

# Blockchain-Based Land Registry Platforms: a Survey on their Implementation and Potential Challenges

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**Abstract.** In recent years it has been demonstrated that the use of the traditional property registry models involves the risk of corruption along with long waiting times. This paper points out the main problems associated with conventional models and makes a survey of the new ones which are based on blockchain technology. This type of model is already being developed as a proof of concept by different countries. With the use of this technology in land registry systems, it is possible to improve the transparency of the processes as well as optimize costs and execution time. To show the theoretical results of this study, the Spanish land registry has been taken as an example of a use case scenario.

**Keywords:** Blockchain · Land Registry · E-government · Challenges · Survey.

## 1 Introduction

One of the concerns of governments today is the optimization of the bureaucratic processes carried out in property registry systems. This optimization is understood as the improvement in the profitability of their management, the increase in the speed at which those processes are carried out, and the reduction of the ambiguities that occur in the processing of data [26]. The e-government concept, based on the precepts of optimization and reduction of ambiguities, is beginning to develop into a bureaucracy. Through the internet it is possible to provide the different governments with features such as standardization, departmentalization, operational profitability, construction of coordination networks, collaboration with external entities, and citizen services [30, 32, 34].

In today's industry, several models are being applied to allow for the automation and distribution of their processes, obtaining very good results [8, 10]. To fully achieve the automation and distribution of processes in the registry field, e-governments must make use of a technology that provides the system with

a unique and immutable registry, the blockchain [21]. The study of the use of blockchain technology has been extended to many areas, beyond those underlying the economy of the so-called cryptocurrencies (Bitcoin, Ethereum, EOS, Tron) [33], especially for the areas that use some type of record, such as in the identification of objects in a unique way [27, 20], for the traceability of assets [24], for the audit of insured goods [29, 9], or in the creation of data markets between machines [35, 5, 23].

One of the main aspects by which the use of blockchain technology is spreading to so many different areas is the possibility of implementing smart contracts, which can be automated, eliminating the need for a human intermediary [25]. Since the code of these contracts is stored in the blockchain in an immutable way, and each one of its executions is verified by the set of nodes that make up the blockchain network, it becomes feasible to automate processes that involve actors with different interests who do not trust each other. The studies developed to date in e-government all provide a sufficiently powerful tool for local governments to reinvent themselves, deepening, in this case, the e-government paradigm. Thanks to the supportive structure that blockchain technology offers, e-governments can provide the citizens with automated processes, like the management of digital identification and the safe handling of documents [36]. It is precisely in the latter where, as a platform for various applications in e-government, blockchain technology shows great potential to authenticate and properly store different types of documents, such as property records, birth and marriage certificates, vehicle registration, (business) licenses, educational certificates, student loans, social benefits and votes cast in any election process [28].

Specifically, the current work focuses on the advantages of applying blockchain to the property registry process, mainly following the strategic precepts of transparency, understood as the democratization of the access to different data and the reduction of corruption through distributed storage; economic cost reduction, due to the realization and validation of a transaction without human intervention; and the technological precepts of resilience and security of the data.

This work contributes with i) a review of the pilots currently being developed with different governments around the world, in the context of blockchain-based land registries; ii) the potential benefits of a platform like this being implemented in a country like Spain; iii) the natural evolution of the e-government paradigm towards the use of this kind of systems is discussed, along with the challenges that are faced. Because of all the contributions achieved with this paper, public and private researchers, and practitioners alike will benefit from this work.

This introduction is followed by a review of the studies that have been conducted around the world with blockchain-based systems on different land registries, section 2. Then, the research development is established, where current times and costs are detailed, in section 3. Finally, the research is discussed in section 4 and the conclusions are drawn in section 5.

## 2 Blockchain and land registry around the world

Each country has its property registry system, and this section will address property registration cases that use Blockchain technology or are in the process of adopting this system. Blockchain technology can be applied in many legal fields [1], and, although it will not be discussed in this paper, blockchain technology has also been proposed as a tool to solve legal issues with displaced persons or refugees, not only as a regulatory agency for countries but also to solve transaction costs for displaced persons or for receiving aid for refugees and cross-border collaborations.

By 2017, more than half of all households in developing countries have access to the Internet, so they can make a model based on blockchain technology viable [18]. In Africa, for example, we find the case of Ghana. In countries like this, which are less developed and where the political situation is quite unstable, it is not strange that there are cases of corruption in terms of citizens' property. In this kind of situation, where the government's corruption rates are very high, government officials alter titles to registered properties by assigning them to others or themselves. In the case of developing countries, another factor that reinforces this problem is the fact that citizens do not have easy access to information. Although it is not only a question of access to information, it is also a challenge for the African country since around 90% of the land is not officially registered [12].

