Land Registration in the Twenty-First Century: Blockchain Land Registers from a Civil Law Perspective

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Abstract Few things seem so opposite to each other as the highly innovative blockchain technology and the ancient land registration sector, in which one traditionally feels thrown back into the pre-digital era. However, for some believers this unlikely pair might be on its way to form one of the world's new power couples. This contribution aims at analyzing blockchain technology in land registration matters from a material legal point of view. First, some blockchain land registration initiatives are discussed. Second, the possibilities of blockchain technology for land registration are evaluated on the basis of two variables: the lacunar or complete nature of a land register and its negative or positive nature. In doing so, Belgian, French and German law will be taken into account, offering a thorough civil law perspective on the matter.

Keywords Land registration · Blockchain technology · Complete *v.* lacunar land registers · Negative *v.* positive land registers · Trusted third party

This paper is the abbreviated and updated version of an earlier paper on this topic: Verheye (2017, pp. 441–477). See also in Dutch on related topics: Verheye, Verslype, and Danneels (2018, 109 p); Verheye (2018, pp. 212–238). See also, for instance, the special issue of the European Property Law Journal on this topic that appeared in 2017.

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A. Lehavi, R. Levine-Schnur (eds.), *Disruptive Technology, Legal Innovation, and the Future of Real Estate*, https://doi.org/10.1007/978-3-030-52387-9_7

1 Introduction: Blockchain and Land Registration, Opposites Attract

Few things seem so opposite to each other as the highly innovative blockchain technology—speaking in terms like blocks, hashes, mining, bitcoin and ethereum—and the ancient land registration sector, in which one traditionally feels thrown back into the pre-digital era. However, for some believers this unlikely pair might be on its way to form one of the world's new power couples, given the fact that blockchain technology is, at its heart, a registration technology. This idea first emerged a couple of years ago and in the meantime countries ranging from the Netherlands over Sweden to Georgia have been experimenting with blockchain technology in land registration.

This contribution aims at analyzing blockchain technology in land registration matters from a material legal point of view. First, some blockchain land registration initiatives are discussed. Second, the possibilities of blockchain technology for land registration are evaluated on the basis of two variables: the lacunar or complete nature of a land register and its negative or positive nature. In doing so, Belgian, French and German law will be taken into account, offering a thorough civil law perspective on the matter.

Various issues remain outside the scope of application of this paper. Firstly, I will only focus on existing well-functioning and trustworthy land registers and the possible meaning of blockchain technology for these systems. The meaning of the blockchain for land registration in developing countries thus falls outside the scope of this paper. Secondly, the technical aspects of blockchain technology are discussed in other contributions in this book. I will therefore not repeat them in this contribution.

2 Blockchain Technology and Land Registration

2.1 Blockchain Land Registration: Some Initiatives

A lot has been going on in the land registration world as far as blockchain technology is concerned. A wide range of countries all over the world have been experimenting with blockchain applications for land registration purposes. The objective of this part is to briefly discuss (some of) these initiatives and highlight the particularities of each project.

One of the general motives for the authorities to introduce blockchain land registers is the fact that a blockchain land register increases the speed of registration: whereas in a classical system, days may pass between the agreement itself and the registration thereof. Blockchain registers make it possible to proceed quasi-immediately to registration. However, this speed could also be generated through other measures of digitalization (*cf. infra*). Other motives are: connecting various

registers to each other, lower transaction costs—although the blockchain technology must be paid, of course—, e-government objectives, a lower threshold for parties to participate in the market, etc. Again, however, one must wonder whether these advantages cannot also be achieved by means of other technologies than blockchain technology. This question will be touched upon again below (*cf. infra*).

A first interesting project is the Chromaway pilot project in Sweden (https://chromaway.com). The Swedish land register (Landmäteriet) considered its own system too slow, incomplete and outdated. The Landmäteriet has therefore engaged a couple of IT firms (ChromaWay, Telia and Kairos Future) to further enhance the digitalisation of the land register, on the basis of blockchain technology. Landhypothek Bank and SBAB! joined the project in August 2016. As the report on the project clarifies: "Blockchain technology provides the opportunity to solve many of these issues with a modern IT infrastructure that Landmäteriet wants to investigate."

