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BLOCKCHAIN-BASED LAND REGISTRATION: POSSIBILITIES AND CHALLENGES^{*}

by

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In recent decades land registration systems operating in Europe and worldwide have been subject to modernisation processes consisting in implementation of information and communication technologies. Such reforms have gradually led to facilitating access to land information, improving effectiveness of land registration proceedings and even introducing possibilities to dispose of the ownership of land electronically by developing electronic conveyancing mechanisms. Another innovative concept much discussed nowadays is the application of blockchain technology in the land registration sector. This solution is currently being tested in a number of countries.

Distributed ledger technology underlying blockchain is expected to revolutionise land registration by offering a secure architecture to store land transactions with the use of cryptographic protocol. This shall bring advantages of increased trust and processing efficiency as well as reduction of costs. However, the above idea raises concerns given that, under the assumptions of the "original" blockchain model, transactions are irreversible and are carried out without intermediaries, which means the lack of any external control and independent verification of the transactions to be recorded.

The article examines potential benefits and risks of automatisation of land transactions as well as practical experiences of selected countries in implementing blockchain in the area of land registration. On this basis, an assessment will be

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made as to whether blockchain-based registration could indeed replace the existing methodology of registering rights to land.

KEY WORDS

Blockchain Technology, Informatisation, Land Registration, Real Estate Transactions

1. INTRODUCTION

The common use of information and communication technologies transforms progressively the way in which market transactions are carried out and public services are performed by the authorities. This can be illustrated by the example of real estate transactions and land registration which are subject to advanced informatisation processes. Technological improvements being implemented in this area are intended to facilitate the transfer of immovables and increase the functionality of land registers by providing rapid and easy access to reliable information regarding the legal status of land as well as ensuring effective land registration proceedings. Considerable achievements in modernisation of land registration systems have been made recently in European countries, including Poland, which is demonstrated by guaranteeing public online access to land registers and introducing an infrastructure to initiate land registration proceedings electronically, with the use of qualified electronic signatures (for the time being under Polish law applications for entry in the land register are submitted solely via the IT data transmission system by notaries, court executive officers and heads of tax offices, however it is planned that in the future this method of communication be used by other entitled entities as well). In case of an electronic application an automatic notice is made in the land register in real time so that any movements on the property are blocked until completion of the registration procedure.¹ Moreover, in some jurisdictions systems of electronic conveyancing are

¹ See e.g.: Gołaczyński, J. and Klich, A. (2016) Informatyzacja ksiąg wieczystych. Uwagi ogólne. In: Andrzej Marciniak (ed.). *Elektronizacja postępowania wieczystoksięgowego. Komentarz praktyczny. Akty wykonawcze*, Warszawa: C.H. Beck, pp. 31–58; Gryszczyńska, A. (2011) *Nowa Księga Wieczysta. Informatyzacja rejestru publicznego*. Warszawa: LexisNexis, pp. 182 ff.; Wudarski, A. (2016) Das Grundbuch in der Registerwelt. Eine rechtsvergleichende Untersuchung zum deutschen und polnischen Grundbuch im europäischen Kontext. In: Arkadiusz Wudarski (ed.). *Das Grundbuch im Europa des 21. Jahrhunderts*. Berlin: Duncker & Humblot, pp. 23–82; Kaczorowska, M. (2019) Informatisation of Land Registers in Poland and Other Member States of the European Union: A Comparative Overview. *Law and Forensic Science*, 17 (1), pp. 30–48.

being developed. For example, in Finland the parties can conclude the contract of conveyance in a closed electronic system once they have undergone the identification and authorisation procedures and the registration begins automatically after the transaction text has been checked by the registrar.²

Currently, it is expected that the future stage of development of land registers will be the application of blockchain technology which shall revolutionise the land registration process. As highlighted by the promoters of blockchain-based land registration systems, distributed ledger technology underlying blockchain provides a secure architecture to store land transactions, characterised by enhanced transparency and processing efficiency as well as reduced transaction costs resulting from the lack of intermediaries. What is more, actions aimed at testing the possibilities to use blockchain technology in the field of land registration or even introducing blockchain land registers have been undertaken in some countries around the world. At the same time, however, the above idea deserves a thorough analysis because of the concerns that arise given, on one hand, the nature of blockchain and, on the other hand, essential functions of land registers, connected with the specificity of transactions whose object is land. Indeed, it is characterised by high value compared to other assets as well as particular importance from the socio-economic point of view, which is reflected in strict formal requirements envisaged in law, relating to transfer or establishment of real property rights. What needs a particular emphasis is that due to a complex character of real estate transfer, parties to the contracts are commonly assisted by legal professionals and the effect of land registration proceedings is to ensure not only publicity but also certainty of the transaction. It should be therefore considered what role can be played by blockchain in the area of land registration and, above all, whether it can constitute an alternative to the land registration systems functioning nowadays.

² Niemi, M. I. (2017) Electronic Conveyancing of Real Property in Europe: Two Models. The English and the Finnish One. In: Luz M. Martínez Velencoso, Saki Bailey and Andrea Pradi (eds.). *Transfer of Immovables in European Private Law*. Cambridge: Cambridge University Press, pp. 32 ff. See also: Brennan, G. (2015) *The Impact of eConveyancing on Title Registration: A Risk Assessment*. Cham: Springer, pp. 74 ff.; Cooke, E. (2003) E-conveyancing in England: Enthusiasms and Reluctance. In: David Grinlinton (ed.). *Torrens in the Twenty-first Century*. Wellington: LexisNexis, pp. 277–293.

