

Legal challenges and opportunities of blockchain technology in the real estate sector

Blockchain
technology in
the real estate
sector

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Received 29 July 2019
Revised 25 November 2019
Accepted 26 November 2019

Abstract

Purpose – Blockchain, which was originally created to enable peer-to-peer digital payment systems (bitcoin), is considered to have several benefits for different sectors, such as the real estate one. In a standard European-wide real estate transaction, several intermediaries are involved. As a consequence, these agreements are usually time-consuming and involve extra difficulties to cross-border operations. As blockchain, combined with smart contracts, may have an important role in these transactions, this paper aims to explore its prospective challenges, limitations and opportunities in the real estate sector and discover how the traditional intermediaries have to face a possible implementation of this technology.

Design/methodology/approach – This paper analyses the current intermediaries in the real estate sector in European Union (EU), their functions and how can blockchain strengthen the security of these transactions while reducing their time. The author uses a legal methodology to approach it.

Findings – Blockchain, combined with smart contracts, has both challenges and opportunities for the real estate sector. On the one hand, it may improve procedures, allow EU transactions and the interconnection between public administration. However, to not reduce parties rights, this blockchain should have some special features, such as the possibility of being amended.

Originality/value – This paper provides a valuable overview of all the intermediaries that could be affected by blockchain protocols. It is of interest of blockchain developers, public administrations and researchers who are working on blockchain and property conveyancing.

Keywords Real estate, Land registry, Blockchain, Sharing economy, Rental contracts, Tokenization

Paper type Research paper

1. Introduction

Blockchain is increasingly becoming of interest for several sectors (Chichester, 2017). Although originally created to bypass the traditional intermediaries in currency issuance (De Filippi and Wright, 2018), academics, governments and stakeholders envisaged the potential opportunities that this technology offers for their own activities. Even the financial sector, which was the one most directly affected by the creation of the bitcoin currency and therefore the blockchain systems, considered this technology as an opportunity for improving their processes as well as lowering their expenses[1].

The interest in this technology has been reflected in a range of projects that are testing the feasibility of its use (Leloup, 2017). Digital payments, commercial registries, social



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Journal of Property, Planning and
Environmental Law
Vol. 12 No. 2, 2020
pp. 129-145
Emerald Publishing Limited
2514-9407
DOI 10.1108/JPPLEL-07-2019-0039

media, insurances, public administration or healthcare are only some examples of blockchain applications. For example, the Government of Estonia is using blockchain to secure health records, and the UK considered a blockchain to pay and control research grants in 2016. And the Catalan Government recently published the “Catalan Blockchain Strategy”, which aims at implementing a blockchain ecosystem for this regional administration, including an ID system, sharing of health data to boost body organ’s donations and a system to share self-consumption energy through blockchain[2].

Moreover, seven European Union (EU) countries (Cyprus, France, Greece, Italy, Malta, Portugal and Spain) signed in December 2018 a Ministerial Declaration on Distributed Ledger Technologies. In this declaration, these EU Countries confirm that “any legislation on Distributed Ledger Technologies should take into account the decentralized nature of such technology and should be based on European fundamental principles and technological neutrality”[3]. This led to some of them to enact some pieces of legislation related to this technology, such as *Virtual Financial Assets Act* of Malta (01 January 2018) or the *Legge* n. 12, of 11 February 2019, in Italy. For the purposes of this paper, we will concentrate, however, on the fact that real estate conveyancing is also experiencing the use of blockchain and smart contracts, a phenomenon which is being called “proptech” (Nasarre-Aznar, 2018).

Indeed, the cases of uses of this technology focus on different stages of the real estate conveyancing process. Regarding land registration, land registrars from Sweden, New South Wales (Australia), GA and the UK, among others[4], are already exploring the use of blockchain for title registration or for certain covenants. In addition, some private companies are studying the possibility of completing the entire process required to sell a property through a distributed ledger, such as Household, Averspace, Urbit Data, Zillios or Velow.re, which is a permissionless real estate blockchain working on a pilot project at Cook County (USA), thanks to the partnership with the Cook County Recorder of Deeds. The rental sector is also implementing this technology through the consortium between the municipality of Rotterdam, the Cambridge Innovation Centre and Deloitte (Veuger, 2018), in addition to the Rentberry (an application that uses blockchain for renting properties), Elea.io, Midasium and Placetorent. The “tokenisation” of mortgages and property is also being tested (Homelend, Pangea, Atlant): the term “tokenisation” is used to describe the process in which a certain right (e.g. ownership) is included into a “token” or coloured coin, so that the transmission of a token involves the acquisition of the right included.

All these initiatives, in particular the private ones (Household, Rentberry, Homelend, etc.), agree on the potential impact of blockchain technology on the real estate sector and the need to discontinue the traditional processes, to get rid of costly intermediaries. By way of example, the company Atlant[5], who is implementing the tokenisation of property, confirms that blockchain technology is the best way to achieve a proper adoption of the sharing economy while making real estate transactions more transparent, providing liquidity for the trading of these types of assets, enhancing cross-border transactions and also alleviating tax inefficiencies. In the same way, Ethernity[6] confirms that “the traditional illiquidity in real estate markets is made relatively easier to liquidate by the Ethernity trading platform, where buyers and sellers can quickly purchase and sell”. The impact on this sector might be representative because of its importance in the economy: according to the [European Commission \(2015\)](#), “the contribution of the real estate sector to national economies’ production ranged in 2012 from 5,7 per cent of total value added produced in Lithuania to 15,8 per cent in Greece” and the real estate sector grew more than the economy as a whole”.

