Blockchain Solutions for the Business World*

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Abstract

Blockchain technology, based on a decentralized ledger, is finding increasingly broad applications across various sectors of the economy. Its features, such as transparency, immutability of records, and the ability to automate processes through smart contracts, create new opportunities for the development of business models. This article presents the main directions of blockchain adoption in economic activity, including the financial sector, logistics, supply chain management, as well as data protection and digital identity. The analysis addresses the potential benefits of implementing this technology, as well as the barriers to its adoption, including regulatory, technical, and organizational challenges. The aim of the study is to highlight the opportunities that blockchain brings for innovation and the transformation of modern business.

Keywords: blockchain technology, smart contracts, digital economy.

Introduction

The foundation of cryptocurrencies is blockchain technology. It enables the creation, storage of data, and management of knowledge within a network of interconnected units. Its essence lies in ensuring the integrity and authenticity of data without the involvement of any central authority, even when these units do not trust one another. The guarantee of immutability of recorded data is provided by mathematical algorithms rather than trust in a third party, the state, or institutions (Dresher, 2017).

A further innovation is the introduction of smart contracts, which, once created and recorded in the blockchain, are executed automatically when the conditions specified within them are met. State institutions and banks perceive this, on the one hand, as a threat to their own interests, but on the other, they may also use the technology to improve their operations. The aim of this article is to indicate the opportunities that blockchain brings for innovation and the transformation of modern business (Tapscott and Tapscott, 2016).

The concept of blockchain technology, as its name suggests, is to create a chain of interconnected blocks. A single block is a collection of arbitrary digital documents created within a similar time frame and sharing a common digital signature, the so-called "hash." For any document represented as a sequence of bits, a hash is a fixed-length string of characters, usually much shorter than the document itself, and it is practically irreversible. To reconstruct the original document, one would need to check all possible combinations. On the other hand, two different documents generate distinct signatures. Even the change of a single bit in the original document results in a change of the signature (Kliger and Szczepański, 2017).

These properties make it possible to use hashing functions as a simple method for verifying the authenticity of an individual document based on knowledge of its short signature. Importantly, such verification is not computationally

complex. The creation of a block from multiple documents with already computed signatures is most often achieved by arranging them into a tree-like structure and calculating subsequent signatures at each level of the tree (Merkle, 1980), based solely on the signatures of subordinate branches rather than the full documents. This allows new documents to be easily added to a block without the need to recompute values for the documents already included. Once the process of adding documents to a block is complete, a single hash can verify the authenticity of all documents contained within it.

The use of blockchain in the creation of payment instruments

In the case of Bitcoin, the blockchain is used to record successive transactions. To ensure the identification of cryptocurrency owners—or more precisely, their wallets—commonly known asymmetric encryption algorithms are employed. Electronic money is defined by a sequence of executed transactions. A payment is initiated by the owner of the funds through signing, with the private key of their wallet, both the signature of the previous transaction and the public key of the recipient's wallet. The first key guarantees that the sender has the right to transfer the funds, while the second ensures that no one other than the recipient will be able to access them. This resembles a bank transfer, except that instead of account numbers, cryptographic keys are used (Dwyer, 2015).

The monetary system will function correctly only if it is impossible to spend the same funds more than once. In the case of physical money, this is ensured by its tangible transfer. In the case of a bank transfer, the bank acts as a trusted public authority, guaranteeing that the same money cannot be spent twice. In the absence of a trusted intermediary, the only way to ensure that a payer has not previously spent the same funds for other purposes is to have access to information on all transactions and to adopt the rule that only the first transaction concerning specific funds is valid. This goal can be achieved by making all transactions public and ensuring the certainty of their chronological order. This is precisely how it is implemented in the case of Bitcoin (Glaser et al,. 2014).

The popularization of blockchain technology occurred alongside the growing interest in Bitcoin. Hence, its first application was the creation of cryptocurrencies. At present, several hundred cryptocurrencies are already publicly available. While their general operational concept is similar, they can be divided into several types depending on implementation details. These details determine the possibilities of use and the specific features of individual currencies (Dwyer, 2015).

The emergence of new cryptocurrencies resulted from technological development, partly from the shortcomings and limitations of Bitcoin itself, as well as from profit motives and the relative ease of creating new digital currencies. The main disadvantages of Bitcoin include the lack of instant transactions, periodically high transaction costs, the energy intensity of mining and its environmental impact, as well as susceptibility to high concentration of mining activity.

Other first-generation cryptocurrencies modeled after Bitcoin operate on a similar principle. They differ in implementation details, such as the frequency of new block creation, transaction speed and cost, the susceptibility of the algorithm to specialized hardware, and the approach to user privacy, among others. Examples include Litecoin (LTC), which emphasizes speed and low transaction costs, and Monero (XMR), which aims to make it impossible to trace the transactions of a specific user. The assumptions underlying Monero make it particularly attractive as a means of payment for conducting illegal operations.

