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Influence of blockchain on development of interaction system of investment and construction activity participants

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Abstract. The main principles of blockchain operation and its main advantages of efficiency increase of investment and construction activity (ICA) participants' interaction are described in this article. Blockchain process operation principles in a technical sense are stated. Practical examples of efficiency increase of ICA participants' interaction with the use of blockchain process in Russia and abroad are given. The main trends and results of blockchain use in construction domain are systematised. Potential of blockchain process use in development of the system of ICA participants' interaction is described. Specific features and advantages of blockchain use in construction domain are highlighted. The main problems requiring improvement of normative and methodical base while developing blockchain within ICA participants' interaction are analysed. The article gives a review of blockchain influence on improvement of the process of ICA participants' interaction.

1. Introduction

The main problems in construction domain under present-day conditions are insufficient information support of investment and construction market players, high corruption level and non-transparency in implementation of investment and construction designs with the use of budgetary funds. Lately, there has been a push in development of investment and construction activity due to transition to digital economy. This has led to digitalisation of business processes, introduction of digital technologies in the activity of majority of construction domain interacting subjects. Use of digital technologies during interaction between the subjects of construction domain provides for competitiveness in business, increase of business process efficiency, achievement of synergetic effect and the whole sector enhancement due to network interaction between ICA participants, usage of digital platforms, payment systems and digital monetary funds [1].

One of the most prospective digital technologies in construction domain is the system of distributed registers, i.e. blockchain.

Despite gradual introduction of this technology in construction domain, its influence on further development of ICA participants' interaction system in nowadays market conditions has not been studied sufficiently. That's why an urgent problem is analysis of the current status of blockchain process development, specificity of designs developed on its basis in construction domain, and trends of ICA participants' interaction development.

The main objective of this research work is analysis of trends and features of blockchain process usage in ICA and blockchain influence on development of the system of its participants' interaction.



2. Theory and practice of blockchain in present-day construction

The issues regarding the use of this process in various areas of business activity are described both in Russian and foreign scientific works. Specialists in this area have not developed a common approach to blockchain advantages or disadvantages. However, nowadays this technology gains more and more confidence among market players in construction domain under existing conditions of economic globalisation. In the book “The Blockchain Revolution”, the writers Don and Alex Tapscott define blockchain as “an eternal digital distributed log of economic transactions which can be programmed for recording of not only financial operations, but practically everything that is valuable” [2]. The blockchain process functions as a distributed data base, at that, data storage units are not connected to common server. In this data base, continuously extended list of ordered records-blocks is stored, each containing time mark and reference to the previous block. By use of encoding, users get an opportunity to change only those parts of blockchain which are accessible to them, i.e. blockchains have private keys limiting access to files. Besides, encoding provides synchronisation of copies of a distributed blockchain of all users who have access to the latter ones [3].

Consequently, a block is a data package containing all the previous data and a part of new data. The chain itself is a data base distributed among the participants, functioning without centralised control [4]. The key element of blockchain is exactly lack of centralisation that means that data are stored on user computers, with that, users can see the same. That's why blockchain always works and cannot be cracked; at least as long as minimum one computer operates which is hooked up. The system functions in such a way that all participants of blockchain continuously check arriving data, and the result is confirmation of integrity and validity of network data during operation [5]. New records are generated in the end of blockchains over already checked ones and are partially based on them. Change of a part of data by fraud will cause necessity of changing the further data chain. Otherwise, there will be an error, which will be noted by all the participants, at that, it will be technically difficult and labour intensive to change data on the majority of computers. That's why, on account of unavailability of the central server which can be cracked, or its owner who can be influenced on, blockchain provides data integrity and accuracy [4].

In the opinion of D. L. Seutz, the main advantages of blockchain processes include the following: trust-based data exchange; trust to the algorithm, decentralisation of the system, unchanged data; absence of mediators between participants and authorised users; data quality, integrity, transparency and stability, reliability; accessibility and rapid transactions; duration, lower transaction expenditures [6].

In the opinion of the authors J. Wang, P. Wu, X. Wang, W. Shou, presently, the blockchain process has a number of advantages which could contribute to solution of the problems of construction domain [7]:

- transparency due to public or distributed storage that means open access to events record for all the system participants;
- providing confidentiality of data by decentralisation, necessity of encoding key for data access;
- equal rights of participants, equal status and capabilities, as there are no administrators (data keepers) in blockchain;
- encoding for transaction confirmation providing safety.

