a promising solution. Smart contracts—self-executing agreements stored on blockchain networks—enable **automated, secure, and transparent execution of predefined terms.** When properly coded, they eliminate the need for trusted third parties to hold deposits or enforce conditions, significantly reducing the likelihood of opportunism or fraud.

In this paper, we propose a dual-framework model for managing real estate deposits through blockchain-based smart contracts and decentralized arbitration, designed specifically for the Spanish legal context. The first model envisions a **peer-to-peer (P2P) implementation**, in which the buyer and seller interact directly by deploying a smart contract via the **Kleros Escrow** product. This smart contract encodes the deposit conditions in immutable code, independent of any centralized platform or custodial intermediary. Once deployed on a decentralized blockchain network, the contract's terms—such as the release of funds upon the execution of the public deed before a notary, or refund conditions upon verified legal non-compliance—cannot be altered unilaterally by either party.

The second implementation model is tailored for **traditional users**, in which a licensed **law firm acts as a facilitator** in the configuration and deployment of the smart contract. In this context, the law firm not only provides legal guidance but also fulfils all applicable **Anti-Money Laundering (AML) and Know Your Customer (KYC)** requirements pursuant to Spanish Law 10/2010. The legal advisor ensures the proper integration of the blockchain contract into a conventional written agreement and documents the parties' identities, the origin of funds, and the underlying contractual intent. Although the law firm does not hold the funds, it provides a regulatory and evidentiary layer that reinforces the system's legal credibility.

In both models, potential disputes concerning the release of funds—such as disagreements following a failed due diligence process—are resolved via **Kleros**, a decentralized arbitration mechanism. Operating through a protocol based on **cryptoeconomics and game theory**, Kleros randomly selects jurors from a pool of staked participants who are incentivized to rule fairly and in line with the evidence submitted. This architecture enables Kleros to function as a **trustless and neutral dispute resolution platform**, independent of national jurisdictions and free from the delays and costs of conventional litigation.

Because the arbitration outcome is directly linked to the smart contract's execution logic, **rulings are automatically enforced** on-chain without the need for judicial enforcement, ensuring that deposits are either released or refunded in accordance with the binding decision of the decentralized jury.

This model is particularly well-suited for the Spanish real estate context, like mentioned, where early-stage agreements are often concluded without legal oversight and are especially prone to dispute. As the smart contract holds the funds in escrow and defers their release until predefined legal and transactional criteria are fulfilled, **the risk of premature or unjustified disbursement is significantly mitigated.**

Importantly, the proposed integration aligns with the newly enacted **Ley Orgánica 1/2025**, which formally incorporated **Medios Adecuados de Solución de Controversias (MASCs) —Alternative Dispute Resolution Mechanisms—** into Spanish civil procedure. Under this law, parties are encouraged—and in certain cases required—to exhaust alternative dispute resolution mechanisms before initiating formal litigation. Provided that the parties expressly incorporate Kleros arbitration into their contract, the system may be recognized as a legitimate and enforceable method of resolving civil disputes, including those arising from smart contract–based transactions.
As the subsequent sections will explore in greater depth, the convergence of blockchain-based smart contracts with decentralized dispute resolution introduces a viable and legally compatible paradigm for modernizing real estate transactions

in Spain. Through procedural automation, legal adaptability, and the reduction of institutional friction, this model offers a scalable framework for addressing long-standing inefficiencies in the early phases of property acquisition—while reinforcing key legal principles such as party autonomy, contractual freedom, and procedural fairness.

Section 2. Understanding Blockchain Technology

A. Decentralization and Immutability

As outlined in the previous section, one of the central challenges in the early stages of real estate transactions in Spain lies in the lack of standardization and legal safeguards—particularly given the frequent absence of legal counsel and institutional oversight. Against this backdrop, blockchain technology offers a compelling framework for reimagining how such transactions can be conducted with greater transparency, efficiency, and procedural fairness.

At its core, a blockchain is a distributed ledger that records transactions across a decentralized network of computers. Unlike traditional databases managed by a central authority—such as banks, land registries, or notaries—blockchains operate on a peer-to-peer (P2P) structure where data validation and storage are collectively maintained by network participants. This **decentralization** reduces reliance on intermediaries and minimizes the potential for corruption, fraud, or error.

Validation within a blockchain network is achieved through consensus mechanisms such as **Proof of Work (PoW)** or **Proof of Stake (PoS)**, depending on the underlying protocol. Once validated, transactions are grouped into blocks and added to the chain in a linear, chronological order. This structure gives rise to the blockchain's second critical feature: **immutability**. Once a block is added, its content cannot be altered without redoing the entire chain—a practically unfeasible task in established networks like Ethereum or Bitcoin. As a result, blockchain technology ensures that transaction histories are permanent, auditable, and resistant to tampering.

These attributes**—decentralization and immutability—**are especially pertinent in the context of Spanish real estate, where early-stage contractual ambiguity, cross-border transactions, and informational asymmetries create an environment prone to legal conflict and opportunistic behavior. Blockchain can offer a **technological guarantee of trust**, shifting reliance from institutions to cryptographic verification and transparent record-keeping.

As Don and Alex Tapscott argue in *Blockchain Revolution* (2016), this technology forms *"a new platform for building a trusted digital economy,"* precisely because it replaces centralized institutional trust with distributed technological consensus—a shift that is highly relevant in complex and fragmented legal fields such as property transactions.

B. Smart Contracts and Their Functionality

Building upon the decentralized and immutable architecture of blockchain, **smart contracts** introduce programmable logic to automatically execute and enforce agreements without human intervention. First conceptualized by Nick Szabo in the 1990s, a smart contract can be defined as "*a set of promises, specified in digital form, including protocols within which the parties perform on these promises*" (Szabo, 1997).

Smart contracts function on an **"if-this-then-that"** basis. For example, in a Spanish property transaction, a smart contract could be designed to hold a buyer's reservation deposit in escrow and release it only upon successful registration of the property title or notarized confirmation of sale. Crucially, these contracts are stored directly on the blockchain, meaning they execute autonomously and cannot be altered post-deployment.

The advantages of smart contracts are considerable:

- **Automation:** Reduces the risk of delays and manual errors.
- **Cost-efficiency:** Eliminates fees associated with intermediaries such as banks, lawyers, and notaries for escrow or deposit management.
- **Transparency:** All contractual logic and transaction states are publicly auditable.
- **Security:** Immutable code and cryptographic enforcement guard against tampering or unauthorized modification.

These benefits align particularly well with the legal and practical challenges identified in the Spanish real estate market, where the traditional escrow processes are often informal and opaque, and where international parties may face additional legal uncertainty.

As Antonopoulos and Wood explain in *Mastering Ethereum (2018)*, smart contracts serve as *"the building blocks of decentralized trust infrastructure."* This functionality is further enhanced by projects like **Kleros**, which will be explored in the following section. Kleros extends smart contracts with a **decentralized dispute resolution layer**, allowing parties to resolve conflicts without relying on courts or arbitration centers. This is especially relevant in Spain, as mentioned before, where the recently enacted **Ley 1/202**5, which integrates ***Medios Adecuados de Solución de Controversias (MASCs)* - Alternative Dispute Resolution Mechanisms -** into procedural law, explicitly legitimizes alternative online resolution systems.

However, as with any technological system, smart contracts are not without limitations. They are only as reliable as the code upon which they are built, and coding errors can lead to serious vulnerabilities, as seen in high-profile incidents such as the 2016 DAO hack. Additionally, smart contracts cannot interpret legal

ambiguity or context; they execute predefined rules but cannot mediate interpretive disputes without additional systems, such as decentralized arbitration.