In short, they all justify their creation in the need to shake up and revolutionise the real estate sector. However, is this prospective disruption ensuring the rights of buyers/tenants

when acquiring a property? Are these projects going to positively contribute to the real estate market and, more specifically, to facilitating access to housing for citizens or even to safeguarding their right to housing? Is there room for ensuring a real cross-border acquisition of property between citizens of different member states? Taking into account these questions, this paper aims at exploring, from a legal perspective, the prospective challenges, limitations and opportunities of blockchain applications in the real estate sector, and discover how the traditional intermediaries have to face a possible implementation of this technology, which could make real estate conveyancing faster, more effective and more affordable for the contracting parties, even boosting cross-border operations, the number of which remains very low within the EU. To do so, this paper is firstly based on previous legal results regarding real estate conveyancing systems in Europe ([Schmid et al., 2007](#); [European Commission, 2018](#)), and it then analyses how implementing disintermediation through the use of distributed ledgers would affect this sector and proposes measures to prevent a reduction of the rights of the affected parties.

2. Current intermediaries and other public services involved in a real estate transaction

2.1 General aspects

Real estate conveyance is a heterogeneous phenomenon in which several intermediaries and public services might be involved, depending on the type of transaction, on the step being taken as well as on the country. Indeed, every EU country has its own process and requirements, which is one of the reasons why cross-border transactions are decidedly difficult to accomplish, even taking into account the high number of projects intended to do so, such as the European Land Information Service (EULIS), abolished in 2018, the IMOLA I and II (Interoperability Model for Land Registers), CROBECO, as well as the EU Parliament's "Cross-border acquisition of residential property in the EU: problems encountered by citizens" ([Sparkes et al., 2016](#)).

It is thus essential to make a distinction, when analysing the possible impact of blockchain technology on the real estate sector, between the type of transaction and the country. Here, long- and short-term rentals as well as the purchase of property and mortgages from a civil law perspective are covered.

2.2 The role of intermediaries in the acquisition of property and the creation of mortgages

In a first step, parties might hire a real estate agent, the professional who helps them when finding or selling/renting a property and concluding a specific contract, which is, in fact, a reserved activity in some countries (Belgium – BE, Germany – DE, Ireland – IE and France – FR), according to the [European Commission \(2015\)](#). The involvement of other intermediaries and their respective roles in concluding the transaction depends on the system, which might be classified as follows:

- the Latin notary system, which is applicable in western continental countries. In these countries, a notary must or should participate to undertake various different functions: first, to verify the identity of the parties, while preventing fraudulent sales, money laundering or funding of illegal activities. Second, to prevent premature contracting though the provision of legal advice and consumer protection. Third, securing titles, thus ensuring that the purchase is going to be effective through the checking of the registered titles, securing priority and ensuring that the registration formalities are properly followed. And fourth, ensuring the legality of land transactions, which significantly reduces judicial disputes ([Sparkes et al., 2016](#)). In some cases, the

participation of a notary is mandatory (in The Netherlands, – NL, Poland – PL, Switzerland – CH, BE and DE). In Spain (ES), it is voluntary, except in the case of mortgaging a property (parties need a public deed to register this mortgage), but it is actually common practice for the purpose of parties' protection;

- the central and eastern European system, which mainly depend on Latin notaries, but also involves lawyers in the Czech Republic (CZ) and Hungary (HU).
- the system of solicitors or licensed conveyancers in England and Ireland. They are obliged to provide transactional advice on the title, financial aspects, tax and public law, thus being liable if they fail to do so; and
- the system of the Nordic countries, in which the whole process is completed by real estate agents (who in the majority of cases, provide both real estate and legal counselling) or lawyers.

Once the transaction has been completed, it may be registered in the land registry, by “the competent authority for registering the transfer of ownership and the creation of interests in land” (Schmid and Hertel, 2005). It provides security of tenure and information to both the administration and individuals, about the object (e.g. a piece of land), the rights over this object (e.g. rights in rem, ownership, mortgage) and about the subjects of these rights (Vos *et al.*, 2017). The land registry is kept by an independent public authority (PT, ES, BE, NL and Lithuania – LT), by the courts (DE, PL, Austria – AU, etc.) or by a public authority subject to instructions (CH) (Stöcker and Stürner, 2008). The validity of a real property usually does not depend on the registration (ES, PL, BE), with the exception of some countries that do require this (DE, NL, CH, etc.) or with the possible exception of the creation of a mortgage (in ES, for example, the mortgage must be registered to be valid).

Although it is an option, the involvement of these professionals is not compulsory in the majority of countries, that is, a transaction can be legally concluded without their participation, which gives room for the use of blockchain. However, regarding real estate agents, the ZERP Study of Conveyancing Services concluded that around 70 per cent of transactions were facilitated by them (Schmid *et al.*, 2007). In addition, in Spain and Poland, a public deed is only necessary if parties want to register their right (which is only compulsory in mortgages), but not when conveyancing real property or when leasing a dwelling (although it is quite common to do so because of the legal certainty that it provides). Also in Italy (IT), Luxembourg (LX), Portugal (PT), FR and BE even oral contracts are valid, but if parties want to register the agreement, they have to obtain a public deed. In Slovenia (SL), Slovakia (SK), AU and CZ, parties need a certificate that validates their signatures, which is issued by a notary (SL, SK) or by a court (AT, CZ) to register the contract.

