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From Paper to Blockchain: Smart Contracts and the Future of Real Estate Law in Moroccan Legislation

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Abstract. Blockchain technology and self-executing "smart contracts" promise to transform real estate conveyancing by replacing paper deeds, professional intermediaries, and land registration procedures with automated code. Proponents describe this shift through the maxim "Code is Law", suggesting that automated agreements can operate independently of, and eventually displace, national legal systems. This article states that such a claim is legally untenable, and dangerously so when applied to Property rights and the housing market. Building on a functional analysis of smart contract technology and on the mandatory rules that structure property and tenancy relationships, the article argues that a smart contract is an executory instrument, not a source of legal validity: it presupposes, rather than replaces, a legal order capable of determining capacity, consent, and enforceability, and it cannot lawfully override protective statutory rules. The article then evaluates Morocco's legal framework for electronic transactions and land registration, identifies significant regulatory gaps concerning blockchain-based real estate transfers, and proposes a hybrid legal and technical framework capable of reconciling technological innovation with the imperatives of legal certainty and social protection.

Keywords: *Smart contract; Property rights; Land registration; Real estate market; Blockchain*

1. Introduction

Real estate is undergoing a structural transformation driven by the emergence of "smart cities", in which networked services and transactions are integrated into the daily management of urban space. Within this movement, blockchain technology and the "smart contracts" it supports are increasingly presented for simplifying the transfer, financing, and leasing of property by reducing the role of intermediaries and automating the performance of contractual obligations.

The notion of a smart contract itself is not new. As early as 1996, the computer scientist and jurist Nick Szabo defined it as a computerized transaction protocol that executes the terms of an agreement (Szabo; 1996). Two decades later, in the specific context of blockchain platforms, Gideon Greenspan refined the definition: a smart contract is a piece of code stored on a blockchain, triggered by blockchain transactions, which reads and writes data to that blockchain's database (Greenspan; 2016). Understood in this way, a smart contract is a computer program with self-verifying, self-executing and tamper-resistant properties: once its conditions are met, it transfers assets and records the transaction automatically, without requiring further human intervention.

This technical description has fueled a much older debate: whether parties can organize their transactions independently of the state and of national legal systems. Commentators sympathetic to distributed-ledger technology have argued that smart contracts do not need a legal system to exist and that, as a technological alternative to legal enforcement, they may operate entirely outside any overarching legal framework (Savelyev, 2017). Former Russian Prime Minister Dmitry Medvedev captured this ambition when he described smart contracts as systems that "live

by their own rules, beyond the boundaries of law"[1]. The attraction of this "Code is Law" narrative for real estate is easy to understand property transactions are notoriously slow, paper-intensive, and dependent on notaries, registries, banks, and brokers whose intervention adds cost, delay, and the risk of human error.

Yet the same literature acknowledges that the cross-border architecture of blockchain networks, operated simultaneously by computers located in different jurisdictions, makes it particularly difficult to identify which national law, if any, governs a given transaction[2]. This difficulty is compounded, in the specific field of housing, by the fact that most legal systems attach mandatory, Unassailable rules to the residential lease and to the transfer of real property, precisely because one contracting party, the tenant, the consumer, the non-professional buyer, is structurally weaker than the other. A purely technological account of the smart contract, built on the promise that code alone can constitute and enforce legal obligations, is therefore bound to collide with this body of protective and formal rules.

Therefore, the question this article can accordingly be framed is: Can smart contracts govern real estate transactions independently of the ordinary rules of contract and property law; and, if not, does Moroccan law currently offer an adequate normative framework for the safe and lawful integration of this technology into the housing market?

The question is not merely theoretical. Morocco has, since 2007[3], built a legal architecture for electronic transactions and has, since 2011[4], unified its law of real rights[5] in a single code; at the same time, its land registration system remains a paradigmatic example of a formal, state-controlled registry of the kind that blockchain enthusiasts propose to bypass. Assessing the compatibility between the two models is directly relevant to Moroccan legislators, notaries, banks, and property professionals.