While blockchain-based smart contracts offer significant procedural innovation, particularly in managing pre-contractual agreements such as reservation deposits or contratos de arras, it is essential to clarify that **they are not designed to replace the core institutional actors of the Spanish real estate system**. The functions carried out by notaries—including verification of legal capacity, ownership, encumbrances, and compliance with tax obligations—remain indispensable under Spanish law. Likewise, **the Land Registry (Registro de la Propiedad)** plays a constitutionally protected role in providing legal certainty and publicity to property rights. As established in ***Article 1280 of the Spanish Civil Code***, the transfer of real estate requires formalization through a public deed before a notary, and registration is strongly advised to protect the acquirer against third parties. Therefore, smart contracts should be seen as complementary tools that enhance security and efficiency in the early stages of the transaction, not as substitutes for the legal formalities that ensure the legitimacy and enforceability of property rights in Spain. At least; for now.

Nevertheless, in a sector where early-stage risks and procedural uncertainty remain high—as is the case in the Spanish property market—smart contracts represent a transformative tool. When paired with decentralized arbitration systems like **Kleros** and implemented within a compliant legal framework, they could dramatically enhance the trustworthiness, speed, and fairness of real estate transactions in Spain.

Section 3. Kleros Escrow: Trustless Arbitration for Real Estate Transactions in Spain

Following the discussion on blockchain fundamentals and smart contracts, and building on the preceding analysis of Kleros as a decentralized arbitration protocol, this section examines **the Kleros Escrow product**—a real-world application of decentralized justice. We focus particularly on how this tool can address long-standing issues within Spain's real estate transaction framework by providing a transparent, automated, and impartial dispute resolution mechanism. By leveraging blockchain-based smart contracts and decentralized arbitration, it enables a neutral, automated, and secure mechanism for managing deposits and resolving disputes.

A. Operational Framework of Kleros Escrow

Kleros Escrow is a decentralized application (DApp) operating on the Ethereum blockchain that enables secure, autonomous transactions through the use of smart contracts. The system enables what is commonly referred to as a "trustless" environment, wherein participants do not rely on personal trust or institutional oversight, but instead engage with a deterministic and transparent digital framework.

The operational process of Kleros Escrow is structured into a streamlined sequence of procedural stages:

- **Deployment of the Smart Contract:** The transacting parties (typically a buyer and seller) agree upon the conditions of the transaction. These terms are encoded into a smart contract which is deployed via the Kleros Escrow interface. The buyer then deposits the agreed-upon funds into the smart contract.

- **Execution of Obligations:** The seller performs the obligations defined in the contract—such as the provision of legal documents (in accordance with **Article 31.** Minimum information in the purchase and rental transactions of housing according to **Law 12/2023, of 24 May, on the right of housing**), property-related verifications, or transfer of ownership rights. The buyer subsequently reviews and confirms satisfaction with the performance of these obligations.

- **Automated Fund Release:** In the absence of a dispute, the smart contract automatically releases the escrowed funds to the seller upon mutual confirmation that all contractual conditions have been satisfied.

- **Dispute Resolution Activation:** Should the buyer raise a formal objection—due to, for instance, incomplete documentation or material non-compliance—the dispute resolution clause embedded within the smart contract activates the **Kleros** decentralized arbitration protocol.

By automating escrow functionality and integrating a binding dispute mechanism, this model significantly mitigates the risk of fraud, reduces transaction costs, and enhances procedural transparency. As **Federico Ast** aptly observes, *"Kleros Escrow brings the benefits of blockchain—transparency, automation, and censorship-resistance—to the heart of real-world commerce"* (Ast, 2019).

B. Decentralized Arbitration: Juror Mechanism, Economic Incentives, and Enforcement

In the event of a dispute between the parties, Kleros employs a fully decentralized arbitration system designed to ensure fairness, impartiality, and efficiency. The system operates under a framework that combines cryptoeconomic incentives and random selection, with enforcement executed directly through smart contracts.

The arbitration process unfolds as follows:

- **Initiation of Dispute Proceedings:** A party who contests the fulfilment of contractual obligations submits a formal claim to the Kleros Court, thereby initiating the arbitration protocol.

- **Randomized Juror Selection:** Jurors are randomly drawn from a pool of participants who have staked the platform's native token, **Pinakion (PNK)**, within the specific court designated for that type of dispute. The staking mechanism serves as a filtering and incentive system, ensuring that jurors possess both a financial commitment to the integrity of the process and an interest in maintaining the legitimacy of the protocol.

- **Presentation of Evidence and Independent Deliberation:** Both parties to the dispute submit documentary evidence—such as contracts, communications, or legal certifications—through the arbitration interface. Jurors independently evaluate the evidence and render their votes.

- **Incentive Alignment through Game Theory:** Jurors whose decisions align with the majority are rewarded with additional PNK tokens, while those whose votes deviate from the consensus risk forfeiting a portion of their

stake. This game-theoretic model encourages honest and coherent adjudication, reinforcing both the accuracy and neutrality of verdicts.

- **Automated Execution of the Verdict:** Upon resolution, the outcome of the dispute is executed directly by the smart contract, which releases the escrowed funds either to the seller or refunds them to the buyer, in accordance with the jurors' final decision.

All procedural steps and decisions are recorded immutably on the blockchain, thereby guaranteeing a transparent and tamper-resistant evidentiary record. This system offers a novel model for resolving contractual conflicts in digital environments—one that is neutral, economically sustainable, and enforceable without the need for conventional legal intervention.

C. Application in the Spanish Real Estate Market

As remarked, Spain's real estate purchase process starts with contracts that are often executed before full due diligence is completed. This structure exposes buyers to legal and financial risks, particularly if issues such as unpaid debts, building code violations, or title defects are discovered after the deposit has been made.

It's important to remark however, that the effectiveness of any decentralized legal infrastructure depends not only on its technological innovation, but also on its ability to provide practical utility to users operating within an existing legal and financial system. In the case of Spain, where the conveyancing process is legally formalized at the notarial stage and yet remains exposed to substantial risk during earlier private contracting phases, the integration of smart contracts must be both procedurally coherent and user-adaptable.

The Kleros Escrow product offers such a model. It enables parties to conduct secure, conditional transactions using blockchain-based smart contracts, enforced by a decentralized arbitration mechanism. However, for widespread adoption, especially in real estate—a domain that involves high-value transfers and asymmetrical information—it is essential to examine the **practical entry points, technical usability,** and **legal trade-offs** of this technology.

To accommodate a broad spectrum of users, ranging from crypto-native actors to traditional clients, the use of Kleros Escrow in real estate transactions can be deployed under a **dual-access model**, each with distinct procedural implications, which are explained as follows.

Practical Advantages and Limitations

This smart contract–arbitration integration offers numerous advantages:

- **Decentralized trust:** No reliance on estate agents, agencies, or lawyers as custodians of funds.

- **Automated enforceability:** Funds are not subject to litigation delays or biased negotiation leverage.

- **Legal predictability:** The outcome of disputes is based on written conditions and verifiable facts, rather than subjective interpretation.

- **Cost efficiency:** The elimination of intermediaries significantly reduces transaction costs, particularly for international buyers.

- **Legal Compatibility and MASCs Recognition:** The viability of Kleros arbitration within the Spanish legal order is further reinforced by **Ley Orgánica 1/2025**, which formally incorporated **Medios Adecuados de Solución de Controversias (MASCs)** into the Spanish civil procedural code. As long as both parties have agreed to the use of a decentralized arbitration mechanism and this agreement is documented, the outcome is legally binding within the scope of private law. Moreover, this mechanism satisfies the legal requirement to attempt extrajudicial dispute resolution before initiating formal litigation in certain types of cases.

However, it also introduces limitations:

- **Technical barrier to entry:** Users must either be familiar with blockchain tools or have access to advisory support.