When acquiring a property through a mortgage loan, the number of professionals involved increases. Apart from the optional use of attorneys, who draft the contract and assist the parties, and managers, who are in charge of paying taxes and other bureaucratic paperwork, it requires the involvement of a property valuator and the bank that grants the mortgage to acquire the property. Furthermore, as commented above, the granting of a mortgage is one of the cases where in some jurisdictions it is necessary to have the agreement documented by a notary and entered into the land registry (e.g. in Spain, art. 145 *Ley Hipotecaria* 1946[7]). Thus, the granting of mortgages through a blockchain would be a more complex case, as either a connection with current registries or an amendment of existing legislation would need to be implemented.

2.3 The role of intermediaries in rental contracts

In general, rental contracts do not require the participation of intermediaries, although these contracts are often concluded with the assistance of real estate agents and attorneys when drafting the contract. They usually do not require to be entered into a land registry (Hoekstra and Cornette, 2014; Cornelius and Rzeznik, 2014), but shall be communicated to authorities for taxation issues (Bianchi, 2014). In addition, some jurisdictions, such as Belgium, require their registration in some sort of administrative registries but failure to enter the contracts into these registers does challenge the validity of the contract (Haffner and Bounjough, 2014).

Regardless of not being compulsory, the registration of tenancy agreements in the land registry is a possibility in several EU countries, such as in AT (Section 1095 ABGB, Austrian Civil Code), Spain (Article 2.5 *Ley Hipotecaria*) and in IT (Article 2643 Italian Civil Code), when the term of the contract is longer than nine years. However, it is not common to find tenancy contracts registered there (Prado Gascó, 2017). Consequently, the involvement of notaries and subsequently land registers in rental contracts is not representative of standard practices. Taking into account this lack of registration, blockchain might offer a way of diminishing black market activity in tenancy agreements, which, in some countries, is rather high (in Spain, 38.6 per cent[8]), while reducing tax evasion and avoiding tenant's legal unprotection.

In Table I, one can see the degree of involvement of specified middlemen in each of three proposed cases, when renting or purchasing property and when acquiring property with a mortgage loan.

Intermediaries/ transaction	Real estate agent	Notary	Land registry	Other
Renting a property	Common practice	Not a common practice	Not a common practice	An administrative registry might be compulsory (e.g. registry of bad landlords or registry of deposits)
Purchase a property	Common practice	Common practice (in countries where they exist). If parties intend to register their rights, a notarial deed is usually required to do so (ES, DE)	Common practice. In some countries, registration is compulsory (DE, NL, CH)	In some countries, although registration is not compulsory, parties need to validate their signatures before a notary to access the land registry (e.g. FR, IT, LX, PT)
Purchase a property with mortgage loan	Real estate agents in Nordic countries are usually involved in this process; this is normally due to the shortage of notaries. In other countries, it is common practice to use a real estate agent	Compulsory in some countries	Compulsory in some countries	When mortgaging a property, the participation of a bank and a property valuator is also required

Source: Own elaboration

Table I.
Intermediaries in real estate conveyancing

3. Opportunities offered by blockchain for real estate conveyancing

Blockchain has some characteristics that might contribute to faster, more secure transactions. It is a distributed ledger that exists in all the devices connected to the network. It is cryptographically protected and organised in a chain of transactions. It is decentralised and disintermediated, in such a way that no central authority validates transactions, but rather, this is done by the other computers connected to the network that accept the transactions. It is immutable or, at least, tamper-resistant, so it is not possible to change or eliminate a block. It, therefore, provides trust and transparency, as everyone may check that a certain transaction exists and that it has not been changed, even though no central authority is involved.

Within this general concept, one might find different types of blockchain, such as the private and public ones. The public ones (e.g. Bitcoin) allow any person to connect to the network, to check the information included in the blockchain and to validate transactions, whereas a private one allows only certain people to use it, and a person or an authority manages it. Private blockchains might be also distributed but not decentralised, because their governance is not open, but reserved to a specific person or authority (Preukschat, 2017). Moreover, one might also find hybrid blockchains, i.e. those ones that combine elements of both, such as a blockchain that is privately maintained but publicly accessible.

Blockchains also vary depending on the validation process. A blockchain is permissionless when any user of the network can validate the transaction (e.g. mining bitcoins). On the other hand, a permissioned blockchain allows only certain users to validate the transaction. Normally, private blockchains are permissioned, and public ones permissionless. That is why, these two concepts are indistinctly used. The use of a public or a private blockchain, permissioned or permissionless, depends on the functionalities that the network wants to achieve. However, because blockchain arose as a tool to provide trust to parties that do not know each other, private blockchains could be considered less disruptive and innovative (Gabison, 2016). If a central authority controls access to the network or the mining process of a blockchain, then the functionalities of this technology are less useful, as this authority is already providing trust.

In addition, smart contracts play an important role in blockchain applications. Smart contracts are computer programs, whose codes allow for the automatization of specific processes. An example of it is a simple purchase of cryptocurrency. The smart contract will detect if the buyer's wallet has enough funds. If so, the transfer of cryptocurrency will be carried out. Nick Szabo gave an early definition of smart contracts in 1997 (Szabo, 1997) as:

[...] many kinds of contractual clauses (such as collateral, bonding, delineation of property rights, etc.) can be embedded in the hardware and software we deal with, in such a way as to make breach of contract expensive (if desired, sometimes prohibitively so) for the breacher.