2. ASSUMPTIONS AND POSSIBLE IMPACT OF BLOCKCHAIN ON IMPROVING LAND REGISTRATION

The features attributed to blockchain technology are deemed to predestine it to be used in the public services sector, especially for the purpose of maintaining public registers, and among them land registers.³ The potential of blockchain for enhancing the quality of recordkeeping is recognised in particular as regards developing countries in which the land registration systems are inefficient and unreliable.⁴ The reason is that blockchain is a method of recording data in a digital ledger. It operates as a distributed database using cryptographic techniques to store a continuously growing list of records of transactions, i.e. blocks, accessible to all computers running the same protocol. The first and the most famous example of application of blockchain is a cryptocurrency called *Bitcoin*. The *Bitcoin* system offers a possibility to carry out online payments directly from one party to another without going through financial institutions serving as trusted third parties.⁵

Under the blockchain concept blocks are grouped together in such a way that the first block (genesis block) is followed by a sequence of time-stamped blocks, each of which contains a unique identifier (a digital fingerprint) called *hash*, being a reference to the previous block. As a consequence, an unbreakable chain of blocks is created because any change of a single transaction is impossible without modifying subsequent

³ See further e.g.: Boucher, P., Nascimento, S. and Kritikos, M. (2017) *How Blockchain Technology Could Change Our Lives: In-depth Analysis*. Brussels: European Parliament Research Service, pp. 18 ff.; Arruñada, B. (2018) Blockchain's Struggle to Deliver Impersonal Exchange. *Minnesota Journal of Law, Science & Technology*, 19, pp. 55 ff.; Young, S. (2018) Changing Governance Models by Applying Blockchain Computing. *The Catholic University Journal of Law & Technology*, 26 (2), pp. 1 ff.; Graglia, J. M. and Mellon, C. (2018) Blockchain and Property in 2018: At the End of the Beginning. In: 2018 World Bank Conference on Land and Poverty, Washington DC, USA, 19–23 March, pp. 8 ff. [online] Available from: https://www.confotool.com/landandpoverty2018/index.php?page=downloadPaper&ismobile=true&filename=02-11-Graglia-864_paper.pdf&form_id=864&form_version=final [Accessed 22 December 2018]; Lemieux, V. L. (2017) Blockchain Recordkeeping: A SWOT Analysis. *Information Management*, 51 (6), pp. 22 ff.; Anand, A., McKibbin, M. and Pichel, F. (2017) Colored Coins: Bitcoin, Blockchain, and Land Administration. In: 2017 World Bank Conference on Land and Poverty, Washington DC, USA, 20–24 March. Available from: <https://cadasta.org/resources/white-papers/bitcoin-blockchain-land/> [Accessed 12 December 2018]; Tapscott, D. and Tapscott, A. (2016) *Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World*. New York: Portfolio/Penguin, pp 6 ff.

⁴ These issues will be expanded in the following sections of the article.

⁵ Nakamoto, S. (2008) *A Peer-to-Peer Electronic Cash System*. [online] Available from: <https://bitcoin.org/bitcoin.pdf> [Accessed 12 December 2018]; Sklaroff, J. M. (2017) Smart Contracts and the Cost of Inflexibility. *University of Pennsylvania Law Review*, 166 (1), pp. 268 ff.

blocks. Before being recorded on the blockchain, transactions are subject to verification performed by users called *miners*, who act within a distributed peer-to-peer network, without the intervention of a central authority, specialised or trusted third parties. Blockchain is based on the consensus mechanism which means that transactions need to obtain approval of the network participants and they are communicated transparently across the entire network. A consensus is reached when the majority of active miners (holding at least 51 % of the computing power) agree to an update in the digital register. Each node, i.e. any computer connected to the system, retains a copy of the history of transactions and the copies should match exactly so that no single user is able to manipulate the data. In order to ensure the integrity and authenticity of records a system of asymmetric cryptography is applied. It is based on digital signatures using public and private keys.⁶

It should be noted that blockchains may be designed as either public or private registers. These two models are correlated with the distinction of permissioned and permissionless types of blockchains.⁷ The description presented above refers generally to public blockchain, which is the basic and best known type. Characteristic to a public blockchain is that any user can join the network and participate in verifying transactions thanks to the use of open source software. Public blockchains are often permissionless as no authorisation or authentication of the participants is required and thus they remain anonymous. In case of private blockchain, in turn, the access is restricted to a specific number of authorised users (including either parties who have been privy to the creation of the register, or parties invited to participate according to the system's rules).⁸ Blockchains of the latter type correspond to the idea of permissioned ones in which participants are identified and can access the system on condition they are authorised and authenticated. Permissioned blockchains are intended rather to be used within corporations (e.g. in the banking sector).⁹ Moreover, a type of blockchain being a combination of private and public

⁶ On how blockchain works see e.g.: Lemieux, V. L. (2017) Op. cit., p. 21; Nogueroles Peiró, N. and Martínez García, E. J. (2017) Blockchain and Land Registration Systems. *European Property Law Journal*, 6 (3), p. 300; Spielman, A. (2016) *Blockchain: Digitally Rebuilding the Real Estate Industry*. [online] pp. 42 ff. Ph.D. Massachusetts Institute of Technology. Available from: <https://dspace.mit.edu/bitstream/handle/1721.1/106753/969450770-MIT.pdf?sequence=1> [Accessed 14 December 2018].