A common feature of all cryptocurrencies is their ability to serve as a form of money. In the case of first-generation cryptocurrencies such as Bitcoin, this is essentially their only significant functionality. While it may be realized in a way different from traditional methods, it is still a form of conventional money, whose value derives from its acceptance and from the dynamics of supply and demand. However, given the high volatility of cryptocurrency exchange rates compared to traditional currencies, it can be stated that their main use is speculation, and in practice they are not employed as a means of payment on a significant scale (EBC, 2019).

Second-generation cryptocurrencies provide broader uses of the blockchain. The first representative of this generation is Ethereum, created in 2015. The system's creator, V. Buterin, described the Ethereum network as a decentralized platform for smart contracts and applications (Buterin, 2014). The content of Ethereum's blocks is not limited to transaction history. The network enables the storage of scripts capable of performing arbitrary computations, retaining any type of data, and verifying various conditions.

Ethereum scripts are programs written in a specially created programming language called Solidity. A smart contract is usually a set of conditions specifying what is to happen once those conditions are met. If the contract code is recorded on the blockchain and accepted by all parties, it will be executed automatically once the conditions embedded within it are

fulfilled. Importantly, the blockchain record guarantees that a program, once created, cannot be altered. Proposals to create smart contracts appeared as early as twenty years ago (Szabo, 1997), but it was only blockchain technology that enabled their relatively straightforward implementation.

The ability to store arbitrary data in blocks means that, in the case of second-generation cryptocurrencies, their payment function may turn out to be only a secondary feature. Their networks can be used to record data on virtually any asset, such as traditional currencies, stocks, real estate rights, or certificates of ownership of goods or energy. As with Bitcoin, Ethereum also inspired many followers pursuing similar goals, yet differing in implementation details. An example of a cryptocurrency designed primarily to serve a utility function is Ripple (XRP). Its creators' goal was to develop a global communication protocol for banks and financial institutions that enables instant international payments at minimal cost. Transfers concern traditional currencies, with the possibility of their automatic exchange at the best available rate (Popper, 2020).

Transactions on the RippleNet network are confirmed every four seconds. The high speed of operation results primarily from the use of a consensus algorithm based on proof-of-correctness (Schwartz et al., 2014). This does not require computational effort but only agreement among the network's nodes. No mining of new coins occurs—the number of XRP tokens is fixed (all were issued simultaneously). The network is centralized, and the code of the algorithms used is not publicly available. Thus, it can be concluded that this is a private blockchain of a single organization rather than a public one (Popper, 2020).

The creators' intention is to compete with the currently widespread SWIFT protocol, maintained by an organization of the same name, which has been in use since 1977. SWIFT is costly, slow, does not provide for currency conversion, and features opaque fee structures for clients. Ripple aims to eliminate all these disadvantages. The emergence of Ripple has forced the development of an extension of the SWIFT protocol that improves certain aspects of its functioning. A detailed comparison of Ripple's capabilities with the modernization of SWIFT can be found in (Treasury, 2017). Unlike other cryptocurrencies, participation in RippleNet is restricted not to all exchange participants but only to banks and financial institutions. The sender and receiver of a transfer interact only with their respective banks and do not even need to know how the banks execute their orders.

On a larger scale, international payments based on blockchain were launched by Santander Bank for its customers in Poland, the United Kingdom, Spain, and Brazil (Zuckerman, 2018).

Numerous projects and companies have emerged that provide products and services facilitating the use of cryptocurrencies by their users and that build the infrastructure for applications operating on public blockchains—the cryptocurrency ecosystem. This ecosystem comprises entities engaged in the following services: exchanges, wallets, payments, and mining (Hileman and Rauchs, 2017).

The five cryptocurrencies with the highest daily trading volumes include Tether, Bitcoin, Ether, Binance USD, and XRP. Ether is the native cryptocurrency of the Ethereum platform, currently the most popular decentralized platform built on blockchain technology, supporting smart contracts and decentralized applications (dApps). Many other cryptocurrencies function as interchangeable tokens under the ERC-20 standard on the Ethereum blockchain.

Tether and Binance USD are examples of stablecoins. Compared to other cryptocurrencies, stablecoins are distinguished by the promise of significantly lower price volatility. Stablecoins are digital units of value that do not represent any form of currency (or a basket thereof). Instead, by employing a set of stabilizing mechanisms, price fluctuations relative to those currencies can be minimized (Bullmann et al., 2019).

Stablecoins are used in the market for three main reasons (Calle and Zalles, 2019):

- to realize investment gains, serving as a temporary store of value without leaving the cryptocurrency market;
- to act as a tax haven, functioning as a tool for tax avoidance;
- to provide access to a reference currency (such as the USD) outside of its banking system.