Indeed, smart contracts might include several kinds of clauses to design more complex transactions (e.g. payment of loans) and, as they run through a blockchain system, these transactions are secure, trusted and enforced without a third party. Ethereum was the first blockchain protocol to allow users to write smart contracts through Solidity language, but other protocols are also offering this possibility, such as NXT (public blockchain) or Corda (private blockchain). Thus, with several smart contracts interconnected, for example, with the public administration institutions, parties would be able to automatically check the solvency of the debtor in public registries, make automatic payments related to the contract, contact water and power supplies and pay any required taxes, while simultaneously registering the contract.

One of the first questions that one should consider when thinking about real estate conveyancing through blockchain, is whether its use is necessary or not and what opportunities are available to implement it. Wüst and Gervais already defined in which cases a certain sector needs or does not need a blockchain:

In general, using an open or permissioned blockchain only makes sense when multiple mutually mistrusting entities want to interact and change the state of a system, and are not willing to agree on an online trusted third party (Wüst and Gervais, 2017).

The authors also assess the possible implementation of a land registry running on blockchain and say that:

In particular in countries where corruption might dominate and the integrity of official documents could be questionable, the use of blockchain could potentially help to provide more transparency through public verifiability. As such, several projects have started to secure land titles on a blockchain, but to date it is unclear to what extent these projects will sustain a wider adoption.

Is there room for blockchain in systems like the ones in place in the EU countries, in which notaries and land registers are trusted parties and have ensured transactions for years? The possible opportunities in the EU are more limited than in some countries where the state is untrusted, even taking into account that those ones have the problem to agree on who are the current owners of given pieces of land, and that they should do an expensive and tedious effort to collect all the data, which is not available nowadays. However, the implementation of a conveyancing system through blockchain, in which smart contracts are used from the beginning (pre-contractual phase, property valuation^[9]) through to the registration of the title or deed, might have several potential uses because of its aforementioned features. Otherwise, the implementation of a blockchain to handle only one of the steps (e.g. only the registration) might mean there is no significant benefit for the real estate conveyancing system, in having part of the process in blockchain and other parts outside it.

One of the most important benefits of allowing a complete conveyancing transaction to run through blockchain and smart contracts is the possibility of creating a blockchain for EU real estate conveyance, thus achieving true cross-border transactions (Nasarre-Aznar, 2018). This need is justified by the fact that, in some countries, the share of foreigners acquiring real estate is quite substantial (in Spain, 12.6 per cent, according to stats from *Registradores de España*, 2018). Blockchain's features might cover some of the functions that the intermediaries undertake in the purchase: blockchain is a way to notarise documents, as it ensures the legality of the documents and certifies that they were agreed on a certain date. It is also capable of verifying the identity of the parties when connected to an official identity (ID). Blockchain can transmit data related to the object (piece of land), the titleholder (when connected to an official ID) and to the right (ownership) (Vos *et al.*, 2017). It can also ensure that the individual who sells a property has the right to do so by verifying the chain of transactions. In fact, Act 157/2016, passed in Vermont (USA) recognises the legality of deeds on blockchain and presumes their validity.

Moreover, undertaking real estate conveyance through blockchain might provide faster procedures and less paperwork: according to the NAR report (2017), paperwork is a concern for 24 per cent of the population in the USA when buying a property, being one of the main concerns for the millennial generation. Blockchain and smart contracts might allow for automatic payments, the lodging of rental income, contract registration and automatic payment of taxes, thus being an opportunity to promote the registration of rental agreements while reducing the black market. Furthermore, these smart contracts might be connected to smart locks, such as proposed by the project RemoteLock, thus facilitating the physical access to the purchased or rented dwelling with a smartphone, or easing the

management of properties by real estate agents. Another opportunity might be the reduction of costs. The Latin notary system is the most expensive method of conveyance because of high levels of regulation (Schmid *et al.*, 2007). In relation to land registration, according to Goldman Sachs, “blockchain driven property records could drive up to \$4bn in cost savings due to reductions in headcount and actuarial risk in the US alone” (Schneider *et al.*, 2016).

4. Some challenges to address from a legal perspective

Taking into account the possible applications of blockchain technology in the real estate sector (e.g. validating transactions, checking other encumbrances), the question is whether blockchain is nowadays sufficiently prepared to perform the functions of notaries, land registries, real estate agents, lawyers and so on, ensuring a secure real estate transaction. There are some challenges that this technology must overcome to be considered as reliable, legal and secure as the current real estate conveyancing systems in Europe (taking into account all the differences between member states).

On the one hand, there are some general problems with the blockchain protocols, not only for real estate projects but for any other sector. For example, the costs associated with smart contracts and the scalability of the network, a problem that exists with bitcoin, Ethereum and other altcoins (Preukschat, 2017). To conclude a smart contract through Ethereum, the interested party needs Gas (transaction value) and parties have to pay the stipulated fee even when the transaction is not concluded. This is also linked with the scalability of the system: the more transactions, the more rewards are given to miners to ensure that the transaction is concluded. In addition, the creation of a blockchain database that gathers all the EU real estate transactions of any kind (purchases, renting [. . .]) could certainly make verification time-consuming, needing more miners and thus more fees for each transaction. Several developers and researchers are working on solving this problem, and some of them believe they have found the solution (e.g. the fee-less IOTA, a cryptocurrency for the internet of things, with the Tangle system, where no miners exist, Popov, 2018); however, for a system of real estate conveyancing, a control of these costs (e.g. with a permissioned blockchain in which a central authority regulates prices, or a proof of authority mechanism, where the administration is the validator of transactions) would be desirable, so that this not an impediment that prevents people from registering their rights.