In the work of authors M. A. Motorina, R. I. Evarovich, it is said that blockchain is a method of recording of all public data (bargains, agreements, contracts) whose specificity is in decentralised data storage and providing investment and construction market players with access to necessary data. Blockchain eliminates distrust between the participants which is characteristic of the construction domain in its various aspects and minimises bargaining risks [8].

Thus, block-chain process can substantially minimise the possibility of fraud and corruption schemes and provide safety of ICA participants' interests [7]. Apart from above advantages of blockchain process, one may highlight low transaction cost, minimisation of time consumption to fulfil the functions and tasks by all ICA participants during interaction.

Blockchain process in construction domain shall be divided into a number of trends, such as transfer of register and document flow to blockchain, and, in our case, real estate "tokenization". Token is an account unit used to present digital balance in a certain asset. Token account is provided in data base on the basis of blockchain, and access to it is via electronic digital signature with the use of special applications. Tokenization makes digital analogues to real assets for efficient and safe control of them. This trend of development of blockchain designs is considered the most prospective, as tokenization provides transformation of real estate objects into liquid digital form.

In table 1, the main trends of blockchain usage in construction are given.

Table 1. The main trends and results of blockchain use in construction domain.

Use trend	Designs with the use of blockchain process
Construction monitoring for interaction between participants of investments into real estate throughout the world	<ul style="list-style-type: none"> Digital Platform BitRent is designed to provide accessibility and transparency of investment process. Monitoring of construction process is implemented by means of open modelling and automation monitoring. In construction, radio frequency marks RFID are applied, installed on structure parts which register the status of construction elements in real time [9].
Environmental Protection	<ul style="list-style-type: none"> Technological solution of chipping the blocks of new objects of capital construction provides on-line access to objective data on their status [10]. Chipping of building structures will provide tracing not only their effect on the environment, but also the general status for about 50 years. In total, one can monitor both suitability of structures, and secondary processing of their constituent materials.
Capital construction object design	<ul style="list-style-type: none"> Another blockchain process is information modelling of buildings (BIM) aimed at simplification of the process of design and social assessment of real estate objects taking into account all aspects including suppliers and manufacturers of construction materials [11]. Usage of blockchain and the above construction technologies will provide creation of an independent platform with whose usage one can trace the process of construction, monitor quality, provide design monitoring, and also invest into objects with the use of smart contract system.
Investment into real estate objects	<ul style="list-style-type: none"> Investment process at the primary stage of construction is implemented for crypto currency via Platform BitRent from any place in the world by all concerned participants, both large companies, and individual investors. Practically, Platform BitRent combines the construction, engineering, financial, technical domains and blockchain. Platform BitRent in future will provide transition of all real estate registers to blockchain [12]. Among commercial Russian construction companies one of the first one which introduced blockchain was Osnova SC founded on the basis of the former Morton SC. In 2017, the company became the cofounder of ICO Lab Ecosystem, a multiplatform system with the purpose to search investors for prospective blockchain start-ups. One more project is Platform for ICO (location and attraction of investments for start-ups in crypto currency), which will provide start-ups' emitting of tokens, digital analogues of shares, and investors will be able to buy them for crypto currency making investments into projects [13].