The IT firms have created a blockchain that makes it possible for private parties to transfer real estate to each other through digital applications (apps). In fact, the entire sale process, including the obtaining of a credit, is made digital. However, Landmäteriet will still play an important role, as it is the authority guaranteeing that a digital code in the blockchain truly represents real estate in the physical world and managing the apps and the blockchain. The current register of Landmäteriet will also be maintained connected to the blockchain. A nice demo of the new system can be tried on the Chromaway website.

Nowadays, however, this project seems to have been interrupted. No further information on its development is available.

A second project I wish to talk of here is the Bitfury project in Georgia (the Republic, not the American state) (http://bitfury.com/). Georgia has engaged Bitfury, a blockchain and IT company, to create a blockchain land register for Georgia, in which land titles need to be registered. This register is privately administrated by the Georgian National Agency of Public Registry (NAPR) and integrated in its own registers. Nowadays, it functions well in practice.

The Republic of Georgia is so pleased by the result that it has in the meantime signed a Memorandum of Understanding with Bitfury to apply blockchain technology in other parts of its administration, too. In general, Bitfury is very positive and optimistic about its technology to be used in other land registry issues as well.

Thirdly, the Bitland project that is going on in Ghana should be mentioned (www.bitland.world). Bitland is a non-profit organization that is trying to establish a land register in Ghana—where government land registers are not at all up-to-date and corruption is a major problem—that is entirely based on blockchain technology and is accessible through mobile devices. This happens in cooperation with the Ghana Land Commission. The objective is not only to enhance the land management, land circulation and real credit market and help solving land disputes, but also to avoid corrupt government interventions, fraud and real estate bubbles. In 2016, it had its test project running in 28 communities in Ghana and the first results are positive. At the same time, Bitland develops educational initiatives that enable people to get involved in the digitalizing society. In the future, Bitland hopes to expand its project

to other Ghanese communities and even to the entire African continent, with eight 'ambassadors' conducting scouting missions in other countries in 2016.

Other countries, such as Estonia, the United Kingdom, India and Honduras, are also working on blockchain technology in land registration matters, but it is impossible to cover them all in this contribution (Lemieux, 2017, pp. 392–393, 397 ff.; Nogueroles Peiró & Martinez García, 2017, pp. 317–318).

2.2 Blockchain Technology in Land Registration Matters: An Evaluation

2.2.1 Introduction

Having all the above-mentioned initiatives in mind, one is enclined to hold for true that the future of land registration lies in the blockchain technology. This might very well be true, but it should not be taken for granted without any further research. The quintessential question is if and, if yes, how blockchain technology can contribute to land registration. This forms the topic of the remainder of this paper.

The possibilities of blockchain technology for land registration will be evaluated on the basis of two variables. I have therefore selected two essential pairs of characteristics of existing land registration systems and will analyse the impact of blockchain technology on each of these characteristics. The two pairs are the complete or lacunar nature of a register and its positive or negative nature.

2.2.2 Complete *v.* Lacunar Land Registration Systems

A first characteristic of land registers' is their ambition as to the information they want to provide: is it their aim to provide all relevant information on land (complete) or do they limit their information to certain aspects, *i.e.* rights and transactions, that are deemed more important than others (lacunar)?

The standard example of a complete register is the German *Grundbuch*: *Vollständigkeit* is an important goal of this register (Bauer & von Oefele, 2013, p. 2, see also pp. 8–24). The *Grundbuch* really has the aspiration of containing all legal information on real estate that it considers important to publish. The Belgian land register, by contrast, is more lacunar: it does not pretend that it contains all relevant transactions concerning real estates (De Page, 1957b, nr. 960 ff., pp. 723–728). As such, to name the most famous lacuna, only transfers of rights *intra vivos* need to be published: transfers *causa mortis* need no publication in the land register (art. 1 of the Belgian Mortgage Act, *a contrario*). This flaw in particular has been heavily criticised in the Belgian legal doctrine ever since the establishment of the land register in 1851. Various attempts have been made in the last few decades alone to remedy this flaw, one in 1994–1985 and one in 1991–1992, but both failed (Jacobs, Michiels, & Van der Meersch, 1997, p. 21). In France, however, an attempt to make

the land register more complete has succeeded partially in 1935[1] and definitively and integrally in 1955[2]: since 1955, all transfers *causa mortis* of real estates must be ascertained by a notarial certificate and need to be published in the land register.