The use of blockchain technology for creating smart contracts

A blockchain naturally enables the creation of a distributed ledger. It becomes an effective tool for storing various types of records in which data, once written, cannot be altered. Typical examples include land and mortgage registers, databases of notarial deeds, contract registers, company ledgers, tax declarations, and similar records.

The benefits of maintaining registers in this form include the distribution of the database, the possibility of fast, authorized access, and the ability to automate transactions using smart contracts. An easily imaginable example would be the sale of real estate, where the land register is recorded on the blockchain and payment is made in cryptocurrency or in tokens representing a selected currency. In such a case, the contract could replace the notary and provide security for both parties to the transaction.

Contracts may also serve as a mechanism for remunerating creators for copyright associated with online resources. The act of downloading materials would charge the user and automatically distribute proportional compensation to the content authors. Such a system could also simplify the sale of economic copyright (Rutkowski, 2018).

Another application could be the confirmation of authorship and the time of creation of a document. Recording its signature together with the author's identifier in the blockchain would provide proof of its existence and ownership at a given point in time. Naturally, this could apply to any digital documents, including photographs, films, novels, music recordings, and so forth. Such an approach could facilitate the enforcement of copyright claims or the establishment of priority in patent applications. Similarly, it could secure the authenticity of medical data.

Blockchain also makes it possible to implement a system of resource sharing between parties that do not fully trust one another. One of the largest ICO-funded projects was Filecoin, a blockchain-based network designed for data storage on unused disk space. Owners of free storage capacity will rent it out at attractive rates. Users will declare how much data they wish to store, and storage providers will bid on the price at which they are willing to accept the data. Uploaded files will be encrypted and divided into smaller fragments distributed across different locations (Filecoin, 2018).

Supply chain tracking is of great importance for many industries, such as pharmaceuticals, cosmetics, food (Tian, 2016), and electronics. Combining the use of IoT sensors with the recording of goods movement, along with time stamps and transaction data in a blockchain network, makes it possible to eliminate many abuses during the distribution of materials and goods. Implementing product provenance tracking throughout the entire distribution process enables verification of the complete history of a product based on its production batch number.

The American retail chain Walmart, in cooperation with IBM and Tsinghua University, established the Blockchain Food Safety Alliance, aimed at creating a system for tracking Chinese food throughout the entire distribution process. The pilot program covers shipments of mangoes and pork imported from China to Walmart stores in the United States (Galvin, 2017).

Execution And Settlement of Electricity Trading Transactions

The general concept of settling electricity purchase and sale transactions using blockchain could be based on a dedicated platform designed for such activities. In such a system, every electricity consumer would have the possibility to register on the platform. The same would apply to energy producers. Users would, of course, be required to have appropriate smart meters installed that communicate with the platform, ensuring that information regarding the electricity consumed, produced, and fed into the grid would be recorded and stored in individual blockchain blocks. Such an approach would allow the complete history of each user's energy consumption and generation profile to be registered. Furthermore, the ledger would store information concerning all power flows in the grid as well as executed transactions, thereby creating a constantly updated database of operations and their full history. In line with the principle of a typical blockchain network, transactions would be distributed and verified across the network's nodes. Naturally, the database would not permit any modification of stored data. The operation of such a solution would also require the development of dedicated applications integrated with the platform (Varnavskiy et al., 2018).

Overall, the entire system would consist of multiple parallel chains of data. One segment could be responsible for measuring the amount of electricity generated and consumed, another for executing energy trading operations, while yet another could store payment data related to transactions. By using a peer-to-peer network and linking all data chains and their functions through smart contracts, transactions could be carried out directly among all users registered on the platform. Energy trading would be sufficiently automated so that settlements would occur automatically, taking into account all assumptions specified by individual users. In this way, the power grid could be largely managed by the

blockchain platform itself. The algorithm would automatically initiate transactions on the platform, executed according to predetermined assumptions and operational rules. Consequently, the system could maintain balance in the grid or within a local microgrid between electricity generation and demand (Merz, 2016).

Prosumers could particularly benefit from such a decentralized settlement system. By being directly connected with other consumers, they could autonomously sell their surpluses—for example, to their neighbors. Transactions would be executed automatically and simultaneously recorded in the blockchain data blocks. As a result, the entire history of these transactions would be regularly updated and stored in the blockchain system. The transaction ledger would at the same time be secured against any manipulation. Such a model could thus also serve as a support system for prosumers, potentially encouraging electricity consumers to invest in their own distributed renewable energy sources. In general, blockchain technology has great potential to increase the role of small, individual prosumers in the market. A transaction settlement system utilizing blockchain could also prove highly effective in local microgrids, where energy storage systems are additionally employed. In the event of electricity surpluses, the system—on the basis of smart contract algorithms—would automatically direct the energy to storage, from which it could later be used at times of shortage (Dütsch and Steinecke, 2018).