Ghana is one of the countries that has promoted and joined the blockchain project together with multinational companies that have been working for years in the blockchain sector, along with local startups that know about the area and the possible disadvantages that may exist. In the case of Ghana, they are working hand in hand with IBM and Bitland [2] to modernize and make the land registry immutable. They use *OpenLedger* to create a distributed public blockchain, which more companies are expected to connect to over time.

Blockchain technology is also beginning to be applied at the government level in Asia. In particular, Japan, which is seeing the feasibility and implications of using this technology. The government of Japan is developing projects on the uses of blockchain technology for property registration and the management and unification of all procedures related to the property registry [17].

The intention of using blockchain technology in Japan is to unify all data on empty or unowned properties, land and unproductive spaces, unknown owners, and unidentified tenants or users before agencies. The consolidation of these data and their availability to all relevant agencies through the blockchain contribute to the advancement of several national objectives, such as: encouraging land reuse, promoting sale and purchase, controlling redevelopment, optimizing tax collection, and designing plans related to the environment. Although there is no more information about the trials carried out in different Japanese cities since the summer of 2018, it is expected to cover all of Japan in 2022 [7].

Within the context of Sweden, banks and state authorities have access to the land registry's database, while the seller and buyer, the most important stakeholders of a land transaction, don't have that privilege. Because of that,

the government is aiming at the implementation of a land registry system based on blockchain, where all the actors of a transaction have the same privileges [19]. However, to be able to carry out the change in registry access in the legal fields and in the registration of all its properties [13], there must be a legal modification.

In June 2016, the Swedish property regulator published a report under the title “The Land Registry Blockchain”. It was part of a project on the possibilities of using blockchain as a technical solution for real estate transactions. The project focused on the contracting process because currently, and according to its legal system, it consists of two steps: a contract sale and a deed of sale (the former can be registered as a pending sale and the latter as the final sale). In its current state, the process from the signing of a contract to the registration of the deed of sale takes between three and six months. Even so, in the signing process, many documents are signed on paper and sent by ordinary mail, so digital signatures and identification will be a component of the project (which requires investment in time and money).

Updates in the Land Registry must be checked by the regulatory authority and, in a long-term solution, the Land Registry will remain in charge of enforcing the law. The final aim is that, with the use of a *permissioned* blockchain in its proof of concept, the process of adding information is centralized in the state, while still offering a high level of transparency. In this case, the blockchain is called *permissioned* because only a limited number of actors, from the registration agency, can approve the blocks of data that are going to be stored in the blockchain. Besides, this blockchain is open because all Swedish citizens have access to the information stored in it. The Swedish project is an example of Blockchain as a technology adapted to registration, not a new category of property registration, but as modernization and adaptation of new technologies towards legal efficiency.

On the other hand, Georgia is a country that has begun a project to create a land registry system based on blockchain technology in 2016 and, since then, the National Public Registry Agency continues to act as a third-party enforcer [31]. Today, titles can be issued in digital format and recorded using blockchain technology. However, the process is not fully automated, the stakeholders have to go to the offices of the government to get the certificate of the land before making a transaction with it. Also, the blockchain technology used is just a layer of tamper-proof security with the Bitcoin blockchain, used by the government. This means, the process is still centralized by the government and is not an automatic process [14].

A blockchain property registry has been proposed as a solution for the states with an institutional deficit, as it is believed that a low cost “property” certificate can be issued from a computer. However, a “real right”, effective against all law, needs an institutional infrastructure to protect it. Without legal institutions there is no “real right” or property, but rather expectations, social norms, facts or possession. If the owner cannot go to court to claim or defend their right, its existence is doubtful. In the case of Georgia, its legislative framework allows for

the implementation of this kind of solution because it has enough flexibility to let the government store their citizen's data [14].

As mentioned in the previous cases, each country finds different incentives that lead them to opt for the use of blockchain technology, see summary in table 1. These technologies have different purposes but they converge in the fact of the need for a more immutable and effective property registry and use blockchain technologies as a lever for it. This way, the land registry and legal entities, in general, ensure maximum security in the documents, as well as get rid of possible cases of corruption. The daily market transaction sequence rule [16], concerning the rights over individual land or title registries have been a feature of title registry systems as opposed to the original deed systems where this rule was unknown. This new rule improves the security status of the land registry by limiting access to persons who can consult or extract information. According to this rule, the property registry cannot be entered if the person concerned is not registered as the authorized person. The land registrar must check that the registered person has given his consent or has been part of a legal procedure.