Nevertheless, it must be kept in mind that even a complete land register like the German *Grundbuch* is not entirely complete in the literal meaning of the word. Even in Germany, not all encumbrances of real estate need publicity in the land register. To give an example: the *Grundbuch* only concerns private legal information and no public legal information; *öffentrechtliche Lasten* are not mentioned in the *Grundbuch* (see also § 54 *Grundbuchordnung* (*GBO*)). Thus, one may not interpret '*vollständig*' too literally.

The lacunar or complete nature of an existing land register has some important consequences for the possibility of blockchain land registration. These are discussed in the following paragraphs.

Firstly, it is practically impossible or at least very hard to turn an existing lacunar register into a blockchain register. This is related with the question how to create the so-called 'Genesis block'. The Genesis block is the very first block in the blockchain that contains all the information up to that point. For a land registration blockchain, this means that if one wants to turn an existing land register into a blockchain, the Genesis block needs to contain all information from that land register (Vos, 2016, pp. 20–21). In a lacunar land register, however, it is never sure that the land register mirrors the reality at the moment the Genesis block is created: due to the lacunar nature, it is possible that transactions and/or events have occurred—and changed reality—that have not been registered in the land register. This disparity makes it practically impossible to turn an existing lacunar land register into a blockchain register (Vos, 2016, p. 14, 23).

One possible solution for this problem could be to turn other registers, such as the Belgian cadaster, also in a blockchain and combine the various blockchain registers with each other. Nevertheless, it is clear that lacunar land registers create an additional problem to proceed to a blockchain land register.

Secondly, it must be questioned how a blockchain system without a trusted third party, *i.e.* the state authorities, could replace existing land registers in which state authorities have such an important role to play. Let me clarify this with an example. Person X has a public key in the blockchain land register and according to the blockchain, an apartment in Brussels is connected to that key. Sadly, person X dies and his heir is his only son Y. Son Y now becomes the owner of the apartment and he wishes to sell it. Of course, this transfer will need to be put in the blockchain in order to be effective (German law) or to be opposable to certain third parties (Belgium and France). A big problem arises then: son Y does not have access to the public key of his father, because he cannot use his father's private key. Nevertheless, he needs that access to sign the transfer in the blockchain. Unfortunately, the block-

[1] Decree of 30 October 1935 modifying the publicity regime.

[2] Decree nr. 55-22 of 4 Januari 1995 holding the reform of the immovable publicity, *Journal Officiel de la République Française* 7-1-1955.

chain will not allow that and the transfer will be impossible. One way or another, son Y needs access to the key of father X.

This is a problem for both lacunar and complete land registers, although the problem will be more apparent in lacunar registers. If a person acquires real estate on the basis of the law and not on the basis of a transaction, e.g. on the basis of succession, a mismatch arises between the reality and the blockchain land register. One way or another, the blockchain land register needs to be corrected, but this requires the cooperation of the person to whose public key the real estate is connected. Various solutions for this practical problem in case of blockchain registers can be imagined.

One thing is clear: someone will need to have access to the public key of father X, in order to make a transfer of the connected real estate possible. It would be easy if son Y would simply have access to this key: we could imagine him inheriting it. In order to prevent fraud, however, for instance in case other heirs exist, it seems a bad idea to simply grant access to the public key to another person, albeit an heir. This access would need to be carefully checked by a competent authority: this competent authority could subsequently connect the identity of son Y to the public key of his father X. Another solution is that when a person dies, his public key becomes administered by a competent official authority who subsequently transfers the real estate package to the public key of the heir. In both cases, official intervention is needed, which I elaborate upon below (*cf. infra*). Another solution could be the creation of a special kind of injunction, that complies the person to whose public key the real estate is connected to transfer it. Nevertheless, this solution requires that that person is alive and can be reached, which is not guaranteed. It is therefore better to stick to the previous solution.