- **Perceived legal uncertainty:** Despite their enforceability under private law (Articles 1254–1261 of the Civil Code), smart contract-based rulings may require notarial or judicial confirmation to be accepted by public registries or carry legal effect. As established by **Civil Code Article 1280**, *the transfer of real property must be executed via a public deed signed before a notary*, and only after registration with the Land Registry does it become legally valid and enforceable against third parties.

- **Regulatory scrutiny:** High-value transfers may attract attention from tax and financial authorities, especially in the absence of traditional AML compliance processes.

In this context, **Kleros Escrow introduces a new standard for secure, fair, and efficient pre-contractual protection** in the Spanish real estate market.

D. Implementation Models: From Legal Facilitation to Peer-to-Peer Use

While the technical structure of Kleros Escrow is optimized for direct peer-to-peer interaction, its real-world applicability can be adapted to accommodate users with varying levels of familiarity with blockchain systems. This adaptability allows for a **dual implementation framework, expanding access to both traditional users and crypto-native participants.**

1. **For users unfamiliar with blockchain** or digital assets—such as private individuals, elderly property owners, or non-technical investors— **Law Firm-Facilitated Model:** a law firm may act as a facilitator in the setup and execution of the Kleros Escrow smart contract. In this role, the law firm does not hold custody of the funds but instead assists the parties in interacting with the decentralized system. Additionally, the law firm is responsible for conducting anti-money laundering (AML) and Know Your Customer (KYC) procedures, as required by Law 10/2010 on the Prevention of Money Laundering and the Financing of Terrorism, including identity verification and documentation of the source of funds. This approach maintains the trustless and neutral architecture of the escrow system while ensuring full regulatory compliance.

   As mentioned, the lawyer plays a facilitative rather than custodial role:

   - The legal advisor drafts a written agreement that reflects the terms encoded in the smart contract.
   - The lawyer ensures the parties understand the legal and technical implications of the contract and guides them through the deposit process.
   - Importantly, the law firm also ensures compliance with **Anti-Money Laundering (AML)** and **Know Your Customer (KYC)** obligations, particularly under **Law 10/2010**, and manages documentation to ensure traceability and legal robustness.

   Though the law firm does not hold the funds or manipulate the smart contract, it acts as a compliance gateway, thereby integrating the decentralized structure into the regulated legal and financial landscape of Spain. This hybrid model offers a bridge between blockchain's technological capacity and the procedural safeguards of conventional legal practice.

2. **For users who are experienced in the use of cryptocurrencies and decentralized platforms - Peer-to-Peer (P2P) Model** - the escrow transaction can be conducted directly between the parties using their own

digital wallets. In this case, the entire process—from deposit to arbitration—is executed in a strictly peer-to-peer manner, without the need for any intermediary; neither any VASP (Virtual Asset Service Provider) involvement. Because there is no regulated entity involved, such transactions generally fall outside the scope of the European Union's Transfer of Funds Regulation (EU 2023/1113)— and to the Travel Rule, which we will later mention—further reinforcing the legal independence of P2P blockchain transactions under current frameworks.

In this P2P model, parties interact directly with the blockchain interface, using self-hosted cryptocurrency wallets (such as MetaMask) and initiating smart contract-based agreements without institutional or custodial intermediation. The buyer deposits the reservation or arras payment into a non-custodial smart contract. This smart contract includes embedded logic specifying the release conditions for the funds—such as the successful outcome of due diligence, confirmation of legal compliance, or registration checks.

The key characteristics of this model include:

- **Self-execution:** Once the conditions encoded in the contract are met or breached, the contract enforces the agreed result—either releasing funds to the seller or refunding them to the buyer—without the need for human intervention.

- **Autonomy and finality:** Parties cannot alter the smart contract once it has been deployed, ensuring procedural certainty and protection from opportunistic manipulation.

- **No institutional intermediaries:** Because no VASP, financial institution, or real estate agency controls the funds, the transaction may fall outside the regulatory perimeter of obligations such as the EU Transfer of Funds Regulation (Travel Rule), provided it is entirely peer-to-peer.

This model is particularly suitable for users already familiar with blockchain ecosystems and comfortable with managing digital assets through decentralized tools.

In both models, if a dispute arises—such as the buyer requesting a refund due to an encumbrance or irregularity discovered during due diligence—the matter can be referred to **Kleros**, the object of the paper & the decentralized arbitration protocol proposed.

Illustrative Use Case:
Model A: Peer-to-Peer Deployment

Step 1: Preliminary Agreement and Written Documentation:
The buyer and seller agree on deposit amounts (e.g., € 6,000 reservation deposit and a 10% *arras*), specific due diligence milestones (such as registry checks or debt clearance), and dispute-triggering conditions. For this model, although the parties can draw up the private document parallel to the smart contract without legal advice, the advice of a lawyer is also recommended in order to comply with all legal requirements. This binding parallel written agreement would explicitly reference the use of the Kleros Escrow smart contract and arbitration protocol.

Step 2: Wallet Configuration and Fund Allocation:
Each party installs MetaMask (https://metamask.io/) or another Ethereum-compatible wallet. The buyer ensures there are sufficient funds to cover both the deposit and associated Ethereum gas fees.

Step 3: Smart Contract Initialization
Through MetaMask, the buyer accesses the Kleros Escrow DApp and signs in. They select "New Payment" and choose "General Service" escrow mode. Within the interface, they complete fields including:

- Buyer and seller Ethereum addresses
- Deposit amount and ERC-20 token type
- Deadline for automatic fund release if no dispute is raised
- An uploaded document or direct text entry of contractual terms to guide jurors

Step 4: Deposit and Contract Deployment
MetaMask prompts to authorize the transaction. Upon confirmation and gas fee payment, the smart contract locks the funds in escrow on Ethereum.

Step 5: Transaction Monitoring and Notifications
The transaction appears under “My Payments.” Optional email alerts may be enabled, although blockchain explorers can also be used for independent tracking.

Step 6: Fulfillment or Dispute Process
- For straightforward cases, once conditions are met, either party clicks “Yes” in the DApp. The smart contract then releases funds to the seller on-chain.

- If an encumbrance arises and the buyer initiates a dispute, they click “No.” If the seller contests, both sides pay arbitration fees and the case is submitted to Kleros. Jurors are selected from PNK stakers, and decisions are executed on-chain.

Step 7: Final Settlement and Withdrawal
Following the arbitration verdict, the smart contract disburses funds accordingly. Both parties can withdraw using MetaMask once the transaction is confirmed on the network. Or if the Public Title Deed has been signed correctly; the seller would receive the funds.

Model B: Law-Firm Facilitated Deployment

Step 1: Legal Drafting and Smart Contract Design
A licensed attorney drafts a formal purchase contract incorporating deposit terms, Kleros Escrow mechanisms, and the arbitration clause in accordance with **Ley Orgánica 1/2025** (MASCs). The lawyer ensures the deposit conditions are accurately reflected in both the smart contract and human-readable agreement.

Step 2: AML/KYC Compliance by Legal Advisor
The law firm collects identification documents, verifies source of funds (per **Law 10/2010**), and retains records in anticipation of reporting obligations.

Step 3: Smart Contract Deployment via Guided Interface
With lawyer assistance, the buyer deploys the smart contract using MetaMask. The attorney can oversee the transaction and confirm contract integrity without holding client funds.

Step 4: Escrow Management
Funds are deposited into the smart contract. The arrangement is escrowed on-chain, but the law firm keeps the documents as proof of deposit and milestone verification.

Step 5: Completion or Dispute Resolution

- If pre-agreed milestones are met (e.g., due diligence confirmation / signature of the Public Title Deed), either party authorizes fund release through MetaMask-connected DApp.

- If a dispute arises, the attorney assists in initiating arbitration via Kleros and submits supporting evidence. Kleros jurors adjudicate, and funds are automatically released or refunded according to the ruling.