To summarize, making use of blockchain technology as a storage system in which the information generated, along with the smart contracts containing the logic to govern the platform, are stored in a distributed database, allowing governments to create a public ledger of transactions that is transparent to all citizens and a proven anti-corruption mechanism. Besides, the use of digital signatures in the communication protocol and a time-stamped fingerprint of the data, obtained with a hashing algorithm, as a mechanism for validating the information, are very powerful tools for preserving the kind of files generated in land registry systems. Also, the use of a network of nodes as the keeper of the information facilitates its retrieval under any circumstances, due to getting rid of a single point of failure of centralized systems.

Country	Framework Summary
Ghana [12, 2]	In the case of Ghana, they are working hand in hand with IBM and Bitland to modernize and make the land registry immutable. They use <i>OpenLedger</i> to create a distributed public blockchain, which more companies are expected to connect to over time.
Japan [17, 7]	The intention of using blockchain technology in Japan is to unify all data on empty or unowned properties, land and unproductive spaces, unknown owners, and unidentified tenants or users before agencies. Although there is no more information about the trials carried out in different Japanese cities since the summer of 2018, it is expected to cover all of Japan in 2022.

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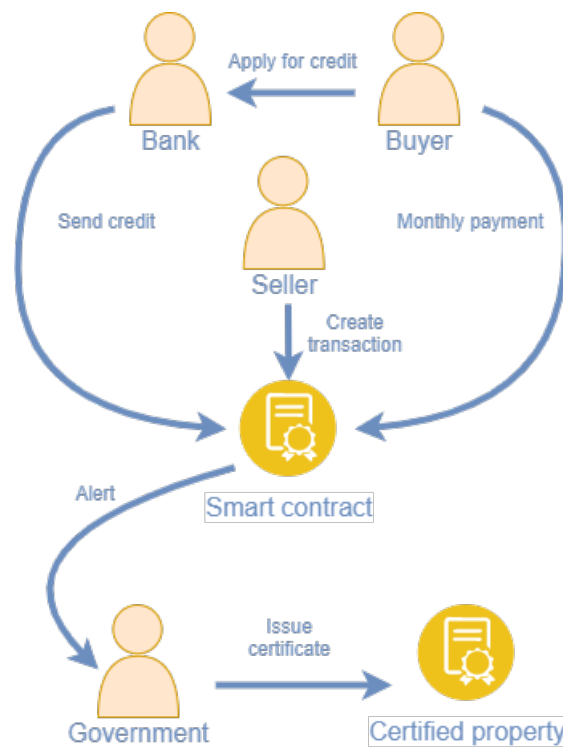
Country	Framework Summary
Sweden [19, 13]	To be able to carry out the change in registry access in the legal fields and in the registration of all its properties, there must be a modification in the Swedish legislation. The final aim is that, with the use of a <i>permissioned</i> blockchain in its proof of concept, the process of adding information is centralized in the state, while still offering a high level of transparency. Besides, this blockchain is open because all Swedish citizens have access to the information stored in it. The Swedish project is an example of Blockchain as a technology adapted to registration, not a new category of property registration, but as modernization and adaptation of new technologies towards legal efficiency.
Georgia [31, 14]	Georgia has begun a project to create a land registry system based on blockchain technology in 2016. Today, titles can be issued in digital format and recorded using blockchain technology. However, the process is not fully automated, the stakeholders have to go to the offices of the government to get the certificate of the land before making a transaction with it. Also, the process is still centralized by the government and is not fully automated. A blockchain property registry has been proposed as a solution for the states with an institutional deficit, as it is believed that a low cost “property” certificate can be issued from a computer. However, a “real right”, effective against all law, needs an institutional infrastructure to protect it. Without legal institutions there is no “real right” or property, but rather expectations, social norms, facts or possession. In the case of Georgia, its legislative framework allows for the implementation of this kind of solution because it has enough flexibility to let the government store their citizen’s data.

Table 1. Summary of studied frameworks per country.