Thus, it is clear that one must have considerable reserve towards turning existing well-functioning and trustworthy land registers into blockchain registers. First, I have demonstrated how this is very hard for existing lacunar land registers. Second, in both a lacunar and complete blockchain land register, in some cases someone will need to grant access to the public key of the predecessor in title to the successor in title. One thing has become clear in this respect: we need a central authority capable of giving access of the public key of one person to another person, in case that first person is not capable anymore of transferring the real estate package in the blockchain to the new person who is entitled to it, for instance on the basis of inheritance law. Because in a lacunar register more disparities can arise between the real life titular and the registered titular of real estate, all this is even more troublesome in lacunar registers.

2.2.3 Positive *v.* Negative Land Registration Systems

The notions ‘positive nature’ and ‘negative nature’ of land registers have everything to do with the presumption concerning the correctness of the published information that a land registration system creates and the subsequent protection of third parties *de bona fide*. Essentially, negative publicity does not guarantee that the information

is correct, whereas positive publicity does create this presumption. A negative system only guarantees that all information that is not published, despite an obligation thereto, does not exist/is not opposable to third parties *de bona fide* (Grziwotz, Keukenschrijver, & Ring, 2016, § 892, nr. 2; Storme, 1997–1998, pp. 1175–1176; von Staudinger, Gursky, Gutzeit, Kutter, & Seiler, 2012, § 892, nr. 4). However, no guarantee about the validity of the provided information is given and a third party may by no means trust that an act is valid, because it is published. Thus, the Belgian and—in principle—French land registration systems are both negative systems: publicity of a particular act means nothing as to the validity of that act in respect of third parties. "*La publicité ne purge pas l'acte de ses vices*" (De Page, 1957a, n° 1055; Sagaert, 2014, 728 ff.). If that act is annulled on a later moment in time, even after a third party has acquired rights on the real estate, then that act is also null towards that third party—at least, in principle—, who suddenly appears to have acquired a good from someone who was not the owner—which is necessary for a valid transfer of ownership, we call this the 'chain of owners'—and thus loses the real estate due to the *nemo plus iuris*-principle ("*Nemo plus juris transferre potest, quam ipse habet*") (Byttebier, 2005, nr. 639 ff.; De Page, 1957b, pp. 395–396; Sagaert, 2014, p. 707, 729; Stranart & Alter, 2002, p. 493).

A positive publicity system, by contrast, goes further than only this negative guarantee—which it also gives (!)—: a positive system also guarantees the validity of an act—*i.e.* a previous act—on the moment the register is consulted, it creates *öffentliche Glaube*. A positive system, for instance the German *Grundbuch*, creates the presumption that a published act concerning a real right—*i.e.* the *Eintragung* of a *Einigung*—is valid and that the *Grundbuch* is correct (§ 891 *BGB*, *Vermutungswirkung*) and when a third party *de bona fide* acquires that real right, the validity of the previous act cannot be discussed anymore (§§ 892–893 *BGB*). "*Der Inhalt des Grundbuchs gilt als richtig*." (Wilhelm, 2016, p. 321) Thus, the German publicity system creates more than a mere negative guarantee, it also creates a positive guarantee. Thus it is more protective towards third parties *de bona fide* (*Vertrauensschutz*) and thus towards the free circulation of real estate, which was its explicit aim (*Verkehrsschutz*) (Hager, 1990, pp. 2–3; Lutter, 1964, p. 124; von Staudinger et al., 2012, § 892, nr. 7; Wiegand, 1978, p. 145). This absolutely does not mean that the *Grundbuch* is always correct—hence the possibilities of *Berichtigung* and *Widerspruch*—, but it does mean that it provides third parties *de bona fide* with protection against mistakes in the *Grundbuch*, *i.e.* situations in which the true state of affairs is not mirrored by the *Grundbuch*.