Use trend	Designs with the use of blockchain process
Road construction and repair	<ul style="list-style-type: none"> • Functioning of the system of common accreditation of participants of state and corporate purchases on all electronic platforms permitted to bid according to laws No. 44-FZ and No. 223-FZ is feasible by the principle of single distributed register on blockchain providing multiple verifications of data and exclusion of their illegal changes. Electronic platforms may be connected to the Platform by FL No. 44-FZ and FL No. 223-FZ. For today, such a system is planned to be introduced in RTS-Tender [6, 14]. • The system of common accreditation of participants of purchases on all platforms will substantially extend the options of their participation in tenders. As a result, it is possible to collectively solve the problems associated with purchases, for example, to substantially simplify access for small and medium companies to participation in purchases, provide creation and automatic updating of the single vendor profile and optimise operational expenses of large certifying centres. As a result, blockchain will provide increase of efficiency of information interaction, transparency and purchase security. [12, 13].
Registration of agreements of participatory construction interest (APCI)	<ul style="list-style-type: none"> • The project was implemented by Rosreestr together with AHML and Vnesheconombank (VEB). The first APCI with application of blockchain technology was registered in the housing complex of village Kedrovo of the Vsevolozhsk District of the Leningrad Region. Also, 42 APCIs for purchasing apartments in the same housing complex were concluded on blockchain, and the object delivery was planned for the second quarter of 2020 [14]. • The principle of operation of technology with APCI as an example is specific. At first, agreement on blockchain service is registered. Participants of ICA in this case are: applicant (whose agreement is registered); builder by object in relation to which the agreement is being registered; Rosreestr; the Foundation of Civil Rights Protection in Participatory Construction Interest (hereinafter referred to as Foundation), to which the builder pays over 1.2% from the sum of every agreement. When Rosreestr receives data on assets payment from the Foundation, the agreement is subject to registration. [14]. • The agreement concluded using blockchain technology proves that the builder made payment by APCI, and that operation corresponds to requirements of the Russian Federation law. E-document contains topical data accessible simultaneously for all participants of the agreement. The quantity of participants in APCI registration with the use of blockchain remains the same, but the process of registration is simplified. The sides of an agreement can change the terms of the agreement independently. Blockchain is used during interaction of IT-systems of Rosreestr with the Foundation and simplifies the interdepartmental cooperation. The use of blockchain process within the design reduces the time of interaction of Rosreestr with the Foundation [15]. Previously, data from the Foundation arrived at Rosreestr within one day, with the use of blockchain, this process takes from 15 minutes to one hour.
Improvement of interaction of construction domain participants and credit institutions	<ul style="list-style-type: none"> • An example is agreement between Tinkoff Bank and AHML on foundation of a joint venture in 2018, whose aim will be mortgage credit granting and support on E-Process Platform. The Platform provides drawing of mortgage clients via Internet with the use of Tinkoff Bank technologies. This development includes the system of automatic finalisation of mortgage requests by AHML standards, signing credit documents and credit granting, on-line registration of agreements in Rosreestr and on-line accommodation of bank mortgage whose shareholder is AHML.

3. Discussion

The world experience of blockchain introduction into ICA is vast. In many countries (Sweden, the Ukraine, Greece, UAE, Russia, Georgia, Japan, Ghana), designs are prepared on transition of real estate federal registers to blockchain that provides reliability of data storage and reducing the time of bargain registration. In the Ukraine, in 2017, for the first time in the world, a transatlantic electronic

bargain was concluded on agreement of real estate exchange with the use of smart-contract on blockchain Ethereum. The apartment in Kiev was bought by an American citizen via decentralised marketplace of real estate Propy (USA), the object seller was located in New York. The deal was paid in Ethereum [16].

Radical changes in the global real estate market will provide for electronic purchase and sale deals in mode 24/7, and all the deal data will be recorded in blockchain [17]. The Buyer will receive electronic certificate of property right reliably protected by blockchain technology. The bargain process will be automated with smart contract. As per scientists view, a problematic issue might be in use of legal consequences of bargain invalidity and return of property by purchase and sale agreement because it is not possible to cancel or change data in blockchain. These provisions of civil legislation in blockchain have not been implemented yet, probably, instead of bargain record cancellation, a new record on right transfer to the former owner will be made in the register [18].

While mastering blockchain within interaction of ICA participants and elimination of problematic aspects, normative and methodical base will be improved. Changes in mortgage business are related to digitalisation and signing of law on electronic mortgage in 2017. Soon, other federal offices and organisations will work using blockchain [13]. The Russian Federation government has developed a draft law, in accordance with which, in 2018, all real estate bargains will be implemented with the use of blockchain. The system of distributed data storage has been already used by Sberbank for paper work. VEB and Rosreestr conduct a competition of blockchain solutions in the area of account and registration of real estate, as it is important to provide reliable protection of data, and, consequently, cooperate with the bodies of state security on the problems of blockchain technology introduction.

The usage potential of blockchain technology in development of the system of interaction of ICA participants is in decreasing the number of mediators and supervisors in the network, as they do not obtain functionality. As all the participants in construction domain keep blockchains with operations that have been agreed by them, blockchain provides transparency, reliability and decentralisation of the process of interaction [19]. Thus, the perspectives of process application in construction domain are good enough, as in this domain, the problem of confidence between economic agents participating in complicated financial relations and exchanging values is urgent.