### 3 Benefits of blockchain technology in land registry

This paper focuses on the benefits and contributions that the use of blockchain technology in land registries would have if used in the case of the Spanish land registry system. To reap the benefits of using a blockchain-based platform for the optimization of the Spanish land registry system, the general architecture must be as described in figure 1. In that figure, one observes that the system

is governed by the smart contracts deployed within the blockchain: i) a buyer (citizen who wants to buy a property) reaches an agreement with a seller (a citizen that wants to sell the discussed property) on the price of the land; ii) the buyer then applies for a credit to the bank, and pays the agreed money to the seller; iii) a set of smart contracts then reflects the transaction and they are in charge of updating the information of the paid credit to the bank; iiiii) when the credit payment is finished, a smart contract raises an alarm with the information of the property for the government; v) and finally, the government issues the certificate with the legal rights of the buyer as the current owner of the property. Being the blockchain network the main element of the system it is possible to create a democratic, tamper-proof, and transparent platform [22].



**Fig. 1.** Generic model for optimizing land registry processes.

One of the possibilities of how blockchain technology can be theoretically used in the Spanish land registry is to make use of an external public blockchain as a service. In those kinds of blockchains, it is not restricted access to the networks, therefore they are prone to attacks and need strong consensus algorithms to gain resilience against them. A public Bitcoin blockchain is used in the case of Georgia. However, it is only used as a tamper-proof security layer and as a

governor of the platform. The issuance of certificates to be signed by the parties is done through the government, so it is not used for the democratization of the process. On the other hand, because state personnel is involved, the automation of the process is not achieved either [14].

To add new blocks of transactions, in the case of the Ethereum and Bitcoin public networks, the Proof of Work (PoW) consensus algorithm is being used. The PoW algorithm avoids the spamming of false data inside the blockchain, by making solving it more computationally expensive than verifying it. Although, as shown in figure 1, the platform should be governed by Turing-complete smart contracts, so in this case, blockchain networks like Bitcoin cannot be used. The main problem of PoW consensus algorithms is that they spent a great amount of energy, so alternatives like Proof of Stake (PoS) and Delegated Proof of Stake (DPoS) have arisen in other public blockchains [33]. Either way, in the case that the low latency of these networks doesn't allow for the deployment of a platform of this scale, it would be possible to create a public blockchain with the nodes of the Spanish estate and the individuals and companies that want to take part in the process.

Another possibility is to use a permissioned blockchain network, in which the nodes that manage it are identified and have well-defined roles inside the network. Thanks to this approach it is not necessary to use energy-eager and low-latency consensus algorithms, because the nodes of the network are known and reliable. On the other hand, the system will be more centralized, but as in the case of Ghana, it can be expected that the network will grow as time passes with the addition of nodes managed from different sources.

In every technological scenario, the private data of a person cannot be stored publicly because of data protection laws. Therefore, the Spanish estate has to continue managing and storing that information on its private servers.

For our study, we have selected 3 variables that have a direct and immediate effect in the case that the blockchain technology is applied to the Spanish land registry. The current situation is then compared with what is expected.

### 3.1 Time

This point details the time needed to be able to carry out a query or make a record. It is based on the minimum formal times excluding any anomaly that might occur. At present, there are some special dispatch periods such as for the legalization of the minutes books of Communities of Owners, set at five working days if there is no incidence, or for the issue of certificates, set at four working days per property, in the same circumstance of lack of incidence.

In addition to the fifteen working days for the formalization of the said register, the time for consultation or request may vary and may also be extended if it is or is not accepted or modifications have to be made. In the case that blockchain technology is used, the registration or consultation is immediate. In a matter of seconds, the transactions can be carried out. Even in the worst-case scenario, in a high latency public network, the registration can be done in a

matter of hours, an incredible upgrade compared to the days that have to pass with the current system.

### 3.2 Economic Resources

In this section, we detail only the part of economic resources at the level of fees or direct cost of registering a property. The costs derived from waiting times, travel or other indirect costs that occur with legal processes in Spain today is taken into account. Currently, in any case, the price of registration will never be less than 24.04 euros or more than 2,181.67 euros. The cost per transaction is in the order of cents, as it does not require either labor or printed certificates.

### 3.3 Inconsistencies and corruption

This point details some inconsistencies that may emerge in the registration process due to the human factor, in addition to corruption and possible advantageous movements of properties associated with changes of government. With blockchain, any change or alteration is recorded so that it is always possible to check and see if any discordance has occurred. Another inconsistency that may exist are the differences between the property registry and the cadastre. There have been many political cases of corruption that appear every year with the property registry [4, 11, 3, 6].

## 4 Discussion

The evolution of society and new technologies makes it clear that there is a need for government systems that, although they have different characteristics, all see the light under the paradigm of incorporating new forms of governance, e-government. One of the supports of the new paradigm is the use of blockchain technology, where the fight against corruption and cost reduction are conformed as guarantees of this technology, but it is precisely in conjunction with the different governments where both fields have to be properly adapted.