Hence, the originality of this article lies in its approach: rather than asking whether a smart contract is a valid contract, it examines whether it can produce real property effects under Law No.39.08 on real rights and the land registration regime. The debate on smart contracts in Morocco has so far treated them as a matter of general contract law, focusing on consent, electronic signature and evidence. What it has not addressed is the setting where the technology is most disruptive: a system in which the transfer of real rights depends on formal instruments and on registration by the state. This change of angle is the article's main original contribution. It shows that the obstacle lies less in the formation of the contract than in the rules that give property transactions their legal effect against third parties: formalities, professional intervention, publicity and the state's guarantee of title. Building on this analysis, the article offers a targeted framework for Morocco, identifying which stages of a real estate transaction can safely be

[1]Dmitry Medvedev remarks on the evolution of law and technology, as cited in Alexander Savelyev, Contract Law 2.0: «smart» contracts as the beginning of the end of classic contract law, Basic Research Program Working Papers 118.IN Contract Law 2.0: «Smart» Contracts As the Beginning of the End of Classic Contract Law by Alexander Savelyev :: SSRN

[2]Savelyev is discussing the cross-border character of distributed-ledger transactions and the resulting difficulty of localizing the applicable law.

[3] Dahir No. 1-07-129 of 19 Kaada 1428 (30 November 2007) promulgating Law No. 53-05 on the Electronic Exchange of Legal Data, Official Bulletin No. 5584 (5 December 2007).

[4] Dahir No. 1-11-177 of 25 Hija 1432 (22 November 2011) promulgating Law No. 14-07 amending and supplementing the Dahir of 9 Ramadan 1331 (12 August 1913) on Land Registration, Official Bulletin No. 6004 (15 December 2011).

[5] Dahir No. 1-11-178 of 25 Hija 1432 (22 November 2011) promulgating Law No. 39-08 on the Code of Real Rights, Official Bulletin No. 6152 (3 May 2012).

automated, which must remain under notarial and registry control, and what legislative adjustments would be needed to connect the two. The article is thus not a general assessment of blockchain technology, but a test of its compatibility with a specific and demanding legal system.

This article adopts a doctrinal legal method complemented by a functional comparative approach. The doctrinal analysis examines the Moroccan legal framework governing real estate and electronic transactions, with reference to the Code of Obligations and Contracts, Law No. 53-05 on electronic data exchange, Law No. 39-08 on the Code of Real Rights, and the 1913 Land Registration Dahir as amended by Law No. 14-07. These sources are analyzed to assess the legal requirements governing contractual validity, proof, registration, and property rights. The functional comparative approach then examines how other legal systems address similar issues relating to smart contracts, electronic transactions, authentication, and real estate registration, in order to identify potential legal gaps and avenues for adapting Moroccan law to blockchain-based real estate transactions.

These two methods shape the structure of the discussion. The first part examines the technological promise of an autonomous contractual order for real estate, presenting the architecture and functional features of smart contracts (I.A) before analyzing the "Code is Law" paradigm and its specific attraction for property markets (I.B). The second part demonstrates the persistence of legal necessity: it identifies the structural limits that mandatory and protective rules impose on any purely automated contract (II.A) and evaluates, against this standard, the adequacy of the Moroccan legal framework, before formulating proposals for its reform (II.B).

2. The Technological Promise of an Autonomous Contractual Order for Real Estate

a. The Legal Foundations and Functional Features of Smart Contracts

A smart contract is, technically, a piece of software executed within a blockchain system, whose sequence of operations is validated by a consensus protocol shared among the network's participants. Consensus itself is not a purely technical notion: it designates a group decision-making process oriented towards agreement, cooperation, and inclusiveness among network participants who do not necessarily know or trust one another. Because performance is entrusted to a computer program rather than to a human agent, the parties to a smart contract can, in principle, obtain near-instantaneous payment or transfer of an asset as soon as the contractual conditions are satisfied, with every update to the agreement recorded on the ledger in real time.