⁷ Lemieux, V. L. (2017) Op. cit., p. 22.

⁸ Thomas, R. (2017) Blockchain's Incompatibility for Use as a Land Registry: Issues of Definition, Feasibility and Risk. *European Property Law Journal*, 6 (3), p. 364.

ones is defined as hybrid blockchain. In this case only specific entities or persons can be part of the blockchain network and participate in the consensus process but at the same time public blockchain is utilised for accounting purposes and as a proof of existence.¹⁰ It is observed, however, that the differences among particular blockchain models are reducing.¹¹

Taking into account the above characteristics of blockchain, in line with arguments put forward by its proponents, predicted benefits resulting from the application of this technology in the field of land registration consist mainly in the lack of intermediaries, a distributed character of the system, transparency and immutability.

Blockchain in its “original” or “pure” form (i.e. the public variant) is defined as a trustless system because it enables the parties to enter into peer-to-peer online transactions without the participation of professional facilitators such as registries, banks, notaries, conveyancers or real estate agents. The only players involved are parties to the transactions assisted by miners whose role is to validate blocks.¹² Under the mechanism governing the blockchain network the recordation of a transaction is considered to be final and is irreversible, any independent verification of the record to be registered being excluded. Once an entry in the register is made, it cannot be altered or deleted without the consent of the miners which provides security from manipulation. It is therefore assumed that no trust is needed anymore. As expected, the elimination of intermediaries from the transaction process shall lead to reduction of costs, savings in time and increased processing efficiency.¹³

The second key advantage of blockchain is considered to lie in the distribution of information in different nodes. Thanks to the fact that

⁹ Lemieux, V. L. (2017) Op. cit., p. 22; Gabison, G. (2016) Policy Considerations for the Blockchain Technology Public and Private Applications. *SMU Science & Technology Law Review*, 189, pp. 330 ff.

¹⁰ Szostek, D. (2018) *Blockchain a prawo*. Warszawa: C.H. Beck, pp. 49, 103 ff.; Vos, J. (2015) Blockchain-based Land Registry: Panacea, Illusion or Something in Between?. *7th ELRA Annual Publication*, pp. 16–19. [online] Available from: <https://www.elra.eu/wp-content/uploads/2017/02/10.-Jacques-Vos-Blockchain-based-Land-Registry.pdf> [Accessed 12 December 2018].

¹¹ Jeżak, Ł. (2019) *Blockchain Prywatny VS Blockchain Publiczny*. [online] Available from: <https://bithub.pl/artykuły/blockchain-prywatny-vs-blockchain-publiczny/> [Accessed 14 April 2019].

¹² Thomas, R. (2017) Op. cit., p. 365.

¹³ Thomas, R. (2017) Op. cit., pp. 365–366; Nogueroles Peiró, N. and Martinez García, E. J. (2017) Op. cit., p. 319; Lemieux, V. L. (2017) Op. cit., p. 23; Vos, J. (2015) Op. cit., p. 3.

the digital register, being a shared database, is replicated in each node, the system becomes more secure because any attack is more difficult.¹⁴ Since a large number of users participate in the blockchain network, there is no single point of control. Consequently, even if a part of the network fails, the other parts continue to operate.¹⁵ The idea of broadcasting the transactions to the blockchain network and the application of consensus mechanism shall contribute to solving the problem of double spending (this refers to a situation in which an owner of a digital currency file can easily make a copy of that file and send it to more than one person) or rather double selling (when considering the possibility to dispose of property simultaneously more than once).¹⁶ As opposed to the above model, the existing land registries commonly use one central database.

It is also highlighted that all entries in the distributed database are public and can be viewed by the authorised users of the blockchain system (as indicated above, the access may be limited when dealing with a private blockchain). Therefore, the level of transparency shall be increased, given that every new block, once added to a public blockchain, is available for anyone to verify its authenticity.¹⁷

Finally, a positive attribute of blockchain is that the integrity of the system is ensured through the application of cryptographic techniques so that any attempt to change the information recorded can be easily detected. It is suggested that this solution ensures protection against potential frauds.¹⁸

3. INCONSISTENCIES AND CONTROVERSIES ABOUT THE IDEA OF A BLOCKCHAIN LAND REGISTRY

Notwithstanding the abovementioned potential advantages resulting from the use of blockchain technology in the land registration domain, there is a need to further analyse the blockchain construct in order to verify whether such a solution is indeed suitable for real estate transactions. Before examining in more detail some questionable issues in this regard, account

¹⁴ Nogueroles Peiró, N. and Martínez García, E. J. (2017) Op. cit., pp. 300, 319.

¹⁵ Thomas, R. (2017) Op. cit., p. 366.

¹⁶ Vos, J. (2015) Op. cit., p. 5; Sklaroff, J. M. (2017) Op. cit., p. 269.

¹⁷ Thomas, R. (2017) Op. cit., p. 366; Vos, J. (2015) Op. cit., p. 11; Spielman, A. (2016) Op. cit., p. 42.