On the other hand, there are some particular challenges that have to be faced when implementing a real estate conveyancing system through a blockchain:

- the control of the parties' IDs;
- the legality of the contract and the verification and protection of rights in rem;
- the registration of co-ownership, and
- the amendment of the ledger.

4.1 Verification of the identity of the involved parties

Some of the major blockchain protocols, such as Bitcoin and Ethereum, do not require any type of personal information when creating a new wallet. ID is one of the important issues not only regarding blockchain, but also for any kind of transaction through the internet. This has been established as one of the reasons why bitcoin is used for illegal activities and money laundering, as requiring a verified ID is essential for the prevention of these crimes (article 22 Money Laundering Directive 2018/843).

If blockchain technology is to be implemented for the execution of real estate transactions, one of the most important issues that must be addressed is the need to check

the real ID of the parties, which is a matter of public control. Of course, the need to know who owns a particular piece of land as well as who the rightsholders are is essential to properly ensure the continuation of existing protections and to continue promoting land development. Which credit institution would grant a mortgage without being certain that the debtor is in fact the owner of the property, not because of the blockchain, but because the ID of this person has not been verified? It should be kept in mind that housing is one of the most important investments for most households, so a lack of clear information regarding a person's main asset could imply that it will become impossible to encumber the assets when necessary. It is, thus, essential to complement the blockchain with an official ID to implement a real estate conveyance system, and one which might contribute not only to providing more security, but also to ensuring that true digital owners can prove their rights over a certain property.

To overcome this problem, the ID should be managed by a central authority (thus preventing the complete disintermediation of the real estate market) or by the blockchain itself, provided that the identity of the users is recognised by nation states (at least by those in the EU, to enable a European conveyancing system). There are several initiatives seeking to implement a blockchain protocol that permits the use of official IDs. One of the examples is the company Accenture, which signed a formal deal with Canada and The Netherlands to implement a blockchain-based ID that will allow travellers to share their biometrics with custom and border control in advance, allowing the coordination of traveller data ([World Economic Forum, 2018](#)).

Another example is the e-residency in Estonia, which does not use blockchain but similar cryptographic hash functions, allowing public and private bodies to securely exchange data. Just by virtually submitting a passport or an ID card, the Estonian Government provides individuals from anywhere in the world with an ID, enabling them to open a bank account in Estonia, sign documents electronically, to set up a company, etc. The control of the true ID of that person is done by online means: after submitting the application, the Estonian Police carry out a background check. Then, the applicant can go to an Estonian Embassy, where he/she will provide fingerprints and collect the ID card and the card reader. However, the e-residence blockchain is now being further developed, jointly with Bitnation, in such a way that:

[...] via the international Bitnation Public Notary, e-Residents, regardless of where they live or do business, will be able to notarize their marriages, birth certificates, business contracts, and much more on the blockchain.

Indeed, some scholars pointed out that creating a transnational e-ID through blockchain is a key step to broader application to real estate ([Sullivan and Burger, 2017](#)).

That is why, some government supported projects to implement a real estate conveyance system, operated through a blockchain, first addressed the issue of ID. For example, the Municipality of Rotterdam, which jointly with Deloitte is developing a blockchain that records lease agreements for the Cambridge Innovation Centre, has established the need to first ensure a valid ID, as its priority. In this sense, member states should preferably regulate an e-ID that complies with the requirements of EU Regulation No 910/2014 on electronic identification and trust services for electronic transactions in the internal market, and thus implies mutual recognition (Article 6) by the other member states. Using this mutually recognised ID would allow any citizen the possibility of conveyancing real estate via a blockchain that uses this identity. At the same time, connecting the blockchain with an official ID would prevent other potential legal problems caused by the loss of the private key for the wallet and thus the denial of access to the cryptocurrency it contains, as the

abandonment of property cannot be presumed by the mere fact of losing a key, but rather an intention to abandon it is needed (e.g. § 959 German Civil Code (BGB), Art. 543-2 Catalan Civil Code). Moreover, this official ID should, under given circumstances, allow for the transfer of a particular property to the owner's inheritors, as pointed out by Verheye, 2017, which is only feasible when a specific authority controls the database. This was the idea of the project IdentiCat[10] in Catalonia, that allowed Catalan residents to use the blockchain to show proof of ID, but Spanish Royal Decree 14/2019[11] forbid using distributed ledger technologies for this purpose, at least until the EU regulates this possibility.

In any case, even with the use of an official ID, there are some functions performed by the notaries – in those countries where their involvement is commonplace – that cannot be simply replaced by a blockchain network. For example, the notary can check the legal capacity of the parties to conclude a transaction, not only regarding their general capacity to conclude contracts, but also regarding their personal status (e.g. a notary would not confirm the purchase of a property by a person acting under coercion). A mere ID cannot determine that a certain person really wants and is able to conclude a transaction, something that in many countries, is presently ensured by notaries (e.g. ES, DE), even when they might find it difficult to ensure that a person understood all the terms of the mortgage. Of course, the transactions that currently do not require this type of control (e.g. rental contracts) could be concluded with this technology but, regarding the other ones (e.g. granting a mortgage), just replacing the notary and land register with a blockchain might result in the parties losing some of their rights and, at the end of the day, may lead to an increase in litigation. This could be also overcome by using computer models that recognise emotions: the so-called “affective computing” (Picard, 1995), which makes possible to detect emotions (e.g. stress, anxiety) by analysing person's heartbeat or voice, or using biometric data of the buyer/tenant (e.g. as proposed in Irisafe and Kairos).