The doctrine identifies several features that distinguish the smart contract from the classic paper or electronic agreement (Greenspan , 2016). First, it's *purely electronic* nature: unlike ordinary contracts, which may be concluded orally, in writing, or through hybrid electronic-paper arrangements, a smart contract exists only as code and cannot be reduced to any other form. Second, it is *software-implemented*: the contractual terms are themselves written into a computer language, an arrangement that the principle of freedom of contract does not, as such, prohibit. Third, it offers *increased certainty*, because computer languages are formal languages with strictly defined syntax and semantics that leave no room for interpretative discretion by the machine executing them. Fourth, it is *conditional* in structure, built on "if-then" statements that mirror the conditional logic of many contractual clauses. Fifth, it is *self-enforcing*: once concluded, its execution no longer depends on the continuing will of the parties or of any third party, which eliminates the risk of opportunistic non-performance or "efficient breach". Sixth, it is, at least in its purest form, *self-sufficient*, in the sense that it does not require courts, bailiffs or a body of default and mandatory rules to supplement its own terms (Mykyta, 2018).

Applied to real estate, these features translate into concrete use cases that go well beyond automated rent collection. Once information relating to title is recorded on a blockchain, its proponents argue, an owner could transfer the property directly, without further interaction with a public registry (Parth et al., 2020), each successive transfer building out an immutable chain of title; escrow-triggered payments could replace notary-held deposits; and the resulting gains in transparency and traceability are said to be capable of reducing transaction costs and even insurance premiums associated with title disputes. These are not purely speculative propositions. Between 2016 and 2018, the Swedish land registry authority conducted, with several banking and technology partners, a real pilot in which a residential sale was tracked on a blockchain from the signature of the preliminary agreement to its completion, with projected savings estimated in the hundreds of millions of euros for the national economy[6]; a comparable pilot was launched by the land registry of Georgia in partnership with the blockchain firm Bitfury[7].

Both experiments illustrate the genuine efficiency gains that motivate the transposition of smart contracts to the property sector and explain why technology cannot simply be dismissed by legal scholarship as a passing curiosity.

b. The "Code is Law" Paradigm and Its Attraction for Real Estate Markets

The technical features described above have given rise to a normative claim that goes beyond mere efficiency: the idea, often summarized as "Code is Law", that a sufficiently well-drafted smart contract renders the intervention of courts, notaries and public registries unnecessary. On this view, the blockchain itself supplies what national legal systems traditionally supply - certainty as to the existence, content and performance of an obligation and does so more reliably, because a computer, unlike a bank officer, a legal clerk or a broker, does not misrecord a figure at its discretion or bias. Reducing or eliminating these "trust intermediaries" is presented as the principal economic benefit of blockchain-based real estate platforms, promising transactions that are simultaneously faster, cheaper and less prone to human error.

For real estate specifically, this narrative has appeal because the sector is unusually intermediary-heavy: notaries[8] or *adouls*[9] authenticate transfers, banks verify solvency and register mortgages, land registries certify title, and brokers coordinate the parties. Courts, lawyers and enforcement officers form, collectively, what economists describe as the institutional apparatus of contract enforcement; a blockchain-based smart contract, its advocates argue, can reproduce many of the same guarantees: proof, traceability, performance, while greatly reducing the costs historically associated with that apparatus, and thereby render blockchain-based property transactions more competitive than transactions conducted through traditional channels.

It would nonetheless be a mistake to conclude, from the fact that a smart contract can be carried out without human intervention, that it can also validly *exist* without reference to any legal system. As the following section demonstrates, the very authors who describe smart contracts as

[6]See the pilot conducted from 2016 by the Swedish National Land Survey (*Lantmäteriet*) together with ChromaWay, Telia, Kairos Future, SBAB and Landshypotek Bank, which recorded a real estate sale on a blockchain from preliminary agreement to completion; the consortium estimated potential annual savings for the Swedish economy in excess of €100 million. See ChromaWay/Kairos Future, *The Land Registry in the Blockchain Testbed* (2017).

[7]The National Agency of Public Registry of Georgia launched a comparable pilot with the blockchain firm Bitfury in 2016, extended by a 2017 memorandum of understanding to additional government registries.

[8] Dahir No. 1-11-179 of 25 Hija 1432 (22 November 2011) promulgating Law No. 32-09 on the Organisation of the Notarial Profession.