¹⁸ Thomas, R. (2017) Op. cit., p. 367; Lemieux, V. L. (2017) Op. cit., p. 22; Nogueroles Peiró, N. and Martínez García, E. J. (2017) Op. cit., p. 319.

must be taken of the complexity of rules governing land transfer and land registration as well as considerable socio-economic relevance of purchase of real estate given that the subject of such transactions are unique high-value assets.¹⁹ This is demonstrated particularly by the role notaries and other specialised lawyers commonly play in the conveyancing and registration process. In most European countries, following the Latin model of notariat, notaries act as persons of public trust vested with competences to draw up agreements of transfer of immovable property and the form of notarial deed is required to complete the registration.²⁰ It should also be underlined that a common characteristic of land registration systems is that registers are maintained by public authorities, being either courts or administrative bodies, but at the same time further significant differences exist among registration regimes adopted in particular countries.²¹

For instance, in terms of the subject of registration a distinction is made between registers of titles and registers of deeds. With respect to title registration, rights on land are inscribed in the register upon prior examination of their legality. This system is characteristic e.g. for Poland, England and Wales, Germany, Spain and Sweden, to mention just a few European countries. By contrast, in case of deeds registration documents regarding land transactions are registered, basically without

¹⁹ See e.g.: Barbieri, M. and Gassen, D. (2017) Blockchain – Can This New Technology Revolutionize the Land Registry System? In: *2017 World Bank Conference on Land and Poverty*, Washington DC, USA, 20–24 March, pp. 8, 11. Available from: http://www.notartel.it/export/contenuti/notartel/pdf/Land_Poverty_Conference_Blockchain.pdf [Accessed 12 December 2018]; Arruñada, B. (2018) Op. cit., p. 78; Méndez, F. P. (2018) *Smart Contracts, Blockchain and Land Registry*. [speech] European Land Registry Association (ELRA) General Assembly. Brussels, 30 November, pp. 7–8. Available from: <https://www.elra.eu/wp-content/uploads/2018/12/Smart-Contracts-Blockchain-and-Land-Registry-by-F-Mendez.pdf> [Accessed 18 December 2018].

²⁰ See e.g.: Blajer, P. (2018) *Rejestry nieruchomości – studium prawnoporównawcze*. Warszawa: C.H. Beck, pp. 183 ff.; Bertrand du Marais and David Marrani (eds.). (2016) *Legal Certainty in Real Estate Transactions: A Comparison of England and France*. Cambridge: Intersentia, *passim*. See also: Méndez, F. P. (2018) The Land Registrar as a Legal Professional. *7th ELRA Annual Publication*, pp. 1 ff. Available from: <https://www.elra.eu/wp-content/uploads/2017/02/6.-Fernando-P.-Mendez-The-Land-Registrar-as-a-Legal-Professional.pdf> [Accessed 7 January 2019].

²¹ See e.g.: Blajer, P. (2018) Op. cit., pp. 337 ff.; Stawecki, T. (2002) Rejestry nieruchomości, księgi hipoteczne i księgi wieczyste od czasów najdawniejszych do XXI wieku. *Studia Iuridica*, 40, pp. 167–208; Martínez Velencoso, L. M. (2017) The Land Register in European Law: A Comparative and Economic Analysis. In: Luz M. Martínez Velencoso, Saki Bailey and Andrea Pradi (eds.) *Transfer of Immovables in European Private Law*. Cambridge: Cambridge University Press, pp. 3 ff.; Cámará Lapuente, S. (2005) Registration of Interests as a Formality of Contracts: Comparative Remarks on Land Registers within the Frame of European Private Law. *European Review of Private Law*, 6, pp. 798 ff.; Lodde, A. (2016) The European Systems of Real Estate Registration: An Overview. *Territorio Italia*, 1, pp. 23–42; Zevenbergen, J. (2002) *Systems of Land Registration: Aspects and Effects*. Delft: Netherlands Geodetic Commission (NCG), pp. 47 ff.

the identification of the last genuine title-holder. Thus, the land register is merely a collection of documents which only have to comply with formal requirements. However, modern registers of documents are often improved and well-organised. Examples of registers of that type can be found in Belgium, France, Italy and the Netherlands.²² In addition, depending on particular system, registration may be of a constitutive or a declaratory character. Constitutive registration is necessary and decisive to create or transfer a right on real estate and is applied e.g. in Germany. Under the latter system registration is aimed only to disclose the legal status of real estate and make the transfer of a right opposable to third parties. Declaratory registration is a rule e.g. in France. In some legal orders (e.g. in Poland and Italy) the registration of the transfer of ownership is declaratory, while in case of the creation of limited real rights constitutive registration is required.²³ Other exemplary criteria include the format of registration (real folium or personal folium), public faith attributed to the content of the register (basically good faith in the land register is protected in case of constitutive registration) and the publicity of registered information (public access for everyone or access restricted to persons with a legitimate interest).²⁴

Considering specific rules adopted in different land registration models, it can be argued that the precepts of the blockchain concept followed by the "original" – public blockchain are incompatible with main functions performed by the land registry in the title registration systems. These include principally: the information function, which consists in reducing uncertainty as to the legal status of land by providing detailed and complete land information; the protective function, relating to ensuring accuracy of information that can be relied on by persons acting in trust to the content of the land register, and the control function, connected with the power of the registration authority to check the correctness of the basis for entry in the register.²⁵ It is therefore clear that under the regime of title

²² Blajer, P. (2018) Op. cit., pp. 226 ff.; Martínez Velencoso, L. M. (2017) Op. cit., pp. 9–12; Cámara Lapuente, S. (2005) Op. cit., pp. 831 ff. See also: Blajer, P. (2013) 'Deeds recordation' a 'title registration'. *Rozwiązania modelowe w zakresie rejestrów nieruchomości w systemie 'common law'*. *Zeszyty Prawnicze*, 13 (4), pp. 53–90.