It is important to see how positive publicity in principle implies negative publicity: the validity of acts and the correctness of a register can only be logically guaranteed (positive), if that register also guarantees that all information that is not published, despite an obligation to do so, cannot harm third parties (negative).

Nevertheless, some exceptions must be mentioned in respect to positive systems. Firstly, even in German law, some exceptions exist in which the publicity in the *Grundbuch* has *only* negative effect, for instance as far as *relative Verfügungsbeschränkungen* are concerned: these can only harm third parties if published, but publicity has no effect whatsoever as to their validity (Fehrenbacher,

2004, p. 251, 260; Grziwotz et al., 2016, § 892, nr. 3; Medicus, 2001, p. 295; Wiegand, 1975, p. 207; Wilhelm, 2016, p. 321, 339, 342). Secondly, third parties *de bona fide* cannot rely on *all* information in the *Grundbuch*: the *öffentliche Glaube* is not extended towards mere facts, e.g. the exact surface of a plot of land, and, more importantly, it only concerns the rights of parties on a certain good and *not*, for instance, their capacity to conclude contracts (*Geschäftsfähigkeit*), for this is not a part of the information in the *Grundbuch* (von Staudinger et al., 2012, § 892, nr. 67; Westermann, 1963, p. 2; Wiegand, 1975, p. 207). So even in German law, with its extensive third party protection rules, it remains possible that a third party *de bona fides* acquires real estate from the person who is marked as *Berechtigter* in the *Grundbuch*, but subsequently loses that real estate again, for that *Berechtigter* afterwards appears to have been incapable of concluding contracts. After all, the *Grundbuch* does not guarantee the validity of the *own* legal act. Thirdly, *öffentliche Glaube* in the *Grundbuch* neither protects a third party who has acquired real estate in a different way than through a contract, e.g. through inheritance (von Staudinger et al., 2012, § 892, nr. 81–86 (*Erwerb kraft Gesetzes*); Westermann, Westermann, Gursky, & Eickmann, 2011, p. 713; Wieling, 1992, p. 269; Wilhelm, 2016, pp. 343–344). Fourthly, only third parties *de bona fide* can invoke the protection in German law: third parties *de mala fide* are not protected (von Staudinger et al., 2012, § 892, nr. 140 ff.; Westermann et al., 2011, 711 ff.; Wieling, 1992, p. 272; Wilhelm, 2016, 349 ff).

A final remark concerning French law must be made here. In principle, the French land register is also an example of a negative system. However, French case law and doctrine have developed the theory of the *propriété apparente*, in which publicity in the land register receives a more positive effect towards third parties *de bona fide* (Algiu, 1912, 67 ff.; Boudot, 2003, pp. 13–14; Danis-Fatôme, 2004, pp. 36–124; Leroux RTDC) integral; (Loniewski, 1905, p. 37; Milliet, 1901) integraal; (Rabagny, 2001, pp. 963–983, 993 ff.; Vouin, 1939, pp. 401–404). This interesting evolution falls, however, outside the scope of this contribution.

The distinction between negative and positive land registers is also relevant for blockchain land registration, because it teaches us that one of the key features of traditional blockchain technology, namely that the information in the blockchain is at all times correct and that third parties can trust on that feature, cannot be applied in blockchain land registration. In fact, a blockchain land register is full-fledged positive: it protects third acquirers of real estate in the most absolute way by guaranteeing them that the information in the blockchain is at all times correct. Most land registers, by contrast, are not fully positive.

After all, one of the essential characteristics of a traditional blockchain is its non-reversibility. If a transaction in the blockchain is non-reversible, the acquirer of the real estate will always be protected by the blockchain in his position towards the real estate. This feature is, however, hardly reconcilable with the needs of a negative and even a positive land register. In both a negative and positive land register, it is possible that a certain transaction that was registered in the register is reversed. In fact, this means that the blockchain becomes wrong, in the sense that it does no correctly reflect reality, despite its aim to be correct at all times (Lemieux, 2017,

p. 418). However, solutions to this problem exist, although some creativity is required. Some examples will clarify this solution.