[9] Dahir No. 1-06-56 of 15 Moharram 1427 (14 February 2006) promulgating Law No. 16-03 on the Status of Adouls as its modified by the law 51.26 in 26 July 2026

self-sufficient in execution generally concede that they remain dependent, for their legal existence, on rules external to the code itself (Werbach and Cornell). The remainder of this article develops that distinction and draws out its consequences for the specific case of real estate.

3. Reclaiming the supremacy of the law of Real Estate over Smart Contracts

a. The Structural Limits of Smart Contracts

A closer examination of technology reveals that smart contracts are not independent of the law. Four structural limits illustrate why the "Code is Law. Based on this thesis, smart contracts cannot be transposed, without qualification, to the housing market.

First, the inability of code to self-certify legal validity, A smart contract is software that executes programmed instructions; it has no means of verifying whether the obligation it is executing was validly and enforceably created in the first place. It cannot, by itself, ascertain that the parties had the capacity to contract, that their consent was free of mistake, fraud or duress, or that the object and the reason for their agreement were lawful. The technical capacity to act, locking a door, transferring a token representing title, does not make the performance of that action legally permissible. In this sense, the smart contract presupposes, rather than replaces, an external body of rules capable of answering the antecedent question of validity (Werbach and Cornell, 2017).

Secondly, Housing law typically grants tenants, as the weaker contracting party, a body of statutory protection that a coded term cannot lawfully override. A smart contract programmed automatically to lock an apartment door upon a missed rent payment is invalid, for example, under German law: a landlord may not resort to self-help eviction merely because rent has fallen due; extraordinary termination without notice requires arrears equivalent to at least two months' rent[10], and even then, the landlord must obtain a court order for repossession, self-help repossession being independently prohibited[11]. A self-executing lock-out clause, however elegant its code, would therefore be unenforceable, and could expose the landlord to civil and even criminal liability.

Third, the primacy of mandatory consumer and tenancy rules under private international law, automated smart contract terms cannot be used to bypass statutory tenant protection through choice-of-law engineering. Although the general consumer-contract rule of the European Union's Rome I Regulation does not, as such, extend to tenancies of immovable property[12] which are instead generally governed by the law of the place where the property is situated, subject to a narrow exception for short-term private lettings[13], the Regulation's overriding mandatory provisions and public policy exceptions independently prevent a coded choice-of-law or performance clause from depriving a tenant of the mandatory protections of the state whose law would otherwise apply[14]. A smart contract's choice-of-law parameter is, in other words, no more immune to these constraints than an ordinary written clause.

[10]Bürgerliches Gesetzbuch (BGB), § 543(2), sentence 1, no. 3, and § 569(3).
[11]BGB, § 543(2), sentence 1, no. 3(b); on the prohibition of self-help repossession by the landlord, see BGB § 858 (*verbotene Eigenmacht*) and § 123 of the German Criminal Code (*Hausfriedensbruch*).
[12]Regulation (EC) No 593/2008 of the European Parliament and of the Council of 17 June 2008 on the law applicable to contractual obligations (Rome I), art. 6(4)(c).
[13]Rome I Regulation, art. 4(1)(c)-(d); a short-term private tenancy of no more than six consecutive months is instead governed, in the absence of choice, by the law of the landlord's habitual residence, provided the parties share that residence.
[14]Rome I Regulation, arts. 9 (overriding mandatory provisions) and 21 (public policy of the forum).

Finally, the irreducibility of human dispute[15] resolution as physical realities are inherent to housing: assessing damage to a property, determining what portion of a deposit should fairly be withheld, evaluating whether non-payment or disrepair cannot be assessed by code alone. A realistic blockchain-based housing architecture must therefore lock disputed funds in escrow and delegate the final apportionment to neutral human arbitrators or courts, reintroducing, at the critical moment of disagreement, precisely the human institutions the technology was designed to bypass.