Step 6: Final Release and Legal Record-Keeping

The smart contract's outcome is executed on-chain. The attorney incorporates the result into legal documentation with the Notary, enabling enforceability through standard judicial mechanisms if necessary.

This dual-use model promotes wider adoption by offering procedural clarity and legal support to traditional actors while simultaneously preserving the full potential of blockchain technology for those who are ready to use it directly.
While the benefits of integrating Kleros Escrow into real estate transactions are evident—especially in terms of automation, trust minimization, and dispute resolution—the technology also introduces important **legal considerations**. Can smart contracts replace or supplement traditional legal contracts under Spanish law? How are blockchain-based rulings recognized by Spanish courts? Are escrow mechanisms based on code legally binding?

These questions are not merely academic—they are central to the real-world implementation of decentralized justice technologies. In the following section, we will explore the **legal frameworks in Spain** governing contracts, arbitration, and digital technologies to assess the viability and limitations of **Kleros-based systems within the Spanish jurisdiction.**

Section 4. The Legal and Financial Implications of Using Smart Contracts According to Spanish Law

The legal and financial viability of smart contracts within Spain hinges on their compatibility with the country's established legal framework and evolving European Union regulations. Central to this assessment is the question of whether smart contracts can replace or supplement traditional legal contracts, and whether blockchain-based mechanisms—such as decentralized arbitration or escrow—can be recognized and enforced by Spanish courts.

Under Spanish law, contracts are governed primarily by the ***Código Civil*** **(Civil Code)**; which we will explain briefly in the next paragraphs. From a European regulatory perspective, recent legal developments further strengthen the legal status of smart contracts. The **eIDAS Regulation (EU No. 910/2014)** establishes that **electronic signatures** and **digital agreements** cannot be denied legal validity solely based on their digital nature. This provides a foundational layer of legitimacy for blockchain-based contracts and transactions.

More significantly, the **EU Data Act (Regulation (EU) 2023/2854)**—adopted in 2023 and applicable from 2025—introduces the **first EU-level legal definition and regulation of smart contracts. Article 30** outlines essential requirements such as **resilience, data preservation, access controls**, and **intervention mechanisms**, especially in the context of data-sharing agreements. While primarily focused on digital infrastructure, these rules mark a major step in the legal standardization of smart contracts across the EU, including Spain.

In parallel, the **Markets in Crypto-Assets Regulation (MiCA)** and the **Digital Finance Package** bring increased regulatory clarity to blockchain-based systems, including decentralized applications and smart contracts. These measures underscore the EU's broader commitment to integrating blockchain technologies into the legal and financial mainstream—creating a supportive backdrop for Spain's recognition of smart contracts, particularly in commercial and peer-to-peer applications.

In summary, under both Spanish and EU law, **smart contracts can supplement—and in many cases replicate—the function of traditional contracts**, provided they meet core legal requirements. They are likely to be recognized as binding where no formalities (e.g., notarization) are strictly required. While Spanish law remains form-sensitive in certain domains, the broader legislative environment increasingly supports the legal enforceability of

blockchain-based agreements, creating fertile ground for innovations like **decentralized arbitration and coded escrow mechanisms**—topics we will explore in the following sections.

A. Can Smart Contracts Replace or Supplement Traditional Contracts in Spain?

Under Spanish law, contracts are governed primarily by the ***Código Civil*** **(Civil Code)**. According to **Article 1254**, a contract is formed when one or more parties consent to bind themselves to deliver something or provide a service. For a contract to be valid, it must meet three essential conditions outlined in **Article 1261**: consent, object, and cause. Importantly, **Article 1278** confirms that contracts are binding regardless of form—meaning that agreements can be oral, written, or even implied through behaviour. This legal flexibility opens the door to the potential recognition of **smart contracts**, so long as they reflect these fundamental elements.

Spanish contract law is rooted in the principle of **freedom of contract**, enshrined in **Article 1255 of the Spanish Civil Code**, which grants private parties the autonomy to establish contractual clauses and conditions as they see fit, so long as they do not contravene legal norms, public order, or morality. Complementing this, **Article 1281** establishes that when the wording of a contract is clear and leaves no room for interpretation, the literal meaning of its clauses shall govern the parties' obligations. These provisions are particularly relevant in the context of **smart contracts**, whose structure is defined not through ambiguous legal language, but through precise, machine-readable code.

The nature of smart contracts, especially those deployed on platforms like Ethereum, is inherently **deterministic**. Each clause is encoded to execute specific outcomes when predefined conditions are met—such as releasing funds when a date is reached or when both parties confirm performance. As a result, **ambiguity is inherently minimized**: the program either executes or does not, based on objective inputs. This deterministic logic contrasts with traditional written contracts, which often require judicial interpretation when disputes arise due to vague or contradictory wording.

While ambiguity in a smart contract is not impossible, it tends to arise not from the code itself, but from **external factors** such as:

- **Poorly defined inputs:** e.g., if a contract releases funds "upon satisfactory completion of due diligence," but fails to codify who determines "satisfactory."

- **Reliance on off-chain events** without clear or reliable data sources (oracles), such as "approval by municipal authorities" where no automatic verification

is possible.

- **Mismatch between human-readable and machine-readable terms**, particularly if the written agreement says one thing and the deployed code enforces another.

However, in the Kleros Escrow model, such ambiguities are mitigated through several safeguards. First, the parties are strongly recommended to work with a **legal professional** to draft a **parallel written agreement** that reflects the coded logic of the smart contract in plain legal terms. Second, the Kleros DApp allows the parties to upload clear documentation and instructions (e.g., PDFs or HTML content) that can later be presented to jurors in the event of a dispute. This helps ensure that the intent of the contract is transparent and aligned across both legal and technological domains.

To illustrate, consider a smart contract for an *arras* deposit that states: "If no encumbrances are revealed by 30 June 2025, release funds to the seller." There is minimal room for ambiguity here—the logic is binary. In contrast, a traditional clause stating "if no substantial legal issues are found" could invite debate over what qualifies as "substantial." In a smart contract framework, terms must be defined explicitly (e.g., "if no charges appear in the Land Registry extract from date X") and encoded accordingly.

Thus, **well-designed smart contracts**, particularly when supported by legal documentation and dispute resolution mechanisms like Kleros, inherently minimize the risk of interpretive ambiguity. Their alignment with the principle of **literal enforcement under Article 1281**, combined with the enforceable freedom of contract under **Article 1255**, makes them a robust tool for managing deposit transactions in real estate contexts governed by Spanish law.

However, it is worth noting that certain transactions under Spanish law—such as real estate conveyance—require public deed formalities and registration, as set out in **Article 1280**. In these cases, a smart contract cannot fully replace the legal procedures required by notarial and registry systems, but it can still serve as a supplementary agreement or automated payment mechanism. Therefore, a **hybrid approach** is currently the most viable: a traditional written agreement outlines the terms and legal recourse, while a smart contract handles execution and enforcement of specific clauses (such as payment schedules or delivery triggers). This model ensures compliance with legal formalities and allows smart contracts to function within established legal frameworks.

B. Are Blockchain-Based Rulings Recognized by Spanish Courts?

Spanish courts have yet to issue clear precedents on the enforceability of **blockchain-based rulings** like those generated through the Kleros arbitration system. However, Spanish procedural law does allow for **alternative dispute resolution (ADR)** mechanisms, such as **arbitration** and **mediation**, under specific conditions.

The **Ley de Arbitraje (Law 60/2003 on Arbitration)** permits private parties to resolve disputes outside the judiciary through binding arbitral awards, provided both parties agree in advance to submit to arbitration. Importantly, arbitration awards—whether domestic or international—are recognized and enforceable by Spanish courts through **exequatur proceedings**, as long as they respect principles of due process, impartiality, and public order.