First, let us look at an example where no third party is involved. A sells his house to B and this is registered in the blockchain. Afterwards, however, the sale is annulled and B is obliged to give the house back to A. Thus the first transaction must be reversed. Vos argues that this might be done by adjusting the blockchain: he suggests that a land register blockchain could be a privately administered one—privately in the sense of overseen by an authority—in which reversing transactions is a possibility (Vos, 2016, p. 17). Another solution could be publishing the court decision reversing a real estate transaction in the blockchain (Vos, 2016, p. 17, footnote 53). A third solution could be the following: the required change in the blockchain register could be operated through a court injunction obliging B himself to retransfer the real estate to A. Instead of reversing the transaction, a new transaction takes place which functionally reverses the previous one.

The same solution could be operated in the second example. A sells his house to B, B sells it on to C and afterwards, the sale agreement between A and B is declared null and void. Depending on the substantial law of the legal system, C is protected or not by the fact that he trusted the blockchain register. In a negative system, he is not protected, whereas in a positive system, he is protected. If, however, the problem would occur between B and C—B appears to be incapable of concluding a sales contract, for instance—a positive system will not protect C, either. In both cases, the latest transaction between B and C could need to be reversed and in a negative system, the transaction between A and B could also need to be reversed. All these changes could be operated in the same way as mentioned above, *i.e.* by issuing an injunction to C and/or B to retransfer the real estate to A.

Nevertheless, this last solution requires the cooperation of the counterparty. This cooperation could, despite legal means forcing people to perform an action, be very hard to acquire. What if, for instance, the counterparty has died in the meantime? Or what if he has moved to a country with which hardly any bilateral international agreements exist (Thomas, 2017, p. 383)?

It is therefore better to apply the same solution that was suggested above with regard to the lacunar nature of the land register: the introduction of a central authority that has the power to adjust the blockchain land register. This party would have the power to correct the blockchain by transferring real estate back to an original titular of a right on it, for instance in case of a court injunction as mentioned in the previous paragraph. The party obtaining such injunction could take it then to that central authority, who has the power to adjust the blockchain accordingly.

2.2.4 The Reintroduction of a Central Authority

We will now take a closer look at the central authority that is mentioned in the previous paragraphs. This need for a central authority to exist is, indeed, at odds with one very important characteristic of blockchain technology: the classical public blockchain is a decentralized system in which no central authority has a role to play.

However, this is not necessarily a problem for the application of the blockchain technology: it is technologically perfectly possible to establish a blockchain that is governed by a central authority: this is precisely what is called a private or hybrid blockchains. As far as I am concerned, this is even the only way that blockchain technology could practically be applied in land registration.

Moreover, this central authority could be the 'manager' of the blockchain, *i.e.* the party who sets up the blockchain and governs it. In this respect, this central governing authority can decide who is granted membership of the blockchain—*i.e.* transfer real estate—, who can read the information in the blockchain, under which conditions this happens—e.g. connection of the public key with an e-ID—, who can add blocks to the blockchain, how the blockchain will be technologically managed, etc. Finally, such central authority could also play a role in the correction of blockchain registers, in case these do not correspond anymore with reality. One thing is clear: a blockchain land register must take the form of a private or hybrid blockchain, with the state authorities maintaining an overriding power.

A very practical idea in this respect could be to set up a blockchain that is governed by the existing land register, that possesses a node, but in which all civil law notaries also possess a node and thus mine information. Such blockchain would constitute a hybrid blockchain, with only a limited number of managing members, but with the possibility for all citizens to become 'ordinary members'. The mining could be rewarded by a small retribution that must be paid by all people wishing to put information in the blockchain.

Every private party that wants to transfer a package through his public key to another private party could have direct access to the blockchain, either with or without assistance of a notary—in the demo of the Swedish blockchain register, this is called 'inviting a party to the transaction'—, but without having his computer as a node. In addition, a particular authority maintains an 'overriding' access, which makes it possible to grant access to a public key of, for instance, a deceased person to his rightful heir. Of course, this would mean that all members of the blockchain need to trust the central authority.