Thus, one can highlight the following specific features and advantages of blockchain use in construction domain:

- security achieved by distributed data storage. For example, in the design of introduction of blockchain in the process of conclusion of agreements on participatory interest in construction, whose technical development was implemented by Vneshekonombank specialists, the result was exclusion of data fake and providing their security. The distributed system immediately encodes a number of transactions in one block and calculates the digital imprint of the current block and the previous one. When there is any operation fake at any stage of the bargain, the data will be changed only in the participant's block, but they will not be confirmed by all the rest participants, as a result, a new block will not be created [14].
- durability and reliability, as technology is error-resistant; blockchain keeps information blocks, identical in all the network, and is not monitored by one participant of blockchain, and, consequently, does not have a single rejection point;
- openness and transparency as information in the network is public by default. Thus, as an example of blockchain use in monitoring and construction of roads, on account of common accreditation of vendors in all areas, transparency of material supply and quality control of construction materials, efficiency of state and corporate purchases is increased;
- stability, as for changing any data block in blockchain, one shall have to change data in all the network, for that, in its turn, substantial computation power is required. This makes blockchain an efficient tool for control of state register of real estate providing reliable data storage and reduction of the time of owner rights registration;

- absence of mediators as the technology gives ICA participants an opportunity to check transaction authenticity and directly exchange data without mediators. For example, during APCI registration, participants of the bargain are applicant, builder, Rosreestr and the Foundation [17];
- substantial decrease of transaction expenditures, reduction of time of bargaining from several days to a few hours. In particular, usage of blockchain technology in APCI registration provided reduction of the time of interaction between Rosreestr and the Foundation from one day to the time from 15 minutes to one hour.

In the process of interaction of ICA participants, usage of blockchain technology will provide comprehensive monitoring of data, its transparency and openness of operations made [20]. Introduction of blockchain in various ICA domains, for example, construction and repair of roads, investments to real estate, registration of APCIs and other agreements will provide for placing on record of all the stages of the process excluding the risk of unauthorised changes of data. Blockchain provides protection of data from fraud that is especially important in construction domain. On the one hand, the technology provides openness of data on operations for the process participants; on the other hand, it provides their security.

4. Conclusions

During development of digital economy, the system of interaction of ICA participants changes significantly, in particular, with increase of transparency of interaction, making available more and more valid objective data on ICA participants in open access. This became possible due to implementation of blockchain process speeding up the process of interaction, increasing efficiency of monitoring of ICA participants, making less transactional expenditures and with a number of other advantages available.

Blockchain technology is distributed and decentralised data base consisting of "a chain of blocks". In this process, block storage units are not connected to the common server, data base provides monitoring of transaction validity without supervisors or regulatory bodies. One cannot make fake data in blockchain due to chronological sequence of records and their public confirmation by all participants of the blockchain.

The research work conducted allows formulating key features of blockchain process:

- distribution; blockchain is a digital decentralised transaction log (or valuable event data base), transactions are stored as distributed on many computers simultaneously;
- transparency; data as a whole are loaded into network, and they are by definition public and accessible to all concerned persons;
- protection; blockchain provides the highest degree of account and identification; omission of transactions is excluded, human errors or computer errors and changes made without finalisation of concerned parties are also excluded.

Systematic and intense introduction of blockchain technology in the construction domain in Russia has been impeded by interrelated legal, process and workforce problems. At the legislative level, for today, a unified system of normative and legal acts and institutions providing support to blockchain process introduction in construction domain has not been developed yet. A part of the state in stimulating introduction of digital technologies in construction is great; however, the state does not have substantial and regulatory impact on development of construction domain. An important problem is also technological retardation of the majority of construction companies and impossibility of introduction of advanced innovative processes that, in its turn, requires development of a set of machinery and tools directed at development of entrepreneurship and stimulation of blockchain introduction in small and medium business. A great part in this process should be of the state. The main problem of development and introduction of blockchain process in construction domain is absence of developed state policy in the area of digital technologies, at that, the existing regulatory acts and programmes are formal. The system of economic stimulation of digital technologies in construction has not been generated in Russia. A big problem of process retardation of the Russian construction domain is lack of competent personnel that impedes development and introduction of

digital technologies. That's why it is necessary to solve this problem comprehensively, starting from stimulating workforce flow to construction that will, in its turn, provide introduction of digital technologies into construction that will provide for labour productivity.

Thus, blockchain is a technology providing reliable account of transactions between investment and construction market players, their storage and public access to them. Blockchain usage will contribute to more trustful relations between participants, lowering risks, speeding up interaction, increase of productivity.

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