This opens the door for blockchain-based dispute resolution systems like **Kleros** to be **legally valid**, provided they are integrated into a contractual arbitration clause and meet basic procedural safeguards. However, enforcement may still require judicial recognition, especially when the losing party does not voluntarily comply with the outcome. Courts may demand clarity around juror selection, impartiality, and procedural transparency—areas where Kleros's game-theoretic and anonymous model could face legal scrutiny.

Nonetheless, as highlighted by legal scholars, Spanish law is **technologically neutral**, meaning it does not preclude the use of digital systems—only that these systems must respect the fundamental principles of fairness and due process.

C. Are Code-Based Escrow Mechanisms Legally Binding in Spain?

The legal binding nature of **escrow mechanisms implemented via smart contracts**, such as **Kleros Escrow**, hinges on whether they reflect the **mutual intent and consent** of the parties and meet contractual obligations under Spanish law.

There is no legal requirement that an escrow must be managed by a licensed intermediary unless it relates to regulated financial activities (e.g., banking, investment services). Therefore, a **smart contract-based escrow** can be considered legally valid if it transparently documents the terms of agreement (such as delivery conditions or refund rules) and ensures both parties understand and consent to its operation.

However, in real estate transactions, particular caution is needed; as exposed. While Kleros Escrow can serve as a secure mechanism for **pre-contractual deposits** (e.g., reservation fees or Arras agreements), the **final conveyance of property** still

requires formal legal steps outside the blockchain.

That said, Kleros Escrow provides a **valuable legal and financial safeguard** in the critical early stages of property transactions, where deposits are most vulnerable. Its automatic enforcement and built-in dispute resolution reduce reliance on subjective interpretations or court battles, provided the smart contract terms are clearly documented and agreed upon.

D. Outlook and Legal Viability

The deployment of blockchain-based smart contracts and decentralized arbitration frameworks—such as Kleros Escrow—within Spain's real estate domain is legally feasible under current frameworks but remains **not fully standardized or regulated**. As commented; Spanish private law permits parties to autonomously construct contractual agreements (Article 1255, Civil Code), and clarifies that the literal text governs when terms are clear (Article 1281, Civil Code). These provisions conceptually align with the deterministic, code-based execution of smart contracts, facilitating enforceability in early transactional stages when paired with proper documentation and arbitration clauses. However, true legal effect for **transfers of real property** remains contingent on the formal **notarial signing of the public deed** (escritura pública) before a notary—a requirement enshrined in Article 1280 of the Civil Code—and subsequent inscription in the **Land Registry** (Registro de la Propiedad) to establish enforceable against third parties.

The Land Registry operates under a two-tier timing structure. Once a deed is presented and taxes paid, registrars are legally obligated to **process and inscribe the deed within 15 business days (if, at the time of such submission, proof is provided that all legal requirements are met and there are no disputes).** Nonetheless, delays may still occur, and the processing of registration can extend beyond three weeks in some cases. During this interval:

- The buyer holds a legally signed deed, but the Registry has not yet published the transfer.

- The seller remains visible as the titleholder in public records, enabling—at least theoretically—the possibility of **duplicate sale** attempts. While such an act is unlawful, the Registry's delay weakens the buyer's protection during this narrow window.

Although the **smart contract engine** cannot yet directly commit a deed to the Land Registry, emerging opportunities may arise in the medium term. Integrations could allow smart contracts to **automatically notify notaries or registries** when specified contractual conditions are met or the public deed has been executed. The notary already **electronically submits the deed for registry inscription**, but registration remains a manually validated act. In the future, smart contracts might

transmit certified metadata that triggers provisional “automatic inscription” workflows or prioritised registration, thereby reducing gaps during critical transaction windows.

That said, such innovations remain **forward-looking and speculative** under current law. To date, deed registry is still a **“manual, rogate” system**—initiated only once an interested party presents a deed and certifies tax payment —and it **cannot be bypassed by any algorithmic mechanism** without legislative reform or judicial recognition. Therefore, **presently, the only irrefutable evidence of title is a public notarial deed followed by Land Registry inscription.** Yet, the digital certification and notarization process demonstrates signs of modernization, such as triggering electronic queues or validating metadata, even if actual inscription remains manually supervised.

The prudent legal strategy—already proposed earlier in this paper—is to employ a **hybrid model**: blockchain-based escrow management and decentralized arbitration for purchaser protection, combined with **traditional public deed execution** and **Land Registry registration** for full legal effect. This preserves the essential functions of notaries and registry while mitigating known vulnerabilities—such as the buyer paying the deposit but being exposed to the risk of registry delays or duplicate sales.

In the medium to long term, legal developments regarding **smart contract recognition in real estate** might close these procedural gaps. Potential reforms include giving **smart contract metadata automatic registry effects**, or providing a blockchain-based notification system to registrars. Until such mechanisms are legislatively recognized, the integration of notarial execution and Land Registry registration remains **indispensable to secure the real property rights** in Spain’s legal structure.

E. Integration of Kleros with the New MASC Legislation in Spain

An especially relevant recent development is the entry into force of Organic Law 1/2025, which took effect on 3 April 2025. This law introduces the concept of Medios Adecuados de Solución de Controversias (MASC)—"Appropriate Means of Dispute Resolution"—into the Spanish legal system.

According to this reform, before initiating judicial proceedings in civil and commercial matters, parties must demonstrate that they have attempted to resolve their dispute using one of the recognized **MASC** mechanisms. These include mediation, conciliation, negotiation, and arbitration, among others. **If no such attempt can be proven, the courts may declare the claim inadmissible.**

This legislation reflects a broader European trend toward reducing judicial congestion and promoting more efficient, participatory, and flexible mechanisms

for resolving disputes. The emphasis is now placed on reaching amicable solutions before resorting to formal litigation.

Within this framework, Kleros' decentralized arbitration protocol can be understood as a **digital and decentralized form of arbitration**, fully aligned with the spirit of MASC. While it operates outside traditional institutional arbitration centers, Kleros adheres to core principles such as due process, impartiality, transparency, and independence of jurors. It provides:

- A fully auditable, blockchain-based evidence submission system
- Randomized selection of jurors from a qualified pool
- Economic incentives to ensure honest and informed decision-making

Consequently, if a dispute arises from a smart contract associated with a real estate transaction, and both parties have previously agreed to submit conflicts to **Kleros**, this can be presented as a valid attempt to resolve the matter via MASC. It meets both the functional and procedural objectives of the new legislation, while leveraging the benefits of decentralization and digital trust.

Section 5. Regulatory Challenges and Compliance

The implementation of blockchain-based real estate transactions introduces regulatory complexities, particularly concerning anti-money laundering (AML), Know Your Customer (KYC) requirements, and the application of the **Travel Rule**. These issues become even more critical when considering high-value transactions and cross-border transfers, which are common in real estate deals. Ensuring legal compliance while preserving the decentralized and trustless nature of blockchain systems presents a unique legal challenge, especially within the Spanish and European legal frameworks.

A. Addressing AML and KYC Requirements

Blockchain does not exempt participants from compliance with AML and KYC obligations. In Spain, these are governed primarily by **Law 10/2010 of 28 April on the Prevention of Money Laundering and the Financing of Terrorism**, alongside the European Union's **AML** Directives, including Directive (EU) 2015/849 and its subsequent amendments.

Entities involved in real estate transactions—such as real estate agencies, notaries, and virtual crypto-asset service providers (**VASPs**)—must identify clients, assess the source of funds, and monitor and report suspicious transactions to **SEPBLAC**, Spain's Financial Intelligence Unit. These obligations apply regardless of whether the transaction is facilitated through traditional or blockchain mechanisms.

For high-value transactions—such as those commonly found in real estate—**AML obligations are significantly heightened**. Spanish law, in line with EU directives, requires **enhanced due diligence** in scenarios involving substantial transfers, particularly those exceeding **€ 10,000 in cash** or when other risk factors are present, such as the use of cryptocurrencies, foreign clients, or complex ownership structures. Thus, **KYC is not merely procedural—it is a legal necessity to verify identity**, assess risk, and prevent real estate from being exploited for illicit financial activity.

B. A Dual Model of Implementation: Crypto-Native and Legal-Facilitated Transactions

Given the diverse profile of real estate market participants, this paper proposes the **dual model** mentioned for the implementation of **Kleros Escrow** in Spain. This model ensures both legal compliance and accessibility to blockchain-based tools

for users with varying levels of technical expertise.

1. Legal-Facilitated Use through Law Firms

In order to broaden access to blockchain-based escrow and arbitration mechanisms within the Spanish real estate market, the model proposed in this paper includes a legal-facilitated option. This pathway is designed for users who may lack technical familiarity with blockchain systems or who prefer to operate within a conventional legal and regulatory framework. In this model, a licensed law firm acts as a facilitator and legal integrator of the Kleros Escrow smart contract process, ensuring compliance with both civil law and anti-money laundering obligations; as well for the due diligence procedure checks.

The participation of a legal professional serves several critical purposes. First, the law firm is responsible for drafting a parallel written agreement that accurately reflects the terms encoded in the smart contract and incorporates the decentralized arbitration clause, ensuring the arrangement conforms with Articles 1255 and 1281 of the Spanish Civil Code. This legal instrument provides clarity and enforceability, both within the private relationship of the parties and, where necessary, before public institutions such as the courts or the Land Registry. In addition, the law firm would carry out due diligence on the properties involved in the sale and purchase, i.e. checking the status of the properties at the Land Registry, Cadastre, tax authorities, community of owners, town hall where the property is located, and other relevant authorities.

Secondly, the law firm undertakes full compliance with **Law 10/2010, of 28 April**, on the prevention of money laundering and the financing of terrorism. This includes conducting **Know Your Customer (KYC)** procedures, verifying the identity and beneficial ownership of the parties, and assessing the lawful origin of funds. Where applicable, the firm is also responsible for reporting suspicious activity to **SEPBLAC**, Spain's financial intelligence unit, and retaining documentation in accordance with national and EU regulations. Although the firm does not assume custody of client funds—since these remain locked within a non-custodial smart contract—it is nevertheless classified as an obligated entity under Spanish AML legislation by virtue of its role in facilitating the financial operation.

From a technical perspective, the deployment and execution of the smart contract follow a secure and traceable process. The law firm provides guidance on the use of a blockchain wallet—typically MetaMask—and oversees the configuration of the Kleros Escrow application. Upon confirming the contract terms and the identity of both parties, the buyer initiates the transaction by transferring the agreed deposit into the smart contract through the connected MetaMask interface. The contract then locks the funds on-chain under predefined conditions, such as the completion of legal due diligence or the verification of registry status. These conditions are

clearly articulated in both the code and the supporting written agreement.

If the transaction proceeds without incident, the parties—via the DApp interface—jointly authorize the release of funds. However, should a dispute arise, for instance due to the discovery of legal encumbrances on the property or the buyer's decision to withdraw in good faith, the law firm assists in triggering arbitration under the Kleros protocol. This includes the submission of evidence and legal documentation to the Kleros jurors, who are selected randomly and incentivized to rule impartially through cryptoeconomic mechanisms. Once a verdict is rendered, the outcome is automatically executed by the smart contract, either releasing the funds to the seller or returning them to the buyer.

Finally, the law firm integrates the blockchain transaction into its legal case file, maintaining a full record of the process, including hashes of the deployed contract, timestamps of deposit and withdrawal events, and all supporting documentation. While the use of a smart contract does not replace the requirement for the notarial public deed and subsequent registration in the **Registro de la Propiedad**, the involvement of the law firm ensures that all digital transactions remain anchored in a legally coherent framework, increasing their acceptability in both judicial and administrative contexts.

2. Crypto-Native P2P Transactions

As explained in Section 3 (pages 18-19); in a crypto-native implementation, parties interact directly through their own digital wallets—such as MetaMask—and independently deploy the Kleros Escrow smart contract on the Ethereum blockchain. This model is designed for individuals who possess a sufficient degree of technical literacy and are comfortable navigating decentralized applications (DApps) without intermediaries. Within this framework, the buyer and seller agree on contractual conditions—such as deposit amount, triggering milestones for fund release, and the invocation of arbitration—and encode them directly into the smart contract, thereby initiating a fully peer-to-peer (P2P), non-custodial transaction.

Once deployed, the smart contract autonomously governs the locked funds in accordance with the coded terms. Upon fulfilment of the agreed-upon conditions (e.g., successful completion of due diligence or signature of the public deed), either party may authorize release of the funds. If a dispute arises, the parties may initiate arbitration within the Kleros protocol, which, as described earlier, adjudicates disputes through a decentralized panel of randomly selected jurors.

Although this configuration offers full technical autonomy, it does not obviate the importance of legal precision. Indeed, given the high financial and legal stakes of real estate transactions—often involving cross-border elements—it remains strongly advisable for the parties to engage a qualified legal professional to draft a **supporting private contract**. This written agreement should clearly define the

obligations of each party and explicitly reference the terms encoded in the smart contract. It should also incorporate a dispute resolution clause recognizing the Kleros protocol as the agreed mechanism under Spanish law, in compliance with the principle of contractual freedom (Article 1255 of the Spanish Civil Code) and the recently enacted **Ley Orgánica 1/2025** governing Medios Adecuados de Solución de Controversias (MASCs).

This supplementary legal instrument serves multiple purposes. First, it ensures that both parties have a shared understanding of their obligations—particularly important when translating legal obligations into deterministic code. Second, it enhances legal certainty by providing a documentary basis that can be invoked before courts or administrative bodies, especially if the smart contract's execution is ever challenged. Third, it allows for consistency between the blockchain logic and the parallel civil law framework, particularly in cases where registration, tax compliance, or third-party notification may become necessary.

From a regulatory standpoint, because the transaction is conducted directly between the parties—without any platform, VASP, or third-party custody—the arrangement falls outside the direct scope of AML obligations under **Law 10/2010** and the **EU Transfer of Funds Regulation (Regulation 2023/1113)**. However, this exemption does not preclude future scrutiny, especially for high-value transactions. Accordingly, participants are encouraged to maintain robust documentation and to voluntarily comply with best practices concerning source-of-funds verification, tax transparency, and contractual clarity.

In summary, while the crypto-native P2P model offers the technical advantages of decentralization, automation, and cost-efficiency, it benefits significantly from the complementary involvement of legal professionals to ensure alignment between code and contract, enforceability under Spanish civil law, and reputational security in complex or cross-border transactions.

C. Legal Formalization and the Limits of Smart Contracts

Despite the functional advantages of smart contracts in automating parts of the transaction —such as managing deposits or defining conditional releases— it is crucial to note that under Spanish law, the **legal transfer of real estate** requires the commented execution of a **public deed before a notary** and subsequent registration in the **Land Registry.**

Thus, while blockchain-based agreements can streamline and secure the pre-notarial phases (e.g., *contrato de arras*, reservation deposits), they do **not substitute the mandatory formal legal acts** required for the transfer of real estate ownership in Spain. Instead, they function as **complementary tools** that reduce risk and ambiguity in the earlier stages of the transaction process.

D. The Travel Rule and Its Inapplicability to P2P Transactions

Crucially, the Travel Rule **does not apply to purely peer-to-peer (P2P) transactions**, where individuals interact directly through their own wallets without any regulated intermediary. This legal nuance is foundational to the model proposed in this paper, wherein reservation deposits and arras payments are made using **non-custodial smart contracts** integrated with **Kleros Escrow**.

Because no third party controls the transaction and the code autonomously governs deposit conditions and dispute resolution, such arrangements arguably fall **outside the current scope of the Travel Rule**. However, this does not eliminate all legal risk. In high-value real estate operations—especially cross-border ones—regulators may closely scrutinize even technically P2P transactions due to the elevated risk of money laundering and fraud.

Therefore, while the **Kleros Escrow model** offers a P2P structure that enhances transparency and reduces reliance on intermediaries, participants should adopt **strong self-regulatory safeguards**, including identity verification and audit trails, to remain in line with emerging best practices and pre-empt future legal obligations.

In summary, while the current legal and regulatory framework in Spain and the EU provides room for the implementation of blockchain-based real estate systems, compliance must be addressed proactively. This involves understanding where decentralization can exempt obligations and where legal frameworks—especially around AML, KYC, and property formalization—still demand traditional legal structures.

Section 6. Smart Contracts for Reservation and Private Deposit Agreements in Spain

Having established the theoretical foundations of blockchain technology, smart contracts, and decentralized justice systems such as Kleros, it is now pertinent to explore their real-world applications. This section analyses case studies that demonstrate how peer-to-peer (P2P) smart contracts and decentralized dispute resolution mechanisms are already transforming the real estate ecosystem, particularly within the Spanish jurisdiction that we are studying.

Therefore, this section explores how the **Kleros Escrow product** can be applied to improve transparency, neutrality, and procedural protection in these early stages of Spanish property transactions.

A. Applying the Kleros Escrow Model to Reservation and Contrato de Arras Deposits

As previously discussed, the Kleros Escrow product enables the deployment of **a non-custodial smart contract** that holds funds securely until both transacting parties confirm that the agreed contractual conditions have been satisfied. This decentralized escrow mechanism replaces traditional intermediaries—such as banks, real estate agents, or legal custodians—with a trustless system governed by blockchain code and Kleros' decentralized arbitration protocol. No single entity can unilaterally control or release the funds, and in the event of a dispute, adjudication is carried out by a randomly selected jury incentivized to rule fairly.

Importantly, as elaborated earlier in the section on implementation models, the **deployment of the Kleros Escrow smart contract** is facilitated through a blockchain wallet interface—typically **MetaMask**—and executed via the **Kleros Escrow DApp**. Parties may access this platform to input the deposit amount, define the conditions for release, and upload relevant documentation or evidence to be used in case of arbitration. For users not familiar with blockchain technologies, a **specialized law firm** may assist in configuring and deploying the smart contract, ensuring both technical integrity and legal validity. This dual-path model ensures accessibility across varying levels of technical proficiency.

Within the context of **Spanish real estate transactions**, this model offers substantial procedural and financial safeguards during two critical early contractual stages:

1. Reservation Stage

Rather than transferring the reservation deposit — typically between € 3,000 and € 6,000 — directly to the estate agency or seller, the buyer deposits the agreed amount into a **Kleros Escrow smart contract**. The smart contract encodes specific conditions that must be met before the funds can be released, such as:

- Completion of initial legal due diligence,
- Verification of ownership and property registry status,
- Confirmation that the property is not subject to encumbrances or pending litigation.

These conditions are either confirmed directly by the buyer or, in the legally assisted model, documented by the law firm involved.

2. *Contrato de Arras* Stage (Private Purchase Contract)

Subsequent to the reservation agreement, the buyer and seller typically enter into a contrato de arras, involving a deposit of approximately 10% of the property's purchase price. In this stage as well, a **second smart contract** may be configured through Kleros Escrow. This contract specifies more advanced verification conditions, including:

- Notarial confirmation of a clear and registrable title,
- Certification that the property is debt-free (free of mortgages, liens, or unpaid taxes),
- Compliance with applicable urban planning or zoning regulations.

The funds remain locked in the contract and can only be released upon mutual confirmation by both parties through the DApp interface or, in case of disagreement, following resolution by the Kleros decentralized court.

This smart contract–based model ensures **dual protection:**

- The **seller** is assured that funds have been committed and secured within an immutable escrow contract.
- The **buyer** is protected from premature or illegitimate fund release, particularly in situations where legal or structural problems arise after the contract has been signed but before the notarial deed has been executed.

By leveraging the deterministic and tamper-proof features of blockchain, alongside

a transparent and neutral arbitration mechanism, the Kleros Escrow model introduces a **layer of procedural fairness and legal certainty** previously unavailable in the informal, pre-notarial stages of Spanish real estate transactions.

B. Decentralized, Peer-to-Peer Design: A Trustless Architecture

Kleros Escrow is fundamentally **peer-to-peer (P2P)**. According to the official documentation from Kleros Labs:

"Kleros Escrow is a smart contract allowing trustless payments in exchange for goods and services. It allows users to make secure transactions without relying on centralized third parties."
— Kleros Escrow Documentation (docs.kleros.io/products/escrow)

The P2P structure means the smart contract is deployed directly by the parties' on-chain. Funds are held immutably within the contract and are **only released** either by mutual consent or after adjudication by **Kleros' decentralized juror system**. This eliminates the role of traditional custodians, reducing both cost and the risk of conflicts of interest.

C. Dispute Resolution through Kleros Arbitration

If a dispute arises—for example, if due diligence reveals a legal defect in the property and the buyer seeks a refund—the parties may submit the disagreement to **Kleros arbitration**. Jurors are randomly selected from the relevant Kleros Court and are incentivized via game-theoretic mechanisms to reach a majority decision based on the evidence provided. The result is a ruling that is:

- Transparent (published on-chain),
- Neutral (jurors have no relation to the parties),
- Automated (enforced by the smart contract).

The **Kleros whitepaper** (Lesaege, Ast & George, 2019) frames this model as a way to *"replace traditional dispute resolution mechanisms with a system rooted in cryptoeconomics and crowdsourced decision-making,"* emphasizing its utility in global, low-trust environments.

As Federico Ast further writes in *"Dispute Revolution: The Kleros Handbook of Decentralized Justice"* (2019):

"What the internet did for information, Kleros can do for justice—providing universal access, neutrality, and speed in resolving commercial and contractual conflicts."

Section 7. Other Practical Implementations of P2P Smart Contracts in Spanish Real Estate

Building on the conceptual and legal foundations explored in earlier sections, this final chapter explores broader practical implementations of **P2P smart contracts** and **decentralized arbitration systems** in the Spanish real estate market. The integration of these tools—particularly **tokenization, self-executing contracts, and Kleros arbitration infrastructure**—has the potential to fundamentally reshape how property rights are transacted, verified, and enforced in Spain.

A. Tokenization and Smart Contracts in the Spanish Real Estate Market

Tokenization refers to the process of converting ownership rights in a physical asset—such as real estate—into **digital tokens** that can be stored, transferred, and traded on a blockchain. Each token represents a share in the underlying property, enabling fractional ownership, increased liquidity, and simplified transfer mechanisms.

In Spain, this approach has started to gain attention through pilot projects that tokenize residential or commercial units and allow investors to buy and sell participation rights via smart contracts. Although, as we have notice in this paper, **Spanish property law still requires a public deed and registration** to formalize full ownership transfers, **tokenization can streamline investment structures like *"sociedades patrimoniales"* (asset-holding companies)** or **Real Estate Investment Trusts (REITs)**, enabling faster and more transparent allocation of rights within legal entities that hold title to the property.

As highlighted in *Blockchain Revolution* (Tapscott & Tapscott, 2016), *"blockchain enables the digitization of trust, allowing real assets to be represented and exchanged in code."* In the Spanish context, tokenization is best seen as a **parallel structure**: smart contracts govern financial rights, dividend distribution, and voting mechanisms, while notarial formalities still govern title transfers.

Tokenization also allows **programmable compliance**, where conditions such as maximum shareholding, KYC thresholds, and geographic restrictions can be encoded directly into the smart contract.

B. Kleros as a Legal Infrastructure for Tokenized Real Estate

The scalability of tokenized real estate requires not only automated contracts but also **credible and neutral dispute resolution mechanisms.** Traditional courts are ill-suited for enforcing micro-agreements involving token transfers, DAO governance, or fractional property rights. This is where **Kleros** functions as a foundational **legal infrastructure.**

In a tokenized property system, disagreements may arise around revenue distribution, token issuance, building maintenance, or rights of use. Rather than defaulting to litigation, parties can opt into **Kleros Courts**—decentralized juror pools designed to handle sector-specific disputes. For example, a "Real Estate Court" could be established within the Kleros ecosystem, where jurors stake PNK tokens and are selected at random to evaluate submitted evidence and vote on outcomes. As described in the Kleros whitepaper (Lesaege, Ast & George, 2019), *"Kleros provides a fast, inexpensive, and decentralized form of justice for the digital economy."*

Federico Ast emphasizes this in *Dispute Revolution* (2019), noting that smart contracts without dispute resolution mechanisms are incomplete: *"No contract—whether paper or code—can prevent disagreements. But Kleros can resolve them fairly, without centralized control, and across borders."*

By incorporating Kleros arbitration directly into the token's smart contract (e.g., via an embedded arbitration clause in the ERC-792 standard), Spanish real estate token issuers can offer stakeholders a **trust-minimized governance framework**, enforceable in real-time and operable independently of traditional court systems.

C. Enabling Strictly P2P Transactions in Spain

Perhaps the most transformative use case lies in enabling **strictly peer-to-peer (P2P) real estate transactions** within Spain. By combining:

- Smart contracts for reservation and arras deposits (see Section 6),
- Tokenized property rights tied to legal entities,
- And Kleros arbitration as an enforcement layer,

a property transaction could be **negotiated, executed, and enforced without any central intermediary**—including banks, agents, or even traditional escrow providers.

While the final notarization and registry inscription remain legally required for property ownership transfer (**as per Article 1280 of the Spanish Civil Code),** the

pre-contractual and contractual stages can be conducted entirely via code. The buyer and seller agree on a smart contract, deposits are made in Kleros Escrow, and in the event of dispute, the outcome is resolved by jurors and automatically executed by the contract; like explained in previous sections.

This model has several advantages:

- **Speed:** Automation eliminates waiting for intermediaries or institutions.
- **Neutrality:** Kleros' cryptoeconomic incentives ensure fair outcomes.
- **Transparency:** All interactions and conditions are visible on-chain.
- **Access:** Foreign buyers and sellers can transact cross-border with minimal reliance on local institutions.

As discussed earlier, the recent **Ley Orgánica 1/2025** recognizing digital MASCs further enhances the legal compatibility of such structures in Spain. While blockchain-based systems cannot yet fully replace public notarial acts, they can offer a legally supported alternative for **deposit handling, reservation enforcement, and dispute resolution.**

Section 8. Conclusions

This paper has undertaken a comprehensive legal-technical analysis of how blockchain infrastructure—particularly smart contracts and the Kleros decentralized arbitration protocol—can be thoughtfully integrated into the early contractual stages of real estate transactions in Spain. These early stages, governed by private agreements such as reservation contracts and *contratos de arras*, are often executed without prior notarial or judicial oversight and thus carry a substantial degree of financial and legal vulnerability for the parties involved. The findings demonstrate that when such blockchain-based mechanisms are properly harmonized with existing Spanish legal norms, they can significantly enhance transparency, procedural fairness, and enforceability in this critical phase of the real estate process.

A central contribution of this work is the development of a **dual implementation model** for the use of the Kleros Escrow product, which accommodates both technologically sophisticated users and those operating within conventional legal frameworks:

- **Crypto-Native Peer-to-Peer (P2P) Transactions** allow experienced users to autonomously deploy the Kleros Escrow smart contract and conduct all stages of the transaction using their own blockchain wallets (e.g., MetaMask). Despite the absence of intermediaries, this model still recommends the inclusion of a lawyer to draft a parallel private agreement to ensure legal clarity and consistency between the smart contract code and the civil law obligations.

- **Law-Firm–Facilitated Transactions** provide a fully compliant alternative for general users. Here, a licensed law firm assists with configuring the smart contract, drafting the private legal agreement, and fulfilling Anti-Money Laundering (AML) and Know Your Customer (KYC) obligations under Spanish and EU law. The firm does not take custody of funds, but functions as a regulatory and technical facilitator, thus falling within the category of "obligated subjects" under Law 10/2010.

In both scenarios, the architecture of the transaction is anchored in a **non-custodial smart contract deployed on Ethereum**, with conditions for deposit release, dispute triggers, and arbitration clauses codified directly in the contract logic. This system follows a standardized procedural lifecycle:

1. **Agreement and Encoding:** Contractual terms are defined and incorporated into both a legally valid private contract and a blockchain-based smart contract.

2. **Deposit and Execution Monitoring:** Funds are locked in the smart contract until conditions are met.

3. **Confirmation or Dispute:** Upon mutual confirmation, the funds are released; in case of dispute, the matter is submitted to Kleros arbitration.

4. **Decentralized Arbitration:** Jurors selected from the Kleros Court examine the evidence and issue a decision based on economic incentives, game theory, and majority consensus.

5. **Smart Contract Enforcement:** The outcome is executed autonomously on-chain, and an immutable record is preserved for legal and evidentiary purposes.

From a legal standpoint, this model is compatible with Spanish civil law. Smart contracts satisfy the essential requirements for contractual validity—consent, object, and cause—as per Articles 1254–1261 of the Civil Code. Parties may freely determine their dispute resolution mechanisms under Article 1255, so long as public order is not violated. Furthermore, the recent enactment of **Ley Orgánica 1/2025**, which introduces **Medios Adecuados de Solución de Controversias (MASCs)** into the Spanish legal system, reinforces the viability of using decentralized arbitration platforms like Kleros, provided the parties have expressly agreed to this mechanism in their contract.

Importantly, this paper does not suggest replacing traditional institutions such as notaries or the Land Registry. Under current Spanish law, the conveyance of real estate requires a **public deed executed before a notary** and **subsequent registration in the Land Registry** (Registro de la Propiedad) to be legally effective and opposable to third parties. These requirements remain indispensable. However, the proposed system complements these formalities by addressing a previously unregulated legal grey zone: the pre-notarial deposit phase. This is the stage most susceptible to fraud, asymmetry of information, and dispute—particularly for foreign buyers or individuals unfamiliar with Spanish legal procedures.

Furthermore, the paper notes that while notaries currently send a digital copy of the public deed to the Land Registry, actual registration is not automatic and may take several weeks. This gap presents a residual legal risk, as a seller could, in theory, sign multiple deeds in a short timeframe. Although the first deed would remain legally binding, the delay in inscription creates procedural uncertainty. Future legal reform could explore the integration of blockchain-based deed metadata or automatic registration triggers, which would enhance efficiency and reduce systemic vulnerability.

In conclusion, this study argues for a **hybrid legal-tech model** that integrates blockchain infrastructure and decentralized arbitration into Spain's real estate ecosystem in a legally sound and operationally practical manner. Far from disrupting the legal order, these technologies reinforce its core principles: contractual autonomy, legal certainty, and equitable dispute resolution. The dual implementation model—one legally assisted, one P2P—broadens the accessibility and scalability of the solution, offering actionable pathways for lawyers, notaries, real estate professionals, technologists, and policymakers alike. As such, the proposed framework is not only technologically innovative but legally coherent, institutionally compatible, and structurally aligned with both present needs and future advancements in property law.

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