4.2 Control of the legality and effectiveness of the contract

As said above, lawyers, notaries and even land registries in some jurisdictions ensure that a given real estate transaction is concluded in accordance with the minimum legal requirements, and they inform the purchaser about previous encumbrances and rights in rem over the property. For example, in mortgage loans, they are even obliged to detect and to inform the parties about possible unfair terms, or notaries are, in most cases, responsible for monitoring transactions to prevent illegal funding activities. Blockchain, as a distributed database, can neither inform in the same way about the consequences of a certain transaction nor carry out a previous check of the legal requirements by itself. This control is currently not possible with blockchain and smart contracts, which only check the fulfilment of the pre-conditions.

It is thus important when designing a blockchain to allow for the purchase or mortgaging of a property, that this control is done, to avoid eliminating some essential rights of the purchaser when implementing it. One fast solution could be the participation of a lawyer, a notary or other gatekeepers that shall verify the transaction in permissioned distributed ledgers or through the use of the so-called “oracles”. Oracles are external agents who verify real-world events and submit the information to blockchain. Current intermediaries, such as notaries and lawyers, could be considered as oracles verifying real-world events, such as the fact that the buyer understood the terms or that a property does not have previous charges. In fact, notaries are calling for the possible use of a “notarial seal of conformity”, with which these professionals would ensure that the online general contractual terms comply with EU consumer legislation[12]. A further step could be the use of artificial intelligence (AI) comparing clauses written in the smart contract with a database

of unfair ones (e.g. with a registry of general terms and conditions, such as the Spanish *Registro de las Condiciones Generales de la Contratación*), thus achieving a true disintermediation without losing guarantees.

In rental contracts, which currently do not need to be registered in the land registry, blockchain jointly with AI could provide the tenant with more control of the content of the contract. Residential leases across Europe have been regulated by special rules aimed to protect the weak party in this contract: the tenant (Schmid, 2014). Although estate agents and lawyers, when drafting the contracts, might check that minimum requirements are drafted, as a general rule no public authority currently verifies that the contract complies with the minimum rights of the tenant. The creation of a blockchain for real estate conveyancing might be an opportunity to carry out a control of prior contracts to detect void clauses in tenancy agreements using AI that compares the clauses or the minimum mandatory content of the contract. These clauses could even be included in a blockchain thanks to the development of smart contracts applied to Ricardian contracts and smart legal contracts, i.e. those computer programs including both computer codes and traditional legal clauses. With them, the parties may read the terms, while computers, at the same time, may execute the agreed clauses.

4.3 Co-ownership and other rights in rem

Current projects, which focus on blockchain and the use of smart contracts, allow the owner to sell the property while this transaction is registered at the same time. This is the case of the *Landmateriet* in Sweden and other projects from private initiatives such as Velow.re. However, the range of rights that can be created and registered in land registers is wider in practice.

It might be difficult to translate certain rights into the code of a smart contract, both rights in rem and even the clauses of a tenancy contract. For example, while the civil law co-ownership by shares (the Spanish *comunidad de bienes* of art. 392 of the *Código Civil* or the German *Gemeinschaft* of §741 BGB) is relatively easy to represent (just needing two wallets to confirm a transaction), there exists a range of other situations that could pose more difficulties when they are to be incorporated into a blockchain (co-ownership with different shares, shared ownership, temporal ownership, etc.). The same happens regarding the usufruct, the right to build, right to use, servitudes, options, etc.

The blockchain should be split at some point to allow for the creation of these rights and even their extinction, for which Vos *et al.*, 2017 propose using “sidechains”. According to Pilkington, 2006: “A sidechain functions as a separately managed ledger, with its own software code, that is ‘pegged’ to the main blockchain ledger so as to allow transfers of key information from one chain to the other”.

We consider that this might be a good solution to allow the creation of rights in rem, but there might still be difficulties in establishing which kind of right in rem we created. Thus, a proper determination of the obligations and rights held by the rightsholder transferred into the code would be essential to know what encumbrances a property has and what rights the titleholder has. As commented above, a Ricardian contract might play an important role at this point because of its readable content.

Certain steps have been taken through tokens or coloured coins, i.e. attaching a certain right to a token in such a way that when parties transfer the token through blockchain, this right is also created or transferred (EU Parliament, 2018). For example, Altestate[13] created tokens representing rights over housing, which users might use to sell square meters of their properties. This is also the case of Homelend, which allows parties to create mortgages (as a security in rem) through tokens, but the existence of several blockchains (861 in May 2019)[14]

with different rights over the same property might not be the most appropriate solution, because then, third-party acquirers would not be aware of possible liens. Thus, it is essential to have an official distributed ledger that gathers the right information about a given property, to protect the legal relations between citizens or, at least, to include in the Land Registry information about the blockchain in which a property was tokenised. However, difficulties in the application of some legal provisions might also be a challenge for creating mortgages through blockchain. Are users who offer an amount of money to other ones (e.g. Homelend system) considered a “creditor” in terms of art. 4 Directive 2014/17/EU? They could be included in this concept, as, according to the Directive, a “creditor means a natural or legal person who grants or promises to grant credit falling within the scope of Article 3 in the course of his trade, business or profession”, and provisions of Directive 2014/17/EU apply, among others, to credits granted by a mortgage provided that they are not offered for free (Article 3). Therefore, taking into account the anonymous nature of public blockchains, would it be compatible with Art. 11 Directive, which specifies that the identity of the creditor must be clear and concise?