²³ Lodde, A. (2016) Op. cit., pp. 37–38; Cámara Lapuente, S. (2005) Op. cit., pp. 809–812.

²⁴ Blajer, P. (2018) Op. cit., pp. 257 ff., 293 ff., 643 ff.; Lodde, A. (2016) Op. cit., pp. 36, 38, 40; Cámara Lapuente, S. (2005) Op. cit., pp. 832–833.

²⁵ Stawecki, T. (2005) *Rejestry publiczne. Funkcje instytucji*. Warszawa: Wydawnictwo Prawnicze LexisNexis, pp. 36 ff.; Gryszczyńska, A. (2011) Op. cit., pp. 41 ff.

registration the control of substantive aspects of a land transaction is essential, whereas blockchain registration basically excludes any intervention of a specialised authority and thus any external verification of the data submitted to the land register. In contrast to the rule of legality underlying registration of titles, in case of deeds registration systems the examination of documents carried out by registrars is limited to formal aspects. For this reason the latter model seems to correspond with the way the blockchain system is designed as it amounts to no more than a recordation of information.²⁶ Nevertheless, other specific aspects of land registration procedure need to be explored as well to determine whether a register of deeds could really follow the blockchain mechanism. Some of these issues will be addressed below.

Disintermediation, cited as one of main strengths of blockchain technology in the context of streamlining land registration, in fact raises many doubts. It should be pointed out that a consequence of how blockchain in its "hard" ("pure") form operates is that it cannot offer a legal presumption of accuracy of an entry, i.e. a presumption of validity of a transaction regarding land, nor a proof of ownership (in the sense of indicating the legitimate owner), which is the case of title registration systems. This is because validation of a transaction performed by miners may be considered in a technical sense but not in a legal sense so it cannot be treated as an equivalent of examination of the title carried out by the registrar. Instead, the only presumption that can be provided for is a factual presumption of authenticity which refers to the date of the transaction, the identity of the parties, the declarations made by them and the time the new block has been added to the chain.²⁷ In consequence, the information stored in the land register cannot be regarded as reliable.

What is more, the idea of blockchain infrastructure poses problems related to conferring priority which is the effect of both title registration and deeds registration. According to the existing rules governing land registration priority assigned to titles or deeds is dependent mainly on the time of application. Therefore, the moment a relevant document

²⁶ Cf. Nogueroles Peiró, N. and Martínez García, E. J. (2017) Op. cit., pp. 301 ff.; Arruñada, B. (2018) Op. cit., pp. 95–96; Méndez, F. P. (2018) Op. cit., p. 19.

²⁷ On this matter, it is justified to share the view of: Nogueroles Peiró, N. and Martínez García, E. J. (2017) Op. cit., pp. 315–316, 319. See also: Szczerbowski, J. J. (2018) *Lex cryptographia. Znaczenie prawnie umów i jednostek rozliczeniowych opartych na technologii blockchain*. Warszawa: Wydawnictwo Naukowe PWN, pp. 42 ff.

arrives to the land registry is decisive to determine the rank in case of a conflict of rights to be registered. In this respect, instruments such as notices of submitted applications are of importance as they prevent the risk connected with the registration gap, i.e. the period between the completion of a transaction and the registration. The warning function of notices is enhanced if the applications are sent to the register electronically. When it comes to the blockchain system, there is no guarantee that the order in which transactions are received by the nodes is the same order in which new blocks are added, the reason being that the order is not based on chronology of applications and depends on a random act.²⁸ In such case the registration gap cannot be eliminated and it becomes difficult to prevent double selling.²⁹ The above risk is even greater in view of the fact that miners are rewarded for validating new transactions and receive fees for obtaining priority. Furthermore, in practice groups of miners, so-called mining pools or mining farms, are created in order to control most of the processing power so that the decentralisation of the blockchain system and the democratic nature of consensus must be put into question. Hypothetically, in such a situation a threat arises not only of manipulating the priority but also of depriving the legitimate owners of their property.³⁰ On this basis, it should be stated that the blockchain's operating methods do not prove appropriate even for deeds registration. After all, under this system priority is not conferred in a mechanical manner, taking into account the applicable rules on good faith and notices.

Another problematic issue connected with the way blockchain is structured regards legal liability in case of errors affecting the transactions to be recorded. This is because blockchain is based on the assumption that there is no single point of failure³¹. As for traditional land registration systems, normally the state liability is envisaged and a compensation is paid in case of a loss suffered due to mistakes from the land registry. When determining who shall bear the risk of mistakes or responsibility for blockchain system abuses we can consider the system administrator, the users of the system (collectively) as well as a person who has derived

²⁸ Nogueroles Peiró, N. and Martínez García, E. J. (2017) Op. cit., pp. 302–305.

²⁹ Méndez, F. P. (2018) Op. cit., pp. 15–16, 19–20.