Taken together, these four limits show that the promise examined in Part I must be reformulated: smart contracts do not dispense with law; at most, they displace some of its *execution* costs while leaving its *validity* and *protective* functions untouched. The question that follows is whether Moroccan law currently provides the framework needed to draw this distinction in practice.

b. The Moroccan Legal Framework: Between Digital Ambition and Regulatory Insufficiency

Any smart contract purporting to produce legal effects in Morocco must first satisfy the ordinary conditions of contract formation laid down by the Dahir formant Code des obligations et des contrats (D.O.C.) of 1913: capacity, free and informed consent, a determinate object, and a lawful cause[16]. Coded logic can express these elements but cannot, by itself, guarantee their satisfaction; the code executes what the parties are deemed to have agreed, but the deeming itself remains a question of ordinary contract law. Real property adds a further, specifically Moroccan, layer of formalism: since the entry into force of the Code of Real Rights in 2011, the transfer, creation or modification of a real right in immovable property must, to be valid, take the form of an authentic deed drawn up by a notary or by *adouls* -a private instrument no longer suffices[17]. A smart contract that purports to transfer title automatically, without the intervention of these authenticating officers, would accordingly run directly against a mandatory formal requirement of Moroccan property law, quite independently of any question of blockchain technology as such.

As a result, the land registration system's exclusivity became a strict requirement reinforced by Morocco's land registration Law. Since 1913, registered immovable property has been subject to a constitutive registration system, administered today by the National Agency for Land Conservation, Cadastral Surveys, and Cartography, under which the entry recorded in the land register determines and guarantees title ownership against illegal acquisition of property by third parties[18].

This reality, echoed in some blockchain literature, of an owner transferring property "without any further interaction with the registry" once title is recorded on a distributed ledger is, under current Moroccan law, simply incompatible with this constitutive function of the ANCFCC

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[15] Wilkinson, Susannah and Giuffre, Jacques, Six Levels of Contract Automation: The Evolution to Smart Legal Contracts - Further Analysis (March 30, 2021). Available at SSRN: https://ssrn.com/abstract=3815445 or http://dx.doi.org/10.2139/ssrn.3815445

[16] Dahir of Obligations and Contracts (D.O.C.), 9 Ramadan 1331 (12 August 1913), as amended, arts. 2-3 (consent), 61-65 (cause) and 488 et seq. (sale).

[17] The real rights code states that the notary acts . governing the required authentic form (notarial or *adoul* deed) for the transfer, creation or modification of a real right in immovable property.

[1818] Dahir No. 1-11-177 of 25 Hija 1432 (22 November 2011) promulgating Law No. 14-07 amending and supplementing the Dahir of 9 Ramadan 1331 (12 August 1913) on Land Registration, Official Bulletin No. 6004 (15 December 2011)., as substantially amended by Loi n° 14-07, establishing a constitutive (Torrens-style) land registration system administered by the Agence Nationale de la Conservation Foncière, du Cadastre et de la Cartographie (ANCFCC).

register: a blockchain entry can, at most, mirror or evidence what the register records; it cannot substitute for it unless the legislator expressly grants blockchain entries equivalent legal effect, which Moroccan law does not currently do.

Moroccan law does not leave smart contracts in a legal loophole, but it does not address them specifically either. Its electronic-transactions framework rests on Law No. 53-05 on the electronic exchange of legal data, promulgated in 2007, which recognizes the legal value of electronic writings and defines the electronic signature and the cryptographic means and services capable of guaranteeing the confidentiality, authentication, and integrity of an electronic exchange. It has since been supplemented by Law No. 43-20 on trust services for electronic transactions, promulgated in 2020, which regulates electronic signatures at different levels of reliability, electronic seals, time-stamping and related trust services.

These texts, together with the general rules of the Code of Obligations and Contracts, can be applied to smart contracts by extension, in particular as regards consent, signature and proof. However, they were designed for electronic documents and signatures, not for self-executing code. None of them addresses automated execution, the recording of transactions on a distributed ledger, or the transfer of real rights through such a mechanism. The problem is therefore not the absence of any applicable law, but the absence of a framework adapted to smart contracts, particularly in real estate, where formalities and registration condition the validity and effects of the transaction.[19].