Apart from this fact, there are currently certain rights in rem that necessarily have to be agreed through a public deed (e.g. the mortgage or surface right in Spain or rights in rem in Germany, §873.2 BGB). This is currently one of the legal impediments to the creation of rights in rem through blockchain. But, of course, if a purpose-built permissioned blockchain is implemented in the future, this part of the legislation should be, therefore, amended or reinterpreted.

4.4 Possibility of amending the blockchain

Lastly, the law usually foresees the possibility to change the owner of a property without reaching an agreement with the former one or the amendment of a certain right or property in given situations. For example, the voidance (e.g. an acquisition of a property by a minor without sufficient capacity, Art. 1301 Spanish Civil Code) or breach of a contract might entail the restitution of performances. Furthermore, in cases of declaratory actions of ownership, the ownership of a property may be challenged and thus the person who has this right changes. The same might happen in the event of illegal activities that need to be revoked, when there are operational errors or even when the physical situation of a property changes. While the blockchain is mainly irreversible, the legislation stipulates the reversibility of transactions or changes of the property. In blockchain frameworks, this challenge can be faced twofold:

- (1) first, nominating a specific authority with the capacity to order a new transaction in favour of the true owner (e.g. in case of challenging the ownership of a property or even in cases of accession), with the costs of this new transaction being covered by the non-prevailing party. However, the voidance of a contract implies that the transfer of ownership never existed (e.g. Art. 1303 Spanish Civil Code[15]), which might not be compatible with creating a new transaction in favour of the true owner. For example, if the smart contract running on blockchain is connected to the tax administration, is it going to charge the same tax if the contract was void?; and
- (2) second, creating a blockchain that allows amendments. In this sense, Accenture[16] is working on a prototype that allows blockchains to be edited, specially designed for permissioned blockchains. According to this project, some of the administrators of the blockchain might have the capacity to amend it, which could be potentially used by public authorities to change the blockchain if necessary (e.g. it could be a solution to allow an heir to have ownership of a certain asset without

the express consent of the testator or when the ownership of a property is challenged). Of course, this type of application is not consistent with the disintermediation that the blockchain wanted to enhance, but it is essential to uphold the current level of protection given to the parties within the EU legal systems.

Table II shows all these opportunities and challenges depending on the transaction.

5. Concluding remarks

As a result, when designing a blockchain for EU real estate conveyancing, one should take note of the abovementioned challenges regarding its amendment, registration of co-ownership and other rights in rem, control of the legality of the contract and the ID of the parties.

A blockchain might be permissioned or permissionless, might have different types of consensus (e.g. proof of work, proof of consensus, proof of authority), might be anonymised or linked to a certain ID, etc. However, to provide a protocol that allows for a complete real estate transaction, which can offer at least the same guarantees for both the signatories and for third parties as current procedures, this technology should meet the following criteria:

- Permissioned blockchain controlled by public authorities: Preferably with this feature, public authorities can ensure that real estate conveyancing provides the minimum legal standards to parties. The consensus should be administered by public authorities, so the type of consensus used would be the proof of authority model, in which the public administration validates any change in the chain. The reason for this is because of the need to guarantee that all transactions are approved only when the legal requirements are met, that the costs are controlled, preventing the registration from becoming economically impossible for low-income citizen, and also to check the legality of the contract and possible unfair terms. In addition, these authorities should have the option of amending the chain in certain circumstances, when a court requires them to do so. Thus, every country may decide to create an official blockchain controlled by public authorities or to recognise, for housing transactions, only those blockchains that meet some requirements, e.g. the ones that control prices, unfair terms, etc.
- The blockchain should be linked to an official digital ID, allowing the transaction only with legitimate access. Otherwise, for example, underaged persons could ask for a mortgage or sell a house without having the legal capacity to do so, something that could increase litigation.

Thus, in front of the current phenomenon in which several blockchains are operating (more than 800), something that can even reduce parties' rights, national lawmakers should take advantage of this technology. This could be addressed just regulating an official blockchain protocol requiring, among others, the ID of the parties, and with the possibility to be connected to other national blockchains to enhance cross-border transactions. However, even with the implementation of this type of blockchain, there are certain challenges that should be solved. For example, creating a better mechanism to control the true consent of the parties with biometric analysis or developing an adequate blockchain environment that ensures that the information about a transaction is properly understood through "affecting computing". Moreover, the cost-saving potential offered by the blockchain might seem to be lower than when implementing a