³⁰ Barbieri, M. and Gassen, D. (2017) Op. cit., pp. 5, 11–12. See also: Gallego, L. (2016) Blockchain and Title Registration. *IPRA-CINDER International Review*, 1, pp. 49–50.

³¹ Gabison, G. (2016) Op. cit., pp. 343 ff.

a benefit as a result of irregular transactions.³² This matter is however more complicated due to the anonymity of the participants of the network which is one of the basic features of blockchain in its “original” form. Although the participating users are connected to digital certificates, their identity is not revealed. This also may entail a difficulty to establish the law applicable to liability in case miners represent different nationalities.³³ Again, the above problems can affect both title registration and deeds registration systems.

In this context the question concerning the anonymous character of blockchain should be developed. A situation in which the identity of the parties involved in the blockchain is not disclosed to the other users is incompatible with the very idea of land registers as one of their core functions is to ensure publicity. Overall, in conditions of anonymity real estate transactions would be hardly conceivable. In order to resolve these difficulties it is postulated that electronic IDs connected to the public keys could be used.³⁴ However, another problem arises – to determine who could receive a public key in the blockchain and under which procedure.³⁵ Moreover, the issue of privacy should be taken into account here.³⁶

There are reasonable grounds to observe that due to the lack of an independent verification, the lack of disclosure of the network participants' identity and the risk of irregularities resulting therefrom, when dealing with a blockchain-based land registration – contrary to the arguments advanced by its advocates – the conveyancing costs can increase instead of decreasing. It can be assumed that the financial institutions providing services to parties may require the involvement of specialised intermediaries in the transactions as a means of hedging their risk; furthermore, extended due diligence exercises and title insurances may be needed.³⁷ Above all, one should consider the perspective of legal recourse as an indispensability. This also applies to situations in which an encryption key is lost or stolen and it is necessary to recover the property

³² See further: Thomas, R. (2017) Op. cit., pp. 387 ff.; Gallego, L. (2016) Op. cit., pp. 30–31.

³³ Nogueroles Peiró, N. and Martínez García, E. J. (2017) Op. cit., pp. 313–314. Cf. Vos, J. (2015) Op. cit., p. 7.

³⁴ Verheyen, B. (2017) Real Estate Publicity in a Blockchain World: A Critical Assessment. *European Property Law Journal*, 6 (3), pp. 458–459. See also: Vos, J. (2015) Op. cit., p. 14.

³⁵ Verheyen, B. (2017) Op. cit., p. 459.

³⁶ Lemieux, V. L. (2017a) Op. cit., pp. 22–23.

³⁷ This is sensibly suggested by: Thomas, R. (2017) Op. cit., pp. 386–387.

associated with it.³⁸ These issues can become particularly problematic if we consider the use of blockchain in cross-border conveyancing, in view of the noticeable diversity of land registration systems.

In contrast to public blockchain, it can be assumed that the features of private or hybrid blockchains would allow some of the above problems to be overcome. Nevertheless, in such case the distributed nature of blockchain, promoted as one of its main advantages, is frustrated³⁹. What is more, there is still a need for trust, which, indeed, shall be supposed to be unnecessary under the blockchain concept.⁴⁰

4. PRACTICAL APPLICATION OF BLOCKCHAIN IN THE AREA OF LAND REGISTRATION – EXAMPLES

As mentioned above, the idea to convert land registers to blockchain databases is already being implemented in practice as shown by initiatives undertaken by governments in such countries as the Republic of Georgia, Sweden, Ukraine, Ghana, Brazil, Honduras, India and Japan. This proves that blockchain-based land registration is of interest to both developing and advanced economies. Recently, a debate on possibilities to use blockchain technology in the real estate market has also been launched in Poland with setting up the *Working Group on Distributed Ledgers and Blockchain* at the *Ministry of Digital Affairs*.⁴¹ In order to illustrate potential solutions in this regard, experiences of Georgia, Sweden and Brazil will be outlined.

The Republic of Georgia is the first country that has started registering land titles using blockchain, with the aim to increase the level of trust. Georgia has developed a blockchain-based registration system as a result of cooperation between the *National Agency of Public Registry (NAPR)* and a bitcoin mining company *Bitfury*. It should be emphasised that before introducing blockchain technology the Georgian land registration system has been reformed for decades so that it has become relatively efficient and corruption-free.⁴² The land register is based on a private permissioned blockchain, administered by *NAPR*, acting as a third party enforcer.

³⁸ Szczerbowski, J. J. (2018b) Transaction Costs of Blockchain Smart Contracts. *Law and Forensic Science*, 16 (2), pp. 1–6; Barbieri, M. and Gassen, D. (2017) Op. cit., p. 12; Graglia, J. M. and Mellon, C. (2018) Op. cit., p. 12.

³⁹ Vos, J. (2015) Op. cit., pp. 16 ff.

⁴⁰ Lemieux, V. L. (2017) Op. cit., p. 23.

⁴¹ Ministerstwo Cyfryzacji. (2018) *Grupa robocza ds. rejestrów rozproszonych i blockchain*. Available from: <https://www.gov.pl/web/cyfryzacja/grupa-robocka-ds-rejestrow-rozproszonych-i-blockchain> [Accessed 4 January 2019].