However, all this is just one idea. As the technologic possibilities for setting up a blockchain register are countless, many more practical models could be thought of.

2.2.5 Is Blockchain Technology Really Required?

The fact that traditional blockchain technology needs to be adapted by reintroducing a central authority in order to fit land registration needs leads to a further question. This question is whether blockchain technology is really the best suited technology to make important efficiency gains in land registration matters.

After all, blockchain technology does not only offer advantages. It also comes with some important disadvantages: it is new, so people do not exactly know how to operate it yet, which renders it risky from a technological point of view, it is highly energy-consuming, which renders it costly, it is, like other technologies, vulnerable to hacking and bugs, etc. (Lemieux, 2017, 435 ff.; Verheye et al., 2018, pp. 21–22).

Given the fact that one of its main advantages, its decentralized nature, gets lost in a land registration application, one must wonder whether other technologies, *i.e.* centralized, are technologies not better suited for land registration. The Belgian land register, for instance, could benefit more on the short to medium-long run from further digitalization of its historic records and centralization of the various registers than from an application of blockchain technology. Undoubtedly, this is true for other national land registration systems as well.

Blockchain technology must never be a goal in itself for land registration. It is my firm conviction that it should only be used when we are absolutely sure that (1) it leads better results than the existing land registration system and (2) the same better results cannot be achieved by other technologies that are cheaper, better established or safer. These issues need to be thoroughly studied for all blockchain land registration projects in the future.

3 Conclusion: Blockchain Land Registration

Blockchain technology appears to be capable of playing an important role for land registration. Nevertheless, land registration shows some particularities that need to be fully taken into account in order for blockchain technology to be apt to play a useful role in this respect. Therefore, a land registration blockchain should be developed in a particular way.

A completely decentralized blockchain land register—a blockchain in the strict sense of the word—seems neither possible nor desirable for land registration purposes. It must be possible for a central authority to grant access to a public key to another party, in order to avoid situations in which a public key is inaccessible due to the incapability of the titular of that public key to transfer real estate, for instance because that titular is deceased. Furthermore, this central authority can also play a role in adjusting the blockchain land register when it does not correctly represent legal reality anymore. Additionally, this central authority could also be the 'manager' of the blockchain.

Admittedly, this central authority is at odds with the decentralized nature of the blockchain. This is, however, to my opinion, the only option to develop a blockchain register that functions as well as the classic land registers. Some blockchain proponents could very well object that the reintroduction of a central authority denaturates blockchain technology. For these proponents, the essence of a blockchain is precisely that no central authority is involved anymore or that as many nodes are constructed as possible or that anybody can perform the mining. To my opinion, however, it is neither possible nor desirable to construct such 'true' blockchain for land registration matters.

All factors taken into account, I believe that blockchain technology is not as disruptive for land registration as some people want us to believe (Barbieri & Gassen, 2017, p. 12; Lemieux, 2017, pp. 439–440; Nogueroles Peiró & Martinez García, 2017, pp. 318–320; Thomas, 2017, pp. 389–391; Vos, 2016, p. 23). I like to

compare this to the modernization of the land register in Belgium in 2001: from that year onwards, it was not required anymore that all deeds were copied by hand, for a scanning system and digital register were established. Nobody, however, described these changes as disruptive. They were merely considered as a modernization of the existing register, but by no means a revolution.

Blockchain technology could very well be the next step in the modernization of land registration systems. It is, however, only a specific form of blockchain technology that could do so, a form in which a central authority still plays an important role and in which all particular sensitivities of land registration and property law are taken into account.

Given this limited impact of blockchain technology on land registration, one must absolutely dare to ask one very important question: is blockchain technology really necessary to achieve the above-mentioned modernization? Other technological solutions might very well be able to achieve the same or even a better result with less costs, risks, or disadvantages. Only if this last question is answered affirmatively for a national land registration system, it becomes useful to consider blockchain technology as a valuable means of modernization of that particular system.

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