	Renting a property	Purchase a property	Purchase with mortgage loan
Blockchain benefits	Blockchain can ensure the <i>legality</i> of the contract and its registration, thus <i>preventing</i> the <i>black market</i> and <i>tenant's unprotection</i> . Blockchain and smart contracts can also be <i>connected to authorities</i> to ensure the payment of taxes, registration of citizens, etc.	Blockchain and smart contracts might make these transactions <i>faster</i> , taking into account the needs of new millennial generation. Moreover, the publicity of blockchain might <i>protect the right of the owner</i> , prevent <i>double sales</i> and <i>connect</i> this database with other administrations or services, allowing transnational operations	Apart from the benefits explained for the rental and purchase contracts, blockchain might <i>connect all the phases</i> of granting a mortgage, thus <i>reducing time</i> and even <i>costs</i> : from the solvency assessment, through the property evaluation and to the registration
Blockchain challenges	Taking into account that to register or to hire a notary for rental contracts is not a common practice, the blockchain does <i>not</i> involve <i>major challenges</i> . However, to benefit from this technology, this blockchain should include the official ID of the parties, and smart contracts should include the agreed legal clauses to control their legality	As pointed out above, it is a common practice to hire a notary and to register it into the land registry (even compulsory in some countries: DE, NL). Blockchain by itself does not check the ID of the parties (public blockchains are anonymous), their capacity to conclude contract and, in general, this database cannot be amended. Therefore, when designing a blockchain for real estate, this should be linked to an <i>official ID</i> . The <i>capacity</i> of the parties should be controlled (by means of affective computing or even thanks to the intervention of oracles). One or some selected <i>official blockchain</i> protocols should be available to protect third-parties' rights (e.g. to allow them to know the actual owner or possible liens). Authorities should be able to <i>amend it</i> when necessary (e.g. courts or in case of inheritance). The <i>costs of concluding new smart contracts</i> should be somehow controlled; otherwise, they could increase (depending on the number of transactions) and thus prevent people with less resources to be protected. A permissioned blockchain controlled by an authority could overcome this challenge	Mortgaging a property through blockchain has the <i>same challenges</i> as the purchase. As pointed out above, in most countries, it is necessary to register the mortgage. The role of land registries depends on the country so that blockchain should at least ensure these functions. This blockchain should also allow the <i>creation of rights in rem</i> , thanks to "tokenisation" or <i>sidechains</i> , and legislation should be amended to allow the creation of mortgages through this technology. In addition, taking into account that mortgage loans may involve a consumer relationship, this technology should be designed to ensure consumers' rights (e.g. the ones from Directive 2014/17/EU)

Table II.
Challenges and opportunities of the blockchain for real estate transactions

Source: Own elaboration

permissionless and public blockchain, as current intermediaries would continue having their role (e.g. validating transactions or acting as oracles to confirm that a certain property does not have previous encumbrances). All these challenges should be, therefore, addressed in future research projects.

In any case, these challenges should be overcome as indicated above, as blockchain is considered to be a mechanism that can enhance speed and facilitate transnational operations and may even be a way to enforce the registration of rental agreements while connecting them to the tax authorities, registries, courts and other administrations.

Notes

1. See for example, the project of Bank Santander: www.santander.com/cs/sgs/Satellite/CFWCSancomQP01/es_ES/Corporativo/Sala-de-comunicacion/Santander-Noticias/2018/04/12/Santander-lanza-en-cuatro-paises-el-primer-servicio-de-transferencias-internacionales-con-blockchain.html (last retrieved: 25 November 2019).
2. More details at the following link: <http://politiquesdigitals.gencat.cat/ca/detalls/Noticia/EI-Govern-aprova-la-primer-estrategia-de-blockchain-i-es-prepara-per-comencar-el-seu-despliegament-dins-lAdministracio> (last retrieved: 18 June 2019).
3. See the declaration at the following link: www.mise.gov.it/images/stories/documenti/Dichiarazione%20MED7%20versione%20in%20inglese.pdf (last retrieved: 25 November 2019).
4. Registrars in Spain signed an agreement with Alastria in 2018 to explore possible case uses of blockchain for land registration, developing the project “Regturi”, to connect tourist dwellings with the land registry. See: www.registradores.org/los-registradores-y-el-consorcio-alastria-exploraran-las-posibilidades-de-la-tecnologia-blockchain/ (last retrieved: 25 November 2019).
5. Atlant whitepaper. 29 July 2017. Available at: <http://whitepaper.global/atlant-atl/> (last retrieved: 25 November 2019).
6. Ethernity whitepaper. Version 7. Available at: <https://icosbull.com/eng/ico/etherty/whitepaper> (last retrieved: 25 November 2019).
7. Decree of 8 February 1946, on the Mortgages Act (*Ley hipotecaria*). BOE No. 58, of 27 February 1946.
8. Data from the *Agencia Estatal de la Administración Tributaria* provided by its director during the discussion of the national budget 2019. See www.elboletin.com/noticia/160354/economia/el-386-de-los-alquileres-no-se-declaran-conoce-los-riesgos-de-alquilar-tu-piso-en-negro.html (last retrieved: 25 November 2019).
9. For example, in 2016, Bank of China and HSBC launched a property valuation for mortgages through blockchain technology, using secure blockchain databases to quickly provide property valuations for mortgage applicants in Hong Kong. See Financial Times. *Banks adopt blockchain for mortgage valuation system*. 18 October 2016. Available at: www.ft.com/content/c856787c-9523-11e6-a1dc-bdf38d484582 (last retrieved: 25 November 2019).
10. www.lavanguardia.com/tecnologia/actualidad/20190907/47200867814/identicat-identidad-digital-catalunya-blockchain.html (last retrieved: 25 November, 2019).
11. BOE No. 266, 5 November 2019.
12. See *Escritura Pública*. 4th Notaries of Europe Congress. No. 108, 2017, p. 13.
13. <https://alt.estate> (last retrieved: 25 November 2019).
14. <https://blog.bitdegree.org/did-you-know-there-are-861-blockchains-c60e1720fad5> (last retrieved: 25 November 2019).

15. Royal Decree 24 July 1889, on the Spanish Civil Code. Spanish Official Gazette (BOE) No. 206 25 July 1889.
16. www.accenture.com/us-en/insight-perspectives-capital-markets-edit-blockchain-question (last retrieved: 25 November 2019).

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