The scope of the implemented project covers sale of land titles, registration of new titles, mortgages, rentals and notary services.⁴³ It is assessed that the above initiative has brought positive effects of increased trust and transparency and there are plans to introduce blockchain technology in other sectors of the administration as well.⁴⁴

Another example of jurisdiction experimenting with blockchain is Sweden. In 2016 the Swedish land registration authority, *Lantmäteriet*, together with a group of partners (including a blockchain startup *ChromaWay*, a consulting company *Kairos Future* and a telecommunications company *Telia*) launched a pilot project to evaluate potential blockchain applications for real estate transactions. According to the assumptions blockchain could be used as a technical solution intended to make the well-functioning land register more efficient. Currently the process from signing the contract of sale until the registration of the property takes approximately 4 months, although the register is digitised and most real estate contracts are submitted to the registry in digital form.⁴⁵ The project has already undergone three stages. After two initial phases, including the proof of concept and building a testbed with working technology, the third stage, aimed at conducting a real-world property transfer using the blockchain system, was completed in June 2018.⁴⁶ The testbed created for the project is based on a private blockchain network. It is accessible only to authorised parties using a smart contract application that manages the transactions. It is designed to store verification records of documents

⁴² Santiso, C. (2018) Will Blockchain Disrupt Government Corruption? *Stanford Social Innovation Review*, (March). [online] Available from: https://ssir.org/articles/entry/will_blockchain_disrupt_government_corruption [Accessed 21 December 2018].

⁴³ Graglia, J. M. and Mellon, C. (2018) Op. cit., pp. 33–34; Higgins, S. (2017) *Republic of Georgia to Develop Blockchain Land Registry*. [online] Available from: <https://www.coindesk.com/bitfury-working-with-georgian-government-on-blockchain-land-registry> [Accessed 21 December 2018]; Shin, L. (2017) The First Government to Secure Land Titles on the Bitcoin Blockchain Expands Project. *Forbes*, 7 February. Available from: <https://www.forbes.com/sites/laurashin/2017/02/07/the-first-government-to-secure-land-titles-on-the-bitcoin-blockchain-expands-project/#2ae7c5184dd> [Accessed 21 December 2018]; Nimfuehr, M. (2017) *Blockchain Application Land Register: Georgia and Sweden Leading*. [online] Available from: <https://medium.com/bitcoinblase/blockchain-application-land-register-georgia-and-sweden-leading-e7fa9800170c> [Accessed 21 December 2018]; Nogueroles Peiró, N. and Martinez García, E. J. (2017) Op. cit., p. 317.

⁴⁴ Verheyen, B. (2017) Op. cit., p. 448; Graglia, J. M. and Mellon, C. (2018) Op. cit., p. 34.

⁴⁵ McMurren, J., Young, A. and Verhults, S. (2018) *Addressing Transaction Costs Through Blockchain and Identity in Swedish Land Transfers*. [case study] pp. 4 ff. Available from: <https://blockchan.ge/blockchange-land-registry.pdf> [Accessed 14 November 2018]; Lemieux, V. L. (2017) Evaluating the Use of Blockchain in Land Transactions. *European Property Law Journal*, 6 (3), pp. 410 ff.; Graglia, J. M. and Mellon, C. (2018) Op. cit., p. 38; Nogueroles Peiró, N. and Martinez García, E. J. (2017) Op. cit., pp. 316–317; Verheyen, B. (2017) Op. cit., pp. 447–448; Nimfuehr, M. (2017) Op. cit.

and not documents themselves, which shall be held by each party to the agreement. Moreover, verification records are summarised in an external blockchain that is transparent to the public. Professional users, such as banks, real estate agents and *Lantmäteriet*, access the contract in a professional interface, which can be integrated with their own systems. Administrators at the land registry and its technical partners administer the contract through a third interface, with changes overseen by all partners running the blockchain. The project also envisages the application of a digital ID system.⁴⁷

Unlike Georgia and Sweden, Brazil lacks a modern integrated land registration system and faces challenges connected with corruption and frauds. The major part of the territory is untitled, there is no electronic database for examining encumbrances and the registration procedure is a complex one. In 19th century the *Torrens* system, based on registration of titles, was adopted in Brazil but it is not much used in practice.⁴⁸ A blockchain pilot project was launched in 2017 by the real estate registry office, *Cartório de Registro de Imóveis*, in cooperation with a blockchain technology company *Ubitquity* in the State of *Rio Grande do Sul*, Municipalities of *Pelotas* and *Morro Redondo*. It is expected that this initiative will improve accuracy, security and transparency of the land registration process as well as lower costs. The purpose of the project is to introduce a parallel blockchain platform to replicate the existing legal structure of property recording and transfer processes, with the use of the Software as a Service business model to record land transactions on behalf of companies and government agencies. The system architecture

⁴⁶ ChromaWay. (2018) *Blockchain and Future House Purchases: Third Phase to Be Completed in April 2018*. [online] Available from: <https://chromaway.com/landregistry/> [Accessed 27 December 2018]; Kempe, M. (2016) *The Land Registry in the Blockchain: A Development Project with Lantmäteriet (The Swedish Mapping, Cadastral and Land Registration Authority), Telia Company, ChromaWay and Kairos Future*. [online] Available from: http://icait.org/pdf/Blockchain_Landregistry_Report.pdf [Accessed 27 December 2018]; Kempe, M. (2017) *The Land Registry in the Blockchain – Testbed. A Development Project with Lantmäteriet, Landshypotek Bank, SBÅB, Telia Company, ChromaWay and Kairos Future*. [online] Available from: https://chromaway.com/papers/Blockchain_Landregistry_Report_2017.pdf [Accessed 27 December 2018]; Kim, C. (2018) *Sweden's Land Registry Demos Live Transaction on a Blockchain*. [online] Available from: <https://www.coindesk.com/sweden-demos-live-land-registry-transaction-on-a-blockchain/> [Accessed 27 December 2018].

