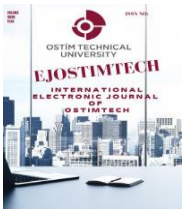

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BLOCKCHAIN TECHNOLOGIES: A LIGHT ON FUTURE WORKS[1]

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Abstract

Blockchain is a data recording system which supports cryptocurrencies and makes it difficult to alter or hack the transactions or engage in fraudulent activities. This technology supports technical properties such as distributed systems, decentralization, time-series data and asymmetrical encryption. Blockchain technology is a competitive technology which have changed social, commercial, and technical fields and is expected transform financial and commercial infrastructure of societies in the future. This study aims to identify the advantages of the blockchain technology in terms of future ways of doing business, its possible disadvantages as well as the gaps in the literature which require more focus in future research. Based on the literature review and a keyword search in the Web of Science database, a list of topics was drafted to provide direction for researchers that are interested in the fields of blockchain and cryptocurrencies.

Keywords: Blockchain, Finance, Management, Auditing, Accounting

Introduction

Technological innovation is considered the primary driver of long-term economic growth. Today, innovation is moving at a faster pace than it has ever been. This pace has resulted in the emergence of the blockchain technology, which is considered the most significant invention since the invention of the Internet. A cryptocurrency payment method called “Bitcoin” was created based on the blockchain technology by a person or group named Nakamoto in 2008 and provided the opportunity to broadcast all transactions on a network (blockchain) in a public manner (anonymously) which allows all users on the network to track all other transactions. Bitcoin has made it possible to transfer all information, data, and money between two parties (peer-to-peer/P2P) on an online platform without being dependent on any authority.

Blockchain technology can be defined as a new generation business process improvement software and as a collaborative technology, blockchain is capable of improving the business processes among companies and is of great importance for almost all sectors since it provides transparency of data, accountability of transactions, unmediated processes and data symmetry. Blockchain applications are categorized as Blockchain 1.0, Blockchain 2.0 and Blockchain 3.0. Bitcoin and other cryptocurrencies constitute the Blockchain 1.0 as the first and the most widespread implementation of the blockchain technology (Mainelli and Smith 2015). Blockchain 2.0 involves smart contracts enabled by Ethereum. Decentralized Autonomous Organizations (DAOs), decentralized applications (DApps) and decentralized autonomous corporations, (DACs) are also classified under Blockchain 2.0 (Swan, 2015). In addition to Ethereum, other projects such as Hyperledger and Codius which created a programmable contract language and an executable infrastructure for the integration of the blockchain technology into smart contracts have led to a noteworthy progress in this area (Xu et al., 2019). And finally, the

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Gönderilme Tarihi: 14 Temmuz 2022/ Kabul Tarihi: 26 Eylül 2022

implementation of the blockchain technology in areas other than finance and cryptocurrencies such as education, healthcare, agriculture and tourism is called Blockchain 3.0. One of the most important elements of Blockchain 3.0 is the token projects. Any person, institution or organization can create their own token project by using a blockchain network for which Ethereum and the ERC20 standard has the most widespread use. Tokens secure intellectual and property rights while allowing for the validation of securities such as stocks and bonds. NFTs (Non-Fungible Tokens), a recently popularized type of token has become rather valuable in terms of showing what the blockchain technology can do. An NFT is an asset kept on the blockchain with a unique identification code which allows for transfer among multiple owners, but its copyright remains unaltered. In 2021, Mike Winkelmann, also known as "Beeple" has brought the spotlight on this token with his NFT Project called "First 5000 days" which was sold for $69,346,250. The blockchain ensures the uniqueness of the NFT, which usually involves but is not limited to works of art. These NFTs can be sold on platforms such as SuperRare, Nifty Gateway, Rarible, Enjin and Decentraland. NFTs can be created in very short periods of time by using individual accounts and wallets since complex programming languages are not required for producing NFTs. There is also an NFT validation mechanism established in Turkey called "NFT Studyo Türkiye" which answers the need for distinguishing fake and original artworks (Doğan et al., 2022).

Cryptocurrency projects have started in 2008 with Bitcoin and reached approximately 16.000 projects in 2022. Today, the blockchain technology has reached the point of individual and corporate investments for conducting research in all fields besides finance and cryptocurrencies. At this point, it seems almost impossible to stay away from this technology which will alter and transform the ways of doing business, research fields and even the daily life. It is evident that persons and institutions integrated into the blockchain technology will have notable advantages and that many firms operating in various sectors are now investing in blockchain research to lower their transaction costs, accelerate the pace of transactions, diminish the risk of fraud and remove intermediaries. This brings out the importance of understanding the blockchain technology, increasing awareness about this technology and identifying the gaps in the literature.

Understanding the Blockchain Technology

Blockchain is a database technology which verifies and stores data by using encrypted chain block data structure; creates and updates data by using a distributed node consensus algorithm; ensures data transmission and access security by using cryptography; and programs and processes data by using smart contracts (Cheng and Huang, 2019: 64). Blockchain allows for the development and coordination of new and sustainable business models. It supports optimization, sharing and virtualization and creates a driver for reaching sustainability goals. In this regard, blockchain is a coordination tool for connecting and coordinating multiple distributed and updated databases (Mercuri and Ricci, 2021).

Compared to a traditional database, blockchain database ensures accuracy, authenticity and up-to-dateness of data. Blockchain database is different compared to an independent database or a spreadsheet where a user can make unsupervised changes (Drescher, 2017). All blocks since the initial block of the network are added to the chain and then recorded by all nodes. As a decentralized and distributed database, blockchain is a shared ledger which does not require any authority. Each page is added as a block to this ledger (Deng et al., 2018) which enables the firms to organize their work while also making intellectual property and payment processes transparent and automatic and lowering transaction costs (Felin and Lakhani, 2018). If and when legal regulations are put into force, firms will be able to declare their taxes automatically via smart contracts and the everlasting problem of tax evasion will be solved (Vishnevsky and Chekina 2018). Blockchain is regarded as a technology which will initiate industrial and commercial revolution and instigate a worldwide economic reform (Chang et al., 2020: 2).

Firms create their own network structures by using blockchain technology and acquire entrepreneurial financing by issuing tokens. They store, transfer, and sell the tokens and coins they have created to solve their financial challenges and meet their financing needs. ICOs (Initial Coin Offering) or token sales provide a new type of fundraising tool which has emerged with the goal to meet the funding needs of entrepreneurs and newly established companies. In other words, ICOs provide a crypto crowd funding tool. Entrepreneurs who issue tokens and coins use these funds to develop the projects

they have manifested in their whitepapers and ensure sustainability. ICOs create large amounts of capital mobility (Deng et al., 2018) and offer benefits to not only small-scale start-ups but also their affiliated companies and investors while also allowing for the development of FinTech (Financial Technology) and innovative and useful projects. This results in the development of projects beneficial to the whole society. Stages of the ICO process are presented in Figure 1.

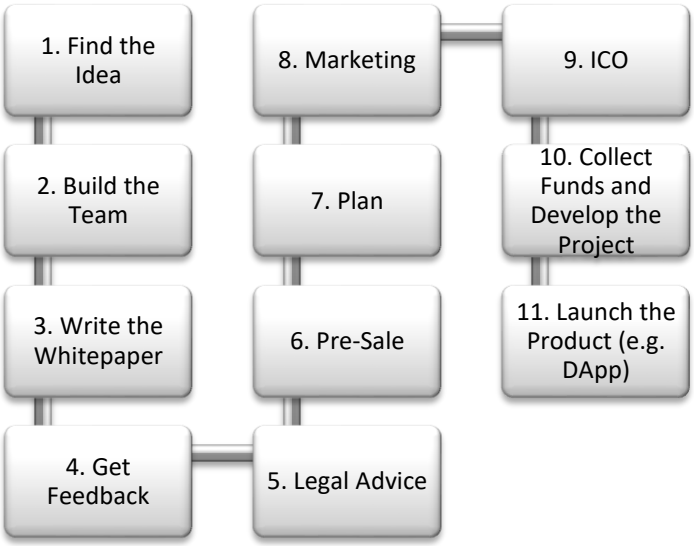

Figure 1. ICO Process

Source: Deng and Huang, 2018.

As depicted in the figure, ICO is a crucial step in any blockchain based project as it provides the funding required for the actual project to be implemented. However, it must be preceded by various other carefully calculated stages such as writing the whitepaper, marketing and pre-sale. These stages create the basis for a successful ICO process which in return brings in the funds needed for the project.

Following section provides a literature review on the changes and advantages to be brought by the blockchain technology on future ways of doing business.

Advantages of Blockchain Technology for Future Ways of Doing Business

Invention of the Internet has fundamentally changed the ways companies acquire, create, and protect value followed by the concept of business models which has brought another dimension to this process of value creation. Blockchain technology, on the other hand, is regarded an even more advanced technology than artificial intelligence and robotics which will fundamentally transform future business models and it has become vital for institutions and organizations to build and develop their own blockchain networks to gain competitive advantage (Schlecht et al., 2021; Khanh, 2016: 51–54).

According to the results of a study conducted by Deloitte and TÜSİAD (Turkish Industry and Business Association), while the blockchain technology has many implications in different areas, the financial sector will be the most affected by blockchain technology with 78%, followed by information technologies with 60% and supply chain and logistics with 59%. The results of the survey are shown in Figure 2.

Gönderilme Tarihi: 14 Temmuz 2022/ Kabul Tarihi: 26 Eylül 2022

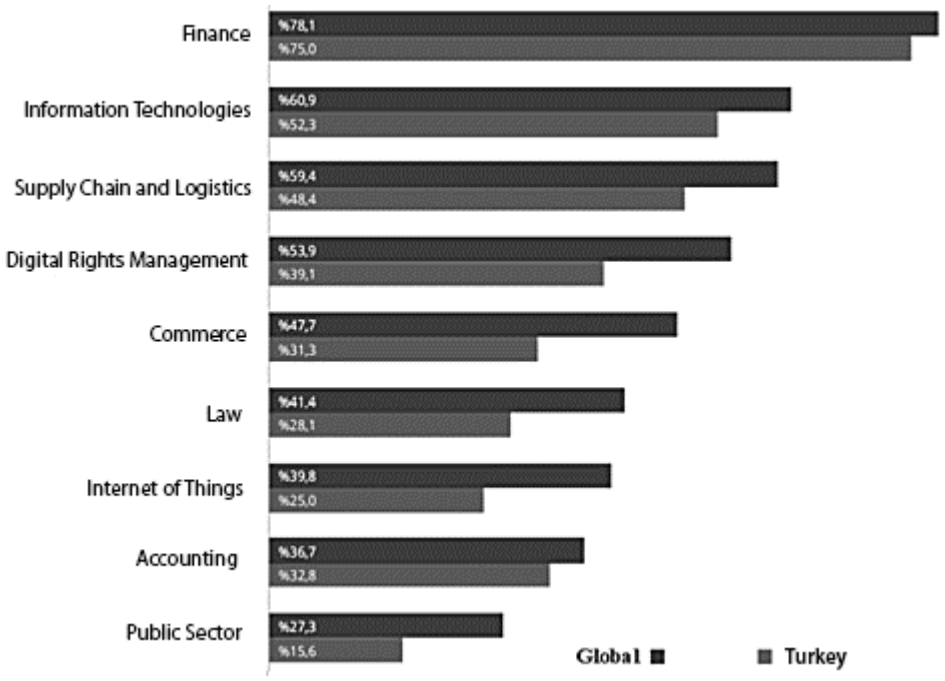

Figure 1: Areas to be Affected by the Blockchain Technology

Source: Deloitte- Tüsiad, 2018.

Accountability and efficiency is expected to increase as blockchain technology provides a secure and robust environment for data, transparency in processes, minimal risk, and flexibility against external threats (Demirkan et al., 2020: 192). Unless more than 51% of the nodes in the system are manipulated, no changes can be made to the records in the database, thus reducing the possibility of incorrect data in the system. In other words, the error rate decreases since blockchain databases record digitally signed data in real time (Salah et al., 2019: 10130). At the same time, fraud and erroneous registrations will be prevented as each new block must be verified by multiple nodes to be added to the chain (Gomber et al., 2018: 220-265). Particularly regarding the financial sector, in the future, it may be possible to increase the efficiency of stock exchange transactions, offer cheaper financial services, and record transactions automatically in the future. Manipulation of data will be prevented, and transactions will be better protected than by financial and regulatory authorities. (Khanh, 2016: 51-54). The areas that will contribute most to the growth and development of blockchain technology are also the areas that will be most affected by that technology. (Piscini, 2017).

Digital Identity

Identity verification is among the most compelling problems of today's world. Identity theft, use of fake identities, CVs or diplomas create a major issue which affects even the most popular websites and social media platforms. Therefore, many entities, particularly financial institutions, invest great amounts in technologies such as Know Your Client (KYC) and Anti-Money Laundering (AML). There are certain recommended digital identity applications such as "Sora Identity" which is a mobile application claiming to solve such problems and allows each individual to sign their own identity cards and decide with whom their information will be shared. Sora uses Hyperledger Iroha blockchain platform for its digital identity protocol (Takemiya and Vanieiev, 2018). Similarly, Estonia begun using the blockchain technology for the notarization of personal data regarding the e-residency program (Sullivan and Burger, 2017). This enables validation of diplomas and valuable papers without the need for a notary.

Blockchain provides a digital identity which can be used to define not only individuals but also institutions. Identities of various persons, institutions and entities engaged in any commercial or

Gönderilme Tarihi: 14 Temmuz 2022/ Kabul Tarihi: 26 Eylül 2022

industrial activity are validated on a general network similar to the Internet. As digital identities will be expanded to include property and object identities, they can be issued by a government agency, such as a driver's license, passport, corporate records, and property deeds (Al-Jaroodi and Mohamed, 2019).

Transition from Risk Control to Full Control and Cost Reduction

Audits that impact executive decision-making processes and control plans and processes are nowadays conducted as risk audits. Audit risk in many cases is fraud risk. Listed companies may engage in fraudulent transactions to cover up losses or inflated profits or manipulate their financial statements. Such fraudulent behavior is often carefully planned and done covertly, not only manipulating financial data but also falsifying original documents. This type of fraud is difficult to detect even for highly experienced auditors, even if they have performed adequate audit procedures. Therefore, the audit may fail. In addition to the risk of fraud, incomplete and falsified data are also common in traditional audits. In traditional audits, the auditee's financial data is typically copied and transferred to audit software used for data processing and analysis. The likelihood of data loss is high in this process. Without comprehensive and complete financial data, auditors are more likely to issue an incorrect audit opinion, and audit risks may change accordingly.

Today, audits in many countries are still performed by on-site audits using traditional methods. The labor and time costs of an on-site audit are quite high. The time required to audit a company's annual report can vary from one week to two or three months, depending on the size of the company and the complexity of its economic activity. In terms of labor costs, the traditional audit workload is overwhelming. Many auditing procedures cost auditors time and effort and the audit of a company's annual report is performed by an audit team of at least 3-5 people. If a company is planning an IPO (Initial Public Offering), the audit process will involve an audit team of more than 10 people. Audit costs are mainly based on verifying the authenticity and accuracy of the audited company's economic activity through external confirmations and evidence. During external confirmations, which is a very reliable audit procedure, the auditors often apply several correspondence procedures for the balance of accounts receivable, accounts payable and bank balances in order to verify the authenticity of the data. Moreover, the auditor cannot guarantee that the confirmation letter is 100% reliable. In the blockchain system, all financial information can be verified by other nodes and is irreversible. Each transaction is cryptographically signed and verified by all mining nodes, which keep a copy of the ledger containing the chain blocks of all transactions. This creates secure, synchronized, and shared records with timestamps that cannot be changed (Salah et al., 10128: 2019). As a result, auditors can fully rely on this financial information, eliminating many unnecessary audit procedures and reducing audit time, which significantly reduces the staff and resources needed to test the reliability of financial information (Cheng and Huang, 2019: 65).

In traditional auditing, there are limitations in terms of sampling. In other words, a portion of invoices are audited using sampling procedures and techniques. It is not possible to check all invoices, vouchers, information, and documents as it requires time and effort. Therefore, the audit is a risk audit and cannot provide 100% assurance. Such an audit is not an absolute guarantee; it only provides reasonable assurance. The limitations of traditional audit procedures expose auditors to higher audit risk. Blockchain technology solves these problems. Above all, for fraud risk, any change in financial data is broadcast throughout the network, and all nodes receive the message about the data change. The data will not be stored unless all nodes in the network validate it. When relevant supervisors and regulators are integrated into the blockchain network, all business decisions of the company are tracked in real time. Abnormal behavior is continuously monitored, and on-site auditing is ensured. This reduces post-event risks and not only regulating authorities, but also all other nodes in the network can perform such an auditing function, effectively limiting the financially fraudulent behavior of companies. And even if the company has actually deleted or falsified financial data, the blockchain system leaves traces so that auditors can easily find and track these changes and determine the reasons behind them. As long as auditors are authorized to log into one of the public ports, they can query all financial data since the creation of the blockchain structure. This financial data is permanent, immutable, and reliable which makes it possible to conduct a complete audit because the financial data that auditors receive is comprehensive and accurate.

Gönderilme Tarihi: 14 Temmuz 2022/ Kabul Tarihi: 26 Eylül 2022

A traditional audit is an investigation of the audited entity's past economic activities, with a certain time lag that gives the entity time to manipulate and delete financial data. Data transmission takes time. For example, a transaction on a company's bank statement may be recorded by the bank, but not by the company. Before the bank statement is sent to the company, it is difficult for the company to recognize this problem and create the accounting entry. This not only causes the financial data to be delayed in the company's books, but also harms its accuracy. The auditor can audit the company by monitoring the blockchain in real time when the company records and stores all transactions in the blockchain, data on each node is updated in real time and the blockchain data is self-sufficient with time stamps. The company has no time to manipulate or delete data, and the risk of financial fraud is reduced. At the same time, in terms of information delay, the data transfer in the blockchain system is in real time. The transaction is distributed to other nodes as soon as there is an entry in the bank account and the transaction is automatically recorded and updated in the company's general ledger. All financial information in the company's ledgers stay up-to-date and accurate in real time. These features of the blockchain enable real-time auditing

Audits are conducted by covering a certain time period. According to the agreements among companies and audit firms, an audit team plans the process for 3-6 months and carries out the audit activities on site. With blockchain technology, audits are performed instantly without being limited to a specific period as full-time records are collected in more than one node. When an activity takes place at any node of the blockchain network, all nodes of the network get notified of the change. After validation, data for the economic activity is not only stored in the ledger of the current node, but also automatically copied and stored in the ledgers of the other nodes. This network-wide updating of data is done in real time. This function ensures comprehensive auditing while also lowering audit costs. Cost reductions are achieved especially in terms of auditing and verification of transactions (Michelman, 2017).

Transparency and Traceability

Blockchain is a very open and transparent database. All data on the blockchain is public, just like the Bitcoin blockchain, depending on the consensus algorithm used. In addition to the private information of the two parties of the transaction, anyone can query all network data in the blockchain database via a public port.

The data in the blockchain is integrated into a chain structure in chronological order. Each blockchain has a timestamp that records the time information generated by the network, and this timestamp is irreversible. Such time series data cannot be deleted or modified after it is created. Blockchain keeps a record beginning with the generation of the network which allows for the recording and validation of all transactions without any modification and this feature enables the traceability of the data. Each node in the blockchain system keeps a transparent ledger which contains all the data since the creation of the network.

Studies in health and supply chain occupy an important place among those demonstrating the benefits of using blockchain technology in terms of transparency and traceability. Research shows that the use of blockchain technology for improving clinical medical research will benefit transparency, especially in terms of patient consent (Benchoufi et al., 2017). It has been proven that the chronological record-keeping function of blockchain technology ensures traceability of food from production to consumption in the supply chain, prevents post-modification of chemical analysis results and prevents food adulteration, which is of great importance to consumers. It creates a common language across the food chain. End-to-end traceability is ensured, and thanks to the blockchain, consumers can easily access the stages of food production on their mobile phones. Food storage temperature, production farms, shipping information, and factory processing information can be transparently followed at all stages (Galvez et al., 2018). Implementation of blockchain technology ensures the elimination of intermediaries in the agri-food sector; increases the traceability of useful information by reducing transaction times and costs and contributes to sustainability (Mercuri and Ricci, 2021).

Table 1 demonstrates the solutions provided by blockchain technologies in terms of conventional traceability issues.

Gönderilme Tarihi: 14 Temmuz 2022/ Kabul Tarihi: 26 Eylül 2022

Table 1. Blockchain Solutions for Traceability Problems

Problem	Solution
How can individual activities be coordinated over the Internet without secure centralized storage?	Blockchain uses chronologically distributed databases where blocks are linearly connected to each other and cannot be deleted.
How can entries be validated without a central authority to verify that a transaction is not fake or invalid?	Blockchain uses a probabilistic approach. It forces the information circulating over a computer network to be more transparent and verifiable by using mathematical problems that require a significant amount of computational power to solve.
How can we make sure that only legit transactions are recorded on a blockchain?	A new data block is added to the end of the blockchain only after computers on the network reach a consensus on the validity of the transaction. Consensus within the network is achieved by different consensus algorithms.
How can the historical entries be protected?	Once a block is added to a blockchain, it cannot be deleted. In addition, the transactions it contains can be accessed and verified by anyone on the network. It becomes a permanent record that all computers on the network can use to coordinate an action or validate a transaction.

Source: Galvez et al., 2018

Immutability and Security

The consensus algorithms of blockchain networks (proof of stake or proof of work) do not allow faulty or fraudulent transactions or manipulation of information. Consensus is needed for an information to be recorded on the network and when there is no consensus among users, the network automatically rejects the input as invalid (Casey and Vigna, 2018). It is not possible for a single user to create a record individually. Consensus algorithms allow transparent sequential recording of transactions only after they are confirmed by users. Transactions are stored by all users on the network which makes them difficult to change, as it requires excessive processing power (Atanasovski et al., 2020: 738). Besides, cyber attacks require consensus from 51% of the users on the network. For an erroneous, fradulent or manipulated data to be recorded, the chronologically recorded data in each user's ledger needs to be altered or deleted, which is almost impossible (Al-Jaroodi and Mohamed, 2019). Another important point is that a malfunction in a single user's ledger will not cause a change or malfunction in other ledgers and moreover, failure of a single node does not affect the operation of the entire network (Chen et al., 2018: 4). As a result of the use of an external hash tree in a distributed ledger structure for increasing security, the system does not allow any employee or institution to make manipulative transactions in the database or processes and therefore it does not carry the risks that may arise in transaction validations under a single manager in a traditional structure (Pinna and Ruttenberg, 2016).

Efficiency

Conventional banking transactions can be made between certain hours of the day. This causes delays in money transfers and commercial transactions between countries. Blockchain network, on the other hand, allows transactions to be made at any time of the day and week which ensures efficiency in the operations of MNCs (Multinational Companies) particularly in import-export transactions and foreign trade financing. Thanks to smart contracts, time loss is reduced as transactions are carried out automatically (Wang vd., 2016: 5).

Business processes with multiple stakeholders such as individual users, commercial firms and government agencies are inefficient due to the multilateral authorization of commercial transactions. Integration of blockchain technologies with artificial intelligence makes decentralized autonomous

Gönderilme Tarihi: 14 Temmuz 2022/ Kabul Tarihi: 26 Eylül 2022

organizations (DAO) possible for fast and automatic verification of data/asset/value transfers among different stakeholders (Salah et al., 2019: 10130).

Blockchain Technology: Possible Disadvantages

Blockchain technology has a great potential to change all ways of doing business. Despite the negative perception of countries and central banks regarding cryptocurrencies, the reason why they allow the use of this technology is mainly because they want to see what this technology is capable of. However, the fact that countries have not yet made any legal regulations in this regard as well as the lack of intellectual capital, i.e. professional manpower, high energy costs and high risk of asset loss are among the possible disadvantages of the technology (Drescher, 2017). The need for new governance models and acceptability problems are also mentioned as barriers to implementing this technology. (Batubara et al., 2018). Possible disadvantages of the blockchain technology identified in the literature are discussed in the following sections.

Lack of Regulations

Emergence of capital inflows without any transnational regulation through cryptocurrency ICOs force the securities market, central banks and regulatory institutions to focus on this issue. Although crypto assets and the blockchain technology ecosystem behind it have advanced globally, the fact that there is neither any implementation framework nor any national and international legislation causes individuals and institutions to implement a wait-and-see policy. Considering the rapid development of technology as well as the number of projects and the size of the market, applying a wait-and-see policy will result in a waste of time for individuals, institutions, organizations, and countries (Cumming et al., 2019).

High Energy and Data Storage Costs

Since all users on the blockchain network work to validate all transactions, it consumes more electricity than any single database and this amount of energy consumption results in high costs while also creating a notable carbon footprint. Executing and storing big data costs much more than storing transaction data. (Chang et al., 2020: 3). In blockchain platforms using the proof-of-work consensus algorithm, the requirement for all users on the network to validate the transactions on all blocks since the beginning of the network causes the energy consumption to be high. Therefore, the adoption of blockchain technologies by institutions and organizations depends on building large scale storage systems and expansion of computer processing powers (Dai and Vasarhelyi, 2017). As an alternative solution to this problem, the proof-of-stake consensus algorithm has been developed in which data hashes are linked to blockchain blocks or used within the blockchain smart contract code to lower the costs (Kokina et al., 2017; Salah et al., 2019). Moreover, the proof-of-stake algorithm does not require the validator to spend computational power (as in proof-of-work algorithm) but requires them to hold a certain amount of assets.

Transaction Per Second Limit

Requesting the transaction validation of all users in the blockchain network prevents it from performing swiftly and the continuous increase in the number of transactions causes the network to slow down. Platforms with higher transaction rates per second such as Ethereum, Quorum and Hyperledger have been developed as a solution to the transaction limit on the Bitcoin platform.

Risk of Losing Assets

In Blockchain wallets, cryptocurrencies are secured using a cryptographic key and it is mandatory for users to protect these keys to protect their assets. When users lose the key, they also lose their assets. While central institutions such as banks protect their customers in terms of the security of their assets, the decentralized structure of the blockchain creates a high risk of asset loss.

Integration Problems

Blockchain technologies are not standalone applications, they are often integrated into systems used by firms such as ERP and CRM. They help influence emerging functions to support future business

Gönderilme Tarihi: 14 Temmuz 2022/ Kabul Tarihi: 26 Eylül 2022

models. However, the process of integrating the blockchain technologies into applications used within the organization is not very easy. Interoperability and security-related problems are among the most significant problems which may arise as the applications used are not ready to adapt to the new technology. At the same time, the use of different programming languages by the developers of the old and the new technology may create another problem and complicate the integration of programs. Therefore, the integration model to be used should ensure the reliability and accuracy of the functions of the applications used as well as the consistency of the business data among all applications. It is important to develop effective models in the integration of blockchain technologies into industry applications (Al-Jaroodi ve Mohamed, 2019).

Interoperability Problems on the Blockchain

Many platforms are developed for the adoption and implementation of blockchain technologies by different organizations or individuals by utilizing various standards. This raises the issue of interoperability. The fact that each institution and organization creates its own blockchain network makes it difficult for these networks to do business with each other (Atanasko et al., 2020: 743). An industry-wide standard blockchain may be more efficient and provide benefits for all stakeholders across an industry (buyers, sellers, investors, regulators, auditors) (PWC, 2018).

Scalability Problem

Adding a block to the blockchain network is a lengthy and complex process because it is recorded in previous blocks but for a blockchain of limited size, this is effective. However, when recording on the blockchain network, problems arise in locating, verifying, or using previous transactions. This is because this process requires many steps, and it is problematic because it is negatively correlated to the size of the network. In other words, as the size of the blockchain network increases, the process slows down. As the number of network participants and transactions increases, scalability becomes an important issue (Al-Jaroodi and Mohamed, 2019). There are currently more than 1 million smart contracts being executed on the Ethereum blockchain. Thousands of platform developers and entrepreneurs are continuously creating new projects and ventures based on the Ethereum platform. The fact that Visa executes 24.000 transactions per second, PayPal carries out 193 transactions per second whereas Ethereum and Bitcoin only conducts 20 transactions per second demonstrates how millions of transactions cannot be handled in a short period of time (Chang et al., 2020: 3). Another aspect of scalability is size and storage requirements. Since copies of all transactions are kept by all participants, the size of the ledger increases in direct proportion to the number of participants. (Atanasovski et al., 2020: 740). The Lightning Network was developed as a solution to this problem to increase the capacity of the blockchain to millions of transactions per second (Kokina et al., 2017: 94).

Lack of Professional Labor

The development, use, and application of blockchain technologies requires a professional workforce trained in the field. In addition, application on an industrial level and integration into systems depends on having teams with knowledge in this area. Education and training of technical professionals is important for the adoption of this technology. In this regard, it is essential to update the curricula at universities, supplement the courses that teach technological knowledge, and include theory and practice in the course content. The establishment of blockchain engineering departments at universities to train people to work in this field as well as the establishment of centers where relevant research and projects will be carried out will contribute to the adoption of the technology.

Competition and Transparency

Blockchain networks can be created publicly, privately, or as a consortium. Bitcoin, the first blockchain network, emerged as a public platform. Public networks have a structure where all information is available to all users. This may cause challenges regarding sharing information that will affect the competition among institutions and organizations. Therefore, private and consortium blockchains have been developed to solve this problem. Companies that will take part in the blockchain network can decide with whom and what information they will share (Andersen, 2016). This allows for the transaction data confidentiality with two separate blockchains where users can view encrypted

Gönderilme Tarihi: 14 Temmuz 2022/ Kabul Tarihi: 26 Eylül 2022

transactions and check the consistency of the network (Dai and Vasarhelyi, 2017). Another blockchain structure is zero-knowledge proof consensus (Wang and Kogan, 2018).

The enactment of the General Data Protection Regulation (GDPR) hindered further adoption of blockchain technology. Blockchain architecture allows all users to record information. According to the regulation, this is undesirable in terms of confidentiality and protection of data. The inclusion of consumer information is considered worrisome in terms of data privacy (Forbes, 2018).

Security Problems

Research shows that public blockchains, where transactions are verified on a proof-of-work basis, have governance issues. One of the users in the blockchain network can seize control of sufficient mining power to deliberately alter the software, consensus or confirmation of transactions to the detriment of other participants, for personal benefit. This is called a 51% attack and is a fundamental security issue (Kokina et al., 2017). This type of attack is a very expensive strategy in the public blockchain architecture. However, there are also types of sabotage which may be organized by one of the users. One of the nodes may misrepresent its capabilities among other nodes and upload a false code to get validation (Yermack, 2017). Low-cost strategies can also be developed to install low-quality software to the detriment of other members of the network. In addition to being a new technology, Blockchain has a constantly evolving and changing architecture. Blockchain leads to up to 80% change and up to 20% innovation in business processes. Blockchain technology is not just applied to solve specific problems that arise in the industry but also enables the development of new ways of producing services and new cooperation models within and between companies. It is a powerful tool for recreating the corporate culture for companies undergoing technology transformation as it leaves authority and trust to decentralized networks (Mougayar, 2016).

Problems with Smart Contracts

Smart contracts occupy an important place among the innovations produced by the blockchain technology. Once defined, smart contracts are self-executing and self-managing contracts without the need for the approval of a notary public or any other authority. For example a lawsuit can be filed or a compensation can be paid automatically when certain conditions are met. Smart contracts, which have a significant impact on the emergence of smart marketplaces, perform transactions without the need for human intervention, guarantor or approval. In this context, IoT (Internet of Things) provides the opportunity to certify automatically occurring events through smart contracts and without human intervention (Mercuri and Ricci, 2021).

The use of smart contracts is costly since miners must complete calculations to ensure contract execution. It is also regarded as main vulnerability of the system (Kokina et al., 2017). In order to solve the security problems related to smart contracts, research should be done and the problems should be resolved. It is possible to code fraudulent transactions that do not conform to the true nature of the relations established between the parties by the users. Users may verify the transaction if they think it is reasonable. However, it should be noted that such fraudulent transactions in smart contracts can be detected as they are recorded and cannot be changed. (Atanasko et al., 2020:745).

Risk of Illegal Activities

The decentralized nature of the blockchain increases privacy and since it provides confidentiality, it is used for illegal activities. Tracking illegal transactions on blockchain is more difficult than tracking banking transactions. Arrangements should be made to prevent money laundering, drug trafficking and financing of terrorism. The benefits of blockchain technology should be increased.

Gaps in the Literature for Future Studies

Blockchain is currently a very popular research topic in almost all areas ranging from engineering to business, law to medicine, agriculture to architecture and many more. A search on the Web of Science database with the keyword “blockchain” indicates that, as of 2022, there are 11,691 articles published in journals included in the Web of Science database most of which are covered in

SCI-E, ESCI and SSCI indices (Web of Science, 2022). This demonstrates the importance and prominence of the topic and the need for more studies in this field.

In the scope of this study, a literature review was conducted combined with a comprehensive search on the Web of Science database using the keywords "blockchain" and "cryptocurrencies" and their variations. Previous studies were reviewed, and the recommendations included in these publications for future studies were examined. Topics derived from this research were categorized based on their relevance and divided under four groups. Table 2 provides the list of topics.

Table 2. Topics for Future Research

Category 1: Understanding the Blockchain Technology	
1	What can we learn from the evolution of a groundbreaking technology? Is blockchain going to do to the financial systems what Internet has done to the media?
2	Who is in control of the blockchain?
3	Security issues in public and private blockchain networks
4	Factors affecting the adoption of the blockchain technology
5	Simulation tools for the blockchain technology
6	Industrial applications of the blockchain technology
7	Integration of the blockchain technology with Internet of things (IoT) and artificial neural networks
Category 2: Cryptocurrencies	
1	Cryptocurrencies in position to other currencies in the economy
2	Crypto-currency or crypto-asset?
3	Accounting and reporting of cryptocurrencies
4	Cryptocurrencies in international trade
5	Cryptocurrencies in terms of the risk of laundering of proceeds of crime
6	Cryptocurrencies in financing of terrorist actions
7	Analysis of the relationship among cryptocurrencies, exchange rates and marketable securities
8	Causality and cointegration relationship between cryptocurrencies and commodity prices
9	Dominance of Bitcoin over other cryptocurrencies: The impact of Bitcoin on other altcoins
10	Relationship between cryptocurrencies and macroeconomic indicators
11	Impact of cryptocurrencies on central banks and other banks
12	Analysis of perception levels of cryptocurrency investors
13	E-businesses and cryptocurrencies
Category 3: Blockchain and the Business World	
1	The impact of blockchain on the future of management
2	Blockchain and business ethics
3	The impact of blockchain on the future competencies of employees

Gönderilme Tarihi: 14 Temmuz 2022/ Kabul Tarihi: 26 Eylül 2022

4	Blockchain and career management
5	Blockchain and international private law
6	The impact of blockchain on financial systems and costs
7	Blockchain and auditing
8	Blockchain and digital marketing
9	Blockchain in public administration
10	The impact of blockchain on logistics and sustainable supply chain management
11	The impact of blockchain on arts and crafts
12	The impact of blockchain on energy efficiency and trade
Category 4: The Future of Blockchain	
1	The impact of legislative regulations on the growth of cryptocurrencies
2	The relationship between blockchain, entrepreneurship and innovation
3	Blockchain based virtual reality and Metaverse
4	Possible impact of blockchain on future ways of doing business
5	Possible impact of blockchain on future leadership styles
6	Possible impact of blockchain on customer relations
7	Possible impact of blockchain on employment
8	Blockchain and universities of future
9	The impact of blockchain on business education
10	The impact of blockchain design education

Topics listed in Table 2 try to draw a picture of the gaps in the literature that require more research. These topics were determined as prominent fields of research that were either completely overlooked in the literature or were somewhat mentioned but still require more attention. The first category involves topics about the basics of the blockchain technology. Although there currently is a significant and growing literature about the topic, there is still room for improvement. The second category covers cryptocurrencies, which is the field where the blockchain technology has its most widespread and penetrating use and therefore requires the most attention. As it affects all financial systems and thereby almost every human being on the planet, this area of research should be probed thoroughly. The third category covers the impact of the blockchain technology in ways of doing business with a focus on specific fields and sectors that are mentioned less in the literature. And finally, the fourth category is focused on foresights on the future impact of the blockchain technology. Based on its evolution, the blockchain technology is expected to affect many more areas in the future and these topics are among the ones that require the most immediate diligence.

Conclusion

With the development of blockchain technology, a new way of doing business has emerged. This has led to changes in the functioning of many public and private institutions and the way they do business. Cryptocurrencies have rapidly become widespread around the world. Despite the risk of cryptocurrencies being used in the financing of terrorism, money laundering and illegal works, the most important reason why countries and especially central banks do not prevent this progress is the desire to see what the blockchain technology behind cryptocurrencies is capable of. This study aimed to provide a basic overview of the technology with its advantages and disadvantages and shed light on the gaps in

Gönderilme Tarihi: 14 Temmuz 2022/ Kabul Tarihi: 26 Eylül 2022

the literature to expand the field and encourage researchers to focus more on this growing area of research.

It is evident that the use of blockchain technology, especially on a social level, has increased in recent years. This technology will continue to do so in the coming years as it changes and transforms the social, commercial, and technical fields. Collaborative leadership, lack of regulatory frameworks, low levels of use, insufficient professional workforce, and difficulty in cross-country cooperation affect the adoption of blockchain technology. Making plans for providing solutions to all these problems will benefit the adoption of the technology. In this context, it is very important for academics and practitioners to create a blockchain application framework together, to evaluate suggestions and opinions from experts in the field, and to prepare a comprehensive blockchain adoption framework to integrate technology into existing applications.

In the future, all companies, institutions, and organizations will create their own blockchain networks. In order not to lag behind technology, to keep up with the future, and to seize opportunities, efforts should be undertaken to establish blockchain networks. Companies should create blockchain labs, in cooperation with universities to invest in blockchain startups, and set up their own blockchain teams to advance their position in the new blockchain industry. Investing in this technology will enable companies to stay a few steps ahead of the competition. Insufficient investment in information technology is among the most serious problems of companies. In order for companies to increase their competitiveness in the local and international arena, they need to strengthen their knowledge building.

Research shows that many countries, institutions, and organizations adopt a wait-and-see policy to implement blockchain technology and make any moves in this regard. The wait-and-see policy will make it too late to be a part of the blockchain technology, which is developing very quickly.

One of the most important problems in the adoption of technology is the lack of professional workforce. For this purpose, blockchain engineering departments should be established in universities, and courses on blockchain and cryptocurrencies should be included in the curricula of undergraduate and graduate programs. Organizing seminars and courses, providing trainings and raising awareness to increase the level of knowledge on this technology will facilitate the adoption of technology.

In the future, management of technology, employees and culture change will gain importance. Organizations adopting blockchain will need to evolve and manage technology, culture change, and people on blockchain. Knowledge building can ensure knowledge circulation within the company, reduce costs and increase efficiency.

Blockchain technology needs to modernize the curricula of faculties in universities to meet the professional workforce needed by companies. Research focuses only the future uses of blockchain technology and the changes and transformations that will occur in future professions and business life whereas curriculum changes on the applications of blockchain technology are not included. Curricula need to be redesigned. While designing the curricula to prepare newly graduates for the market and ensure their employability, the academia should consider how new technologies will be integrated into existing industry practice. The topics listed in this study try to provide recommendations for future research. These topics, combined with evidence from real application examples of blockchain technologies should be evaluated in future research.

Gönderilme Tarihi: 14 Temmuz 2022/ Kabul Tarihi: 26 Eylül 2022

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