In the first place, in the development of blockchain technology linked to the property registry, it is important to know about the existence of certain flexibility that requires precisely a solid governance of the network. These types of governments also need to be able to adapt to changes in functions such as data management and the responsibility of governments themselves [14]. Secondly, it is important to note that more research is needed to create trust, disintermediation, organizational transformation, and governance models under new e-government designs [22]. Thirdly, it should be borne in mind that the incorporation and adaptation to this type of technology, which is still under development, requires periodic audits so that the evolving technology and the forms of government that in turn adapt to it are aligned, mitigating possible undesirable consequences for society [21].

In the research carried out in this work, we have identified some must-have features for a blockchain-based land registry platform: i) blockchain technology can enable a decentralized platform and bring with itself democracy to the data, but, if not used properly, it is just a facade to of false protection, like in the case of Georgia where security risks of data tampering remain [14]; ii) it is needed that the regulation of a country covers the use of digital self-enforcing contracts, or smart contracts, to allow the self-governance of the platform while legally covering failures in the execution of a smart contract [25]; iii) and the private data of the citizens must be protected by the government while ensuring the proper life cycle of the platform.

Finally, and in addition to the above, it is worth noting the evolution towards distribution and decentralization that computer systems are following over the years. In this evolution, three well-differentiated stages can be observed:

- The first and traditional stage of these systems consists of the use of a centralized data system in which a single owner is in charge of adding, modifying, and deleting the data generated within a platform. The rest of the users are exposed to the decisions that this owner has with his data. These systems include the vast majority of current applications, such as Google Drive or Facebook.
- The next and logical evolutionary step for computer systems is when user data is not exposed to the discretion of an owner. It occurs when blockchain technology is used in a computer system to maintain records in which users need to have confidence that they have not been manipulated after their creation. However, their governance, which depends on the proper functioning of the smart contracts that underlie the functionality of these systems, is generally in the hands of a single organization. Examples of these systems are in the area of decentralized applications created in Ethereum or Tron. This step is also taken by governments that want to make use of blockchain technology for the implementation of automated land registration. Although the data generated is controlled in a decentralized and distributed way within a network of independent nodes controlled by different entities, the way to govern such an application, and therefore how users can interact with it, is decided by a single organization.
- The last stage identified is where the governance of a system is given by the users themselves. They can interact with each other directly without the need for intermediaries. Besides, the control of the data generated in the platform is decentralized and distributed in the same way as in the previous step. These systems are achieved through the use of smart contracts that allow users to be part of the government when some condition is met and how this government can change the way applications work. But for such a system to be adopted by a state, this kind of technological advance must be taken into account by the legislation of the countries. For the described reasons, the European Directive on Information Society and Electronic Commerce [15] has established in its article 34 that every member state of the European Union must adjust its legislation on contracts that are executed by electronic

means. This should enable corporate governance through this type of system and the use of intelligent contracts.

## 5 Conclusions

Although the concern of the different estates has always been to comply with the appropriate criteria of efficiency, these criteria are helped by the monitoring and compliance with certain protocols linked, some of them, to the rise of new technologies. The so-called e-government paradigm includes different protocols that go deeper into the idea of approaching services and bringing them closer to citizens, and blockchain technology is part of this. It is at this point that this work highlights the importance of this technology in the proper development of certain public policies. Specifically, this study focuses on the process of property registration.

Aware that there are already different countries that apply blockchain technology to the tracking of property-related records, although in a pilot way, we have observed that it has been possible for property registration organizations to reduce their intermediary role and to focus on the development, maintenance, and governance of the application of blockchain technology to the platforms and applications that serve citizens. Understanding the previous results as positive for public governance, the involvement in the progress towards transparency, among other characteristics that support good governments, is more than clear and determined if they start applying the most disruptive technologies.

To conclude this work, we have to note that some serious challenges arise when implementing this technology in the property registry of a country, which must be addressed in future works. The legal framework of a country is a big obstacle when trying to fully automatize any platform where their user has a great disparity of interests. Because of that, it is needed legislation that covers the use of smart contracts while protecting the rights of the citizens that use them in the case a failure appears. On the other hand, with the rise of regulations that are meant to protect the users' privacy, any blockchain-based solution must find a way to hide those data, while allowing their verification.

[14] the need for conducting research about the legislative framework of Georgia for supporting the further development of this blockchain project.

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