Equally important appears to be the potential application of blockchain technology in the process of unambiguously labeling energy, i.e., assigning it immutable attributes of origin and environmental impact parameters. The most significant element requiring change would be the necessity of registering emission and environmental indicators in real time and linking this information with the registration of electricity generation levels by measurement and settlement devices. This mechanism would need to cover all generation sources, taking into account the differing emission profiles of coal, gas, and renewable carriers.

Such an information package could be transmitted through the system, where, in an ex post mode, the data would be separated and assigned to the appropriate units. Within this mechanism, it would be possible to introduce a correction mode functioning similarly to settlements in the balancing market. A model for the acquisition and aggregation of data on fuel structure and environmental impact operating in this way could be automatically used, within specified timeframes, for the collective presentation of legally required reporting data.

A fuel footprint constructed in this manner would also enable unambiguous identification of the fuel mix for contracted energy, both within the exchange segment and the balancing mechanism. This model could be applied to large-scale energy systems as well as at local and regional levels relevant to distributed energy, for example within energy clusters.

Capital Acquisition Via Blockchain Technology

The cryptocurrency community is particularly creative when it comes to finding new ways of launching projects and raising funds. At the end of 2017 and the beginning of 2018, ICOs (Initial Coin Offerings) appeared, through which development teams raised capital by publicly selling part of the total supply of tokens. This led to a wave of euphoria, as it was expected that these newly issued digital coins would increase in value shortly after being listed on exchanges and made available for trading pairs.

The ICO bubble ultimately burst in 2018, but it did not take long before the market developed a new model with several key differences. By the end of the first quarter of 2019, the first IEOs (Initial Exchange Offerings) entered the market. These IEOs, largely initiated through Binance Launchpad, followed the crowdfunding model of ICOs, but projects were vetted much more thoroughly. Since they were launched on popular exchanges such as Binance, KuCoin, Huobi, OKEx, and others, exchange teams conducted extensive due diligence, which meant IEOs were far less numerous than ICOs—there was a higher barrier to entry. In addition to raising funds, IEOs also benefited from being listed on the exchange that managed the token sale. One of the biggest issues for ICO investors in 2018 was whether, and on which exchange, a given token would be listed, while the sheer number and diversity of ICOs was overwhelming (Varnavskiy, et al, 2018b). In light of these listing concerns, and with the growing popularity of decentralized exchanges such as Uniswap (Ethereum) and PancakeSwap (BSC), anyone could issue a new token and provide it with liquidity. It was therefore only a matter of time before the industry sought to take advantage of this. Thus, in 2021, IDOs entered the scene. It is worth noting that the original concept of IDOs has changed dramatically over the years and, in its most popular present form, bears little resemblance to what it was intended to be when the first IDO took place.

In essence, an IDO is the successor to ICOs and IEOs, as it also aims to raise funds for financing and launching a project. However, unlike ICOs and IEOs—where tokens are sold before listing—in the case of IDOs, they are listed immediately on a decentralized exchange (DEX), hence the name. The first IDO in history took place in June 2019 with the case of Raven Protocol. The team behind the protocol chose Binance DEX, Binance's decentralized exchange. They listed the

token at a set price, and traders could buy it until the hard cap was reached. Similar practices were applied in other early IDOs across most platforms.

However, investors were dissatisfied. The reason was that such sales essentially resulted in tokens being sold out within seconds, leaving little chance for the average participant to secure a share. A belief emerged that tokens were being scooped up by bots and insiders, forcing the industry to adapt in order to meet growing demand. This led to the birth of IDO launchpads—one of the hottest trends at the end of 2020 and into 2021.

In their most popular form, IDOs are particularly similar to IEOs, but with several key differences. In IEOs, the exchange itself was responsible for vetting the project and conducting the token sale. With IDOs, it is different. An external launchpad platform performs the vetting, while the token sale itself takes place in a decentralized manner.

Conclusion

Considering the selected areas of blockchain technology applications presented in the article, it can be concluded that this technology has enormous potential to revolutionize almost every field of life and technology. There is also no shortage of opinions suggesting that blockchain is a platform capable of enabling the construction of an entirely new Internet: secure, private, and focused on the interests of its users. Naturally, widespread adoption of this technology will not occur very quickly. As with many other technologies, some time must pass before it is applied on a mass scale. At present, many governments are investing in the development of this technology, and numerous organizations are emerging to raise funds for research in this area. The enormous potential of blockchain is evidenced by the claim that this innovation will have a significant impact on the global economy.

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