⁴⁷ McMurren, J., Young, A. and Verhults, S. (2018) Op. cit., p. 5; Kempe, M. (2017) Op. cit., pp. 59 ff. See also: Verheyen, B. (2017) Op. cit., p. 458; Nogueroles Peiró, N. and Martinez García, E. J. (2017) Op. cit., p. 317.

⁴⁸ Blajer, P. (2013) Op. cit., p. 73; Cash, A. (2016) *Land Registration in Brazil: An Interview with Alex Ferreira Magalhães*. [online] Available from: <http://www.rioonwatch.org/?p=29200> [Accessed 29 December 2018].

encompasses web frontend that captures information taken from the general real estate registry as well as a web server and backend storage. Additionally, *Colu Colored Coins* protocol is applied to record transactions on the *Bitcoin* blockchain. *Colored Coins* is a group of protocols and methods for representing and managing real world assets, such as real estate, as a data layer on top of a blockchain. In the longer term it is planned to create a system that would incorporate the features of blockchain technology to transform the existing recording and land transfer.⁴⁹

5. CONCLUSION

Concerns raised in the course of the analysis show that blockchain technology in the “classic” form (the public type) is not suitable for the specificity of real estate transfer and land registration. The reason is that the idea behind the blockchain mechanism excludes the possibility to guarantee legal certainty and this applies not only to land registration systems based on title registration, in particular of constitutive character, but also to deeds registration systems under which land registration is not necessary to complete the transfer of ownership. Certainly, a land register cannot be equated to a simple database and land transfer is far more complex than the purchase of low-value consumer goods.

In consequence, blockchain could be applied provided it is adapted to the existing land registration architecture. Conditions to be met in this respect regard primarily limiting the access to the blockchain system and reducing the number of miners to persons fulfilling particular qualifications as well as ensuring proper identification of the users and defining liability rules. As an institutional infrastructure is indispensable to guarantee real property rights, only the use of a private or a hybrid blockchain, administered by the land registry and used by the current stakeholders of real estate transactions (like notaries and conveyancers) could be taken into consideration.⁵⁰

⁴⁹ Lemieux, V. L. (2017b) Op. cit., pp. 403 ff.; Lemieux, V. L., Flores, D. and Lacombe, C. (2017) *Real Estate Transaction Recording in the Blockchain in Brazil (RCPLAC-01)*. [case study] pp. 7 ff. Available from: http://blogs.ubc.ca/recordsinthechain/files/2018/01/RCPLM-01-Case-Study-1_v14_English_Final.pdf [Accessed 27 December 2018]; Graglia, J. M. and Mellon, C. (2018) Op. cit., p. 56; Keirns, G. (2017) *Blockchain Land Registry Tech Gets Test in Brazil*. [online] Available from: <https://www.coindesk.com/blockchain-land-registry-tech-gets-test-brazil> [Accessed 27 December 2018].

⁵⁰ In this regard, I concur with the arguments put forward by: Thomas, R. (2017) Op. cit., p. 390; Nogueroles Peiró, N. and Martinez García, E. J. (2017) Op. cit., p. 319; Verheyen, B. (2017) Op. cit., pp. 465 ff.; Vos, J. (2015) Op. cit., p. 19.

This is also confirmed by the examples provided above (including systems representing the title registration model). In Sweden and Georgia, whose land registers are quite developed and have been digitised, public intervention is maintained and a private blockchain is used as a complementary technology supporting the existing registration systems. The Brazilian conveyancing system, in turn, is unsafe and therefore at the first stage of the pilot project blockchain is supposed to play a role of preserving the archive and facilitating its recovery in case of attack or loss. On this basis, it is reasonably recommended that applying blockchain technology should be preceded by digitisation of land registers.⁵¹ At the same time, blockchain is rightly considered to have a potential in terms of storage of information.⁵²

Furthermore, it should be observed that currently available technological solutions applied in the area of land registration prove to be sufficient to obtain effects considered as main blockchain's advantages, i.e. security, integrity and transparency. Particular reference should be made here to advanced methods of identification, based on digital signatures, as well as electronic time-stamping.⁵³ This shall call into question the justification for transforming land registers in blockchain databases as, indeed, the core novelty of blockchain consists in the distribution of information.

The above remarks lead to a conclusion that blockchain can be effectively used as a tool serving to improve the efficiency of the existing land registration systems, after an appropriate adjustment. It is therefore advisable to continue the discussion on optimal legal and technical ways of taking advantage of the possibilities offered by blockchain technology, in accordance with the principal functions of land registers.

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⁵¹ Graglia, J. M. and Mellon, C. (2018) Op. cit., p. 11.

⁵² Nogueroles Peiró, N. and Martinez García, E. J. (2017) Op. cit., p. 318.

⁵³ This is also accurately pointed out by: Nogueroles Peiró, N. and Martinez García, E. J. (2017) Op. cit., p. 319.

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