Therefore, law No. 43-20 on trust services for electronic transactions, promulgated at the end of 2020, modernized this framework, broadly comparable, in its aims, to the European Union's eIDAS regime, by replacing the earlier electronic-signature provisions with a graduated regime of simple, advanced and qualified electronic signatures, seals and time-stamping services, and by creating a national trust-services authority[20].

Both statutes, however, were conceived to secure classic bilateral electronic documents exchanged between identifiable parties; neither addresses the questions specific to a self-executing, code-based instrument: the legal qualification of code as a contractual term, the evidentiary value before Moroccan courts of an entry recorded on a distributed and often foreign-hosted ledger, the allocation of liability when a coding error produces an unintended transfer or an unlawful automated eviction, or the role of external data feeds ("oracles") that trigger execution.

Ultimately, the foregoing analysis highlights the need to rethink the existing legal framework and explore appropriate avenues for reform. The preceding analysis reveals a genuine normative gap rather than a mere technical lag: Moroccan law regulates the *signature* of an electronic document but not the *autonomous execution* of a coded obligation, and it maintains, for real property specifically, formal and registration requirements that a purely automated transfer cannot, as matters stand, satisfy. Bridging this gap does not require abandoning either the notarial/*adoul* system or the ANCFCC register; comparative experience suggests, instead, a layered approach[21]:

[19]Dahir No. 1-07-129 of 19 Kaada 1428 (November 30, 2007), promulgating Law No. 53-05 on the Electronic Exchange of Legal Data, Official Gazette No. 5584 (December 5, 2007), Arts. 8 and 12.
[20]Dahir No. 1-20-100 of 16 Jumada I 1442 (December 31, 2020), promulgating Law No. 43-20 on Trust Services for Electronic Transactions, Official Gazette No. 6970 (March 18, 2021).
[21]See notes 8-9 above and accompanying text.

- The legislator could extend Law No. 43-20, or adopt a dedicated statute, to define the legal status of smart contracts, requiring that any code-based instrument affecting a real right in immovable property be certified by a notary or *adoul* acting as a "legal oracle" before execution, thereby preserving the authentication function of Moroccan real property law within an automated environment.
- The blockchain records could be integrated with the ANCFCC register as an evidentiary and transparency layer, as in the Swedish and Georgian pilots, without displacing the constitutive effect of registration itself.
- Any template smart contract used in residential leasing should embed safeguards, such as a mandatory judicial or *adoul*-mediated step before any code-triggered restriction of a tenant's occupation, to prevent the automated eviction scenario described in Part II . from arising under Moroccan law.

These reforms presuppose institutional investment in cybersecurity, in the interoperability of ANCFCC systems with permissioned blockchain infrastructure, and in the training of judges, notaries and *adouls* called upon to interpret disputes arising from coded transactions.

4. Conclusion

The maxim "Code is Law" captures a genuine technological achievement, the ability of a computer program to perform contractual obligations reliably, transparently and without recourse to a human intermediary, but it overstates its legal significance. A smart contract can execute an obligation; it cannot, by itself, create one, verify the capacity or consent of the parties who purport to be bound by it, or override the mandatory rules that most legal systems attach to residential tenancies and to the transfer of real property. The comparative examples examined above German tenant protection law, the European Union's private international law of contract confirm that this limitation is not incidental but structural, and that it applies with force to housing, where one party is systematically protected as the weaker contracting party.

Morocco is not exempt from this structural limitation, and its current legal framework, while advanced in certain respects, does not yet resolve it. The Code of Real Rights requires an authentic notarial or *adoul* deed for any transfer of a real right in immovable property; the land registration system administered by the ANCFCC remains constitutive of title; and the successive statutes on electronic exchange and trust services, useful as they are for securing conventional electronic documents, do not address the qualification, evidentiary treatment or liability regime specific to self-executing code. Reconciling Morocco's ambition to modernize its property market with the imperatives of legal certainty and tenant protection accordingly calls not for a wholesale substitution of code for law, but for a deliberate legislative and institutional effort to integrate blockchain infrastructure into the existing architecture of authentication and registration, allowing the technology to accelerate and secure the *execution* of real estate transactions, while leaving their *validity* and their protective legal framework firmly in the